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TRAINING
COURSE

January 2011

Interior Communications Electrician, Volume 1

NAVEDTRA 14120A

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Although the words "he," "him," and "his" are used sparingly in this course to enhance communication, they are not intended to be gender driven or to affront or discriminate against anyone.

PREFACE

By enrolling in this self-study course, you have demonstrated a desire to improve yourself and the Navy. Remember, however, this self-study course is only one part of the total Navy training program. Practical experience, schools, selected reading, and your desire to succeed are also necessary to successfully round out a fully meaningful training program.

THE COURSE: This self-study course is organized into subject matter areas, each containing learning objectives to help you determine what you should learn along with text and illustrations to help you understand the information. The subject matter reflects day-to-day requirements and experiences of personnel in the rating or skill area. It also reflects guidance provided by Enlisted Community Managers (ECMs) and other senior personnel, technical references, instructions, etc., and either the occupational or naval standards, which are listed in the *Manual of Navy Enlisted Manpower Personnel Classifications and Occupational Standards*, NAVPERS 18068.

THE QUESTIONS: The questions that appear in this course are designed to help you understand the material in the text.

VALUE: In completing this course, you will improve your military and professional knowledge. Importantly, it can also help you study for the Navy-wide advancement in rate examination. An additional important feature of this course is its reference to useful information in other publications. The well-prepared Sailor will take the time to look up the additional information.

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Sailor’s Creed

“I am a United States Sailor.

I will support and defend the Constitution of the United States of America and I will obey the orders of those appointed over me.

I represent the fighting spirit of the Navy and those who have gone before me to defend freedom and democracy around the world.

I proudly serve my country’s Navy combat team with honor, courage and commitment.

I am committed to excellence and the fair treatment of all.”

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Course Assignments follow Appendix C

STUDENT FEEDBACK AND QUESTIONS

We value your suggestions, questions, and criticisms on our courses. If you would like to communicate with us regarding this course, we encourage you, if possible, to use e-mail or to post your comments on the Interior Communications Electrician Community of Practice (COP) page located at https://wwwa.nko.navy.mil/portal/home/. If you write or fax, please use a copy of the Student Comment form that follows this page.

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Student Comments

Course Title: *Interior Communications Electrician, Volume 1*

NAVEDTRA: 14120A___________________________________**Date:**_____________

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1 ELECTRICAL AND GENERAL SAFETY PRECAUTIONS

Upon completion of this chapter, you will be able to do the following:

- Describe the basic safety requirements for working with electricity.
- Identify various sources of information regarding safety.
- Identify various warning tags, signs, and plates.
- Explain the purpose for equipment tag-out procedures.
- Describe the safety procedures to follow when working on or with various tools, equipment, and machinery.
- Describe basic first-aid procedures to use on electrical shock victims.
- Describe the Navy's Hearing Conservation and Noise Abatement Programs.
- Describe the Navy's Heat Stress Control Program.

1.0.0 INTRODUCTION

It is Navy policy to provide a safe and healthy work place for all personnel. These conditions can be ensured through an aggressive and comprehensive occupational safety and health program fully endorsed by the Secretary of the Navy and implemented through the appropriate chain of command.

The material discussed in this chapter stresses the importance of electrical and general safety precautions. All electrical equipment is hazardous; therefore, all safety precautions must be strictly observed. The primary goals of an effective safety program are to protect personnel and material and to ensure that unsafe equipment operations do not occur.

As a petty officer, you have the responsibility to recognize unsafe conditions and to take appropriate actions to correct any discrepancies. You must always observe safety precautions when working on equipment or operating machinery. You should also know and be able to perform the proper action when a mishap occurs.

In the interest of making Navy personnel aware of the dangers confronting them in their workplace environment and to outline means for avoiding mishaps, a number of safety precautions that are likely to concern IC Electricians at one time or another are listed in this chapter. You need to exercise caution in these areas. This chapter will further give you some facts so you can teach safety accurately and effectively. Finally, it will give the approved methods of action so you will be able to rehearse your actions and thus be ready in the event of a casualty. Remember: Mishaps seldom just happen; they are caused. Another point to remember is to never let familiarity breed contempt. Hundreds of people have been injured by mishaps and many have died from injuries. Most mishaps could have been prevented had the individuals involved heeded the appropriate safety precautions. Preventing mishaps that are avoidable is one of your highest priorities.

1.1.0 SAFETY RESPONSIBILITIES

All individuals have the responsibility to understand and observe safety standards and regulations that are established for the prevention of injury to themselves and other people and damage to property and equipment. As an individual, you have a responsibility to yourself and to your shipmates to do your part in preventing mishaps. As a petty officer, you have the responsibility of setting a good example; you cannot ignore safety regulations and expect others to follow them. Personnel should always observe the following safety practices:

- Observe all posted operating instructions and safety precautions.
- Report any unsafe condition or any equipment or material deficiency you think might be unsafe.

- Warn others of hazards and the consequences of their failing to observe safety precautions.
- Wear or use approved protective clothing or protective equipment.
- Report any injury or evidence of impaired health that occurs during your work or duty to your supervisor.
- Exercise reasonable caution as appropriate to the situation in the event of an emergency or other unforeseen hazardous condition.
- Inspect equipment and associated attachments for damage before using the equipment. Be sure the equipment is suited for the job.

Safety must always be practiced by people working around electrical circuits and equipment to prevent injury from electrical shock and from short circuits caused by accidentally placing or dropping a conductor of electricity across an energized line. The arc and fire started by these short circuits, even where the voltage is relatively low, may cause extensive damage to equipment and serious injury to personnel.

No work will be done on electrical circuits or equipment without permission from the proper authority and until all safety precautions are taken.

1.2.0 PROMOTING SAFETY

Promoting safety will require you to become safety conscious to the point that you automatically consider safety in every job or operation. Providing safety reminders and setting the example allows you to pass this safety consciousness on to other personnel.

1.3.0 ENFORCING SAFETY

Safety precautions must be enforced. It is your duty to take appropriate action any time you see someone disregarding a safety precaution. You should ensure that all jobs are done according to applicable safety precautions.

Doing a job the safe way in some cases may take a little longer or be a little more inconvenient; however, there is no doubt as to the importance of doing it this way.

1.4.0 SOURCES OF SAFETY INFORMATION

To be an effective petty officer and supervisor, you should become familiar with the types of safety programs implemented throughout the Navy. You should also be familiar with all safety directives and precautions concerning your division. Safety instructions vary from command to command. This makes it impossible to give you a complete listing of manuals and instructions with which you should be familiar. Besides studying the information on safety described in this chapter and throughout this training manual, you should read and have knowledge of the safety information in the following references:

Standard Organization and Regulations of the U. S. Navy, OPNAVINST 3120.32C, chapter 7—Outlines the safety program and the safety organization.

Navy Occupational Safety and Health (NAVOSH) Program Manual for Forces Afloat, OPNAVINST 5100.19E—Provides general shipboard safety precautions and specific occupational health program guidance.

Navy Occupational Safety and Health (NAVOSH) Program Manual, OPNAVINST 5100.23G—Encompasses all safety disciplines, such as systems safety, aviation safety, weapons/explosives safety, off-duty safety (recreation, public, and traffic), and occupational safety and occupational health.

Naval Ships' Technical Manual (NSTM), chapter 074, volume 1—Provides general welding safety precautions.

Personnel are also advised and informed on mishap prevention through the following periodicals:

Sea and Shore Magazine is published bimonthly for the professional benefit of all hands by the Naval Sea Systems Command and the Naval Safety Center. This magazine contains the most accurate information on the design, construction, conversion, operation, maintenance, and repair of naval vessels and their equipment. It also contains articles on safety hazards, mishaps and their prevention.

Ships' Safety Bulletin is published monthly by the Naval Safety Center. This bulletin contains articles on shipboard safety problems, trends, mishap briefs, and statistics.

Flash, a monthly mishap prevention bulletin, provides a summary of research from selected reports of submarine hazards to assist in the prevention program. It is intended to give advance coverage of safety-related information while reducing individual reading time.

These publications, as well as notices and instructions distributed by cognizant bureaus, make excellent reference materials. When these publications are available, you should read them and incorporate them into your training program.

Other sources of safety information that you will be dealing with on a day-to-day basis in your work as an IC Electrician are manufacturers' technical manuals and PMS maintenance requirement cards (MRCs).

These are not all of the safety resources that are available to you. However, these sources give you a good starting point from which you can expand your knowledge of safety procedures. The *Naval Safety Supervisor,* NAVEDTRA 12971, is also a very good resource for strengthening your awareness of safety procedures.

1.5.0 WARNING SIGNS, PLATES, POSTERS, TAGS, LABELS, AND MARKINGS

Warning signs, plates, and suitable guards/markings should be provided to prevent personnel from coming into accidental contact with dangerous voltages; for warning personnel of the possible presence of explosive vapors and radio frequency (RF) radiation; for warning personnel working aloft of poisonous effects of stack gases; and for warning personnel of other dangers that may cause injury to them. Equipment installations should not be considered complete until appropriate warning signs have been posted in full view of operating and maintenance personnel.

1.5.1 Warning Signs

Warning signs (red/white) and caution signs (yellow/black) should be located in an area where known hazardous conditions exist or may exist. Some of the areas that are hazardous are wet, oily, or electrical spaces.

DANGER—High Voltage and **DANGER— Shock Hazard** warning signs are required near the entrance areas of compartments and walk-in enclosures that have equipment with voltages in excess of 30 volts. Signs are to be posted at eye level or above in full and clear view of entering personnel. Signs should also be located on or near equipment that is particularly dangerous or equipment having exposed conductors.

DANGER—Shock Hazard signs are to be used where voltages are between 30 and 500 volts. Where voltages are in excess of 500 volts and where voltages both below and above 500 volts are present, only the danger high voltage warning sign (fig. 1-1) will be used. Appropriate guards should also be installed at these locations.

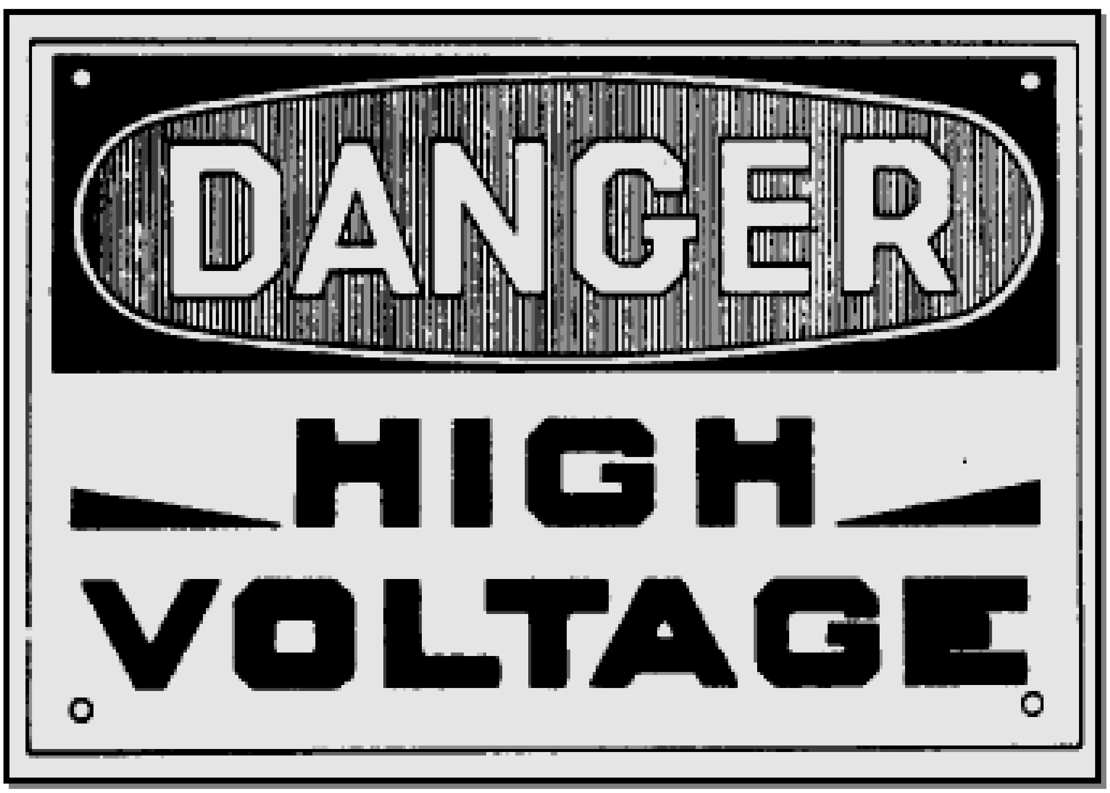


Figure 1-1.-High voltage warning sign.

Warning signs (fig. 1-2) are to be displayed at the bottom and top of all access ladders leading aloft to alert personnel working aloft of the presence of smoke pipe (stack) gases.

Figure 1-2.-Smoke pipe gases warning sign.

1.5.2 Warning Plates
Warning plates (fig. 1-3) for electronic equipment are installed in small craft to warn against the energizing of electronic equipment until ventilation blowers have been operating a minimum of 5 minutes to expel explosive vapors. This warning plate should also be displayed in all spaces where there is a possibility of the accumulation of explosive vapors.

Figure 1-3.-Warning plate for electronic equipment installed in small crafts.

1.5.3 Safety Posters
Safety posters (figs. 1-4, 1-5, and 1-6) are helpful both as safety reminders and in promoting safety. Safety posters should be changed or rotated regularly to different working areas to draw attention to them.

Posters put up and left in one area for months become part of the bulkhead and are ignored, written on, or covered with notices, schedules, or watch bills. The messages of these and other well-designed safety posters are clear and to the point. The left-hand poster of figure 1-6, for example, reminds personnel to think “safety”; the right-hand poster, to act promptly or suffer the consequences. Remember that the messages are aimed at YOU. It is your responsibility to “read and heed,” and to remember your ABCs: Always Be Careful.

Figure 1-4.-Safety posters.

Figure 1-5.-Safety posters—Continued.

Figure 1-6.-Safety posters—Continued.

1.5.4 Tags and Labels

Tags and labels are used in the Navy to identify a defective piece of equipment or instrument. Tags and labels are also used to ensure the safety of personnel and to prevent improper operation of equipment. They will be posted according to authorized procedures and must not be removed or violated without proper authorization and adequate knowledge of the consequences.

The use of tags and labels is not a substitute for other safety measures, such as locking valves or removing fuses from a fuse panel. Also, tags or labels associated with tag-out procedures must never be used for anything other than their intended purpose.

Remember, once a tag or label is used, it should only be removed by signed authorization of the authorizing officer. You should always follow your command's procedures for logging and recording tag-out actions.

1.5.5 Markings

Markings consisting of paint or tape are used to designate safe traffic lanes, operator caution areas, operator working areas, and observer safe areas.

Safe traffic lanes are designated in workshops. These lanes start and stop at all exits and entrances for workshops and are marked by continuous white lines, 3 inches wide, painted on the deck.

Operator caution areas, operator working areas, and observer safe areas are designated for each equipment working area deemed hazardous. Operator caution areas are marked by a continuous yellow line, 3 inches wide outlining the caution area. Operator work areas are marked by painting the deck yellow in areas where it is safe for an operator of machinery or equipment. The outer perimeter of this area is designated by alternate black and yellow lines or checkerboard pattern, 3 inches wide. Observer safe areas are designated as all areas outside of this perimeter and are the normal color of the deck within the space.

Eye hazardous areas are marked with a black and yellow checkerboard, or chevron, pattern and a label plate made up of black letters on a yellow background that reads: "**CAUTION-EYE HAZARD**."

1.6.0 EQUIPMENT TAG-OUT PROCEDURES

As an IC Electrician, you will be either directly or indirectly involved with tagging out equipment on a daily basis. The tag-out may be required to allow you to repair a piece of defective equipment, or it may be just to secure equipment to perform PMS maintenance requirements. A tag-out procedure is necessary in the Navy because of the complexity of modern ships and the cost, delays, and hazards to personnel that could result from improper operation of equipment. Tag-out procedures are mandatory and are governed by *Standard Organization and Regulations of the U.S. Navy*, OPNAVINST 3120.32, article 630.17.

1.6.1 Tags

The purpose of using tags is to prevent the improper operation of a component, piece of equipment, system, or portion of a system when isolated or in an abnormal condition. Equipment that you are intending to repair or perform PMS on must be de-energized and tagged out by use of a DANGER tag.

1.6.1.1 Caution Tag

A CAUTION tag, NAVSHIPS 9890/5 (fig. 1-7), is a yellow tag used as a precautionary measure to provide temporary special instructions or to indicate that unusual caution must be exercised to operate equipment. These instructions must state the specific reason that the tag is installed. Use of phrases such as DO NOT OPERATE WITHOUT EOOW PERMISSION is not appropriate since equipment or systems are not operated unless permission from the responsible supervisor has been obtained. A CAUTION tag cannot be used if personnel or equipment could be endangered while performing evolutions using normal operating procedures. A DANGER tag must be used in this case.

Figure 1-7.—CAUTION tag (colored YELLOW).

1.6.1.2 Danger Tag

The DANGER tag, NAVSHIPS 9890/8 (fig. 1-8), commonly called the red tag, is used to prevent the operation of equipment that could jeopardize the safety of personnel or endanger the equipment systems or components. When equipment is red tagged, under no circumstances will it be operated. When a major system is being repaired or when PMS is being performed by two or more repair groups, both parties will hang their own tags. This prevents one group from operating or testing circuits that could jeopardize the safety of personnel from the other group.

No work shall be done on energized or de-energized switchboards without approval of the commanding officer or in the CO’s absence, the command duty officer. Various PM checks require additional approval from the engineer officer, and the electrical officer.

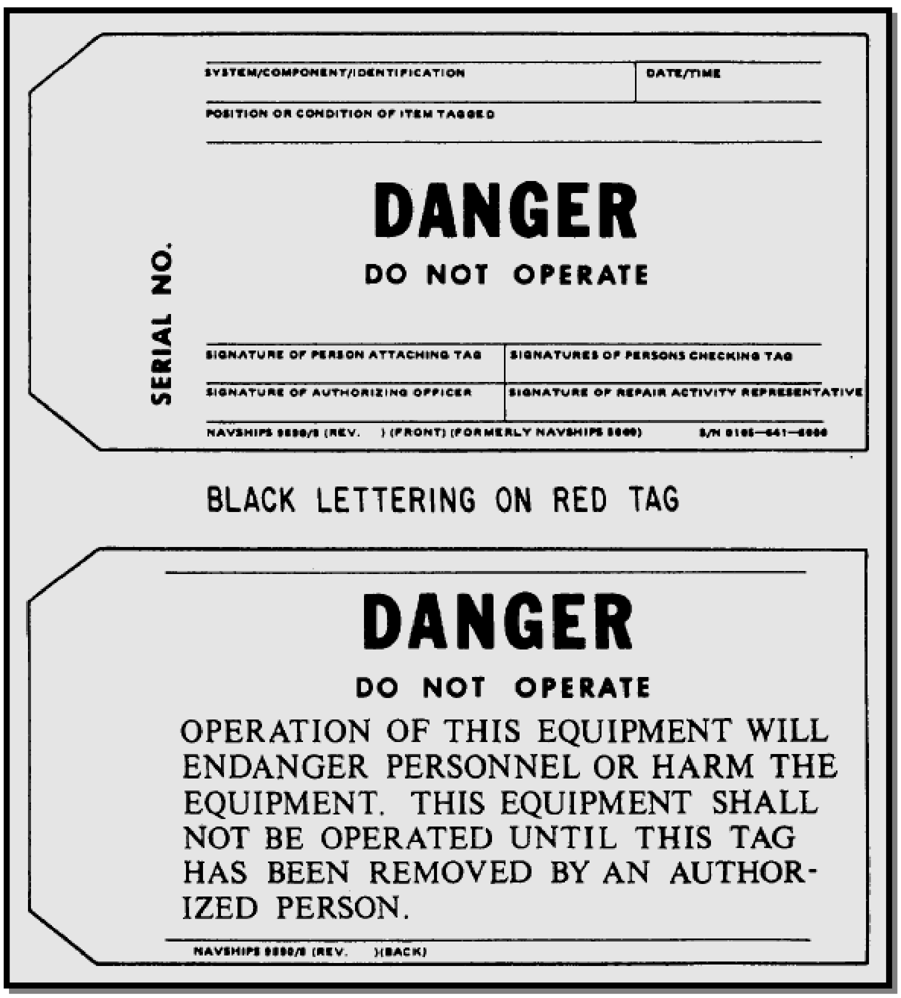


Figure 1-8.-DANGER tag (colored RED).

All supply switches or cutout switches from which power could be fed should be secured in the off or open (safety) position and red tagged. Circuit breakers should have a handle locking device installed as shown in figure 1-9. The proper use of red tags cannot be overstressed. When possible, double red tags should be used, such as tagging open the main power supply breaker and removing and tagging the removal of fuses of the same power supply.

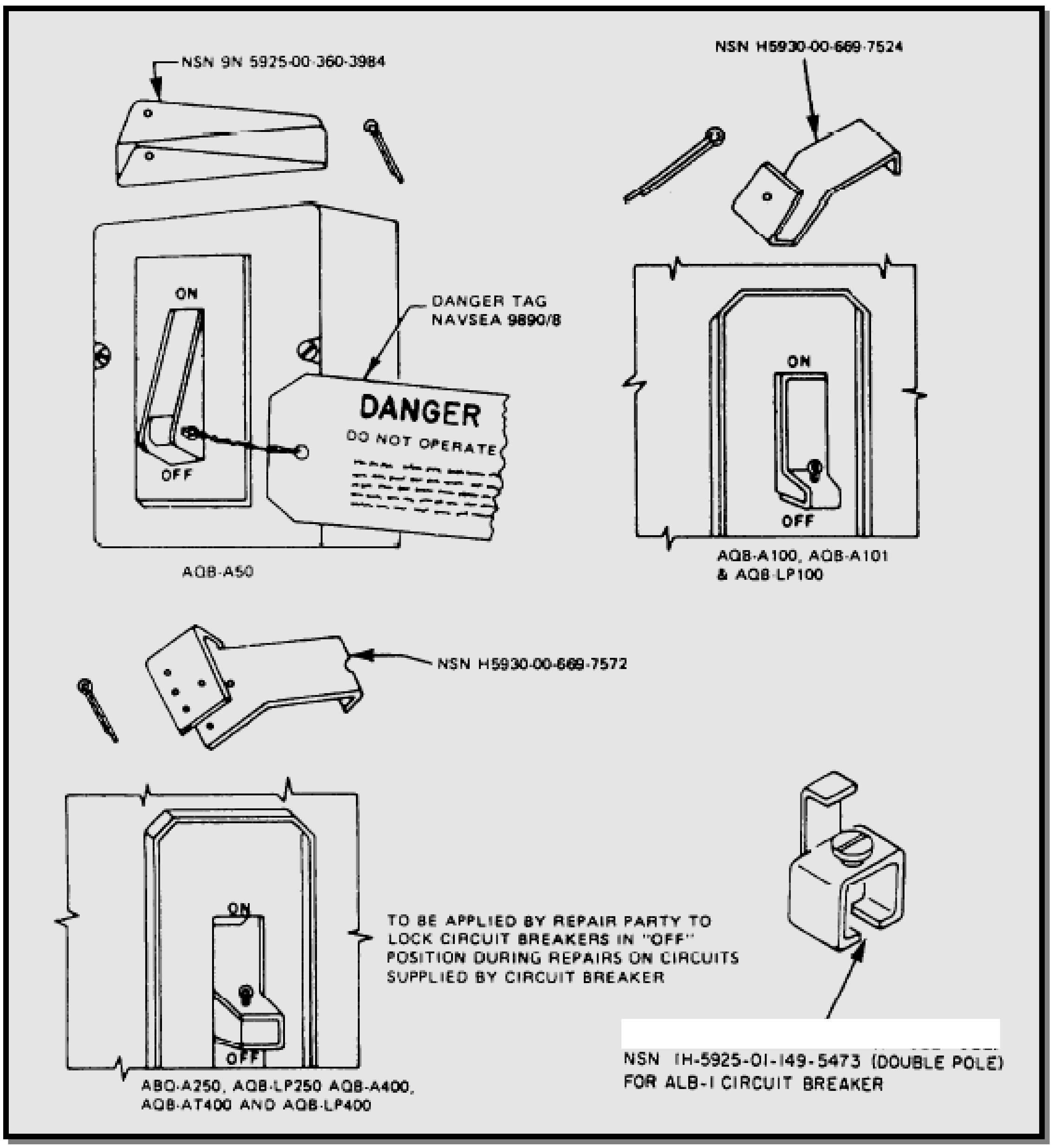


Figure 1-9.-Handle locking devices for circuit breakers.

1.6.2 Labels

Labels are used to warn operating or maintenance personnel that an instrument is unreliable or is not in normal operating condition. There are two types of labels used on instruments, OUT-OF-CALIBRATION and OUT-OF-COMMISSION. The decision as to which label to use is made on a case-by-case basis.

1.6.2.1 Out of Calibration

OUT-OF-CALIBRATION labels (NAVSHIPS 9210/6) are orange labels (fig. 1-10) used to identify instruments that are out of calibration and will not give accurate measurements. In general, if the instrument error is small and consistent, an OUT-OF-CALIBRATION label may be indicates that the instrument may with extreme caution.

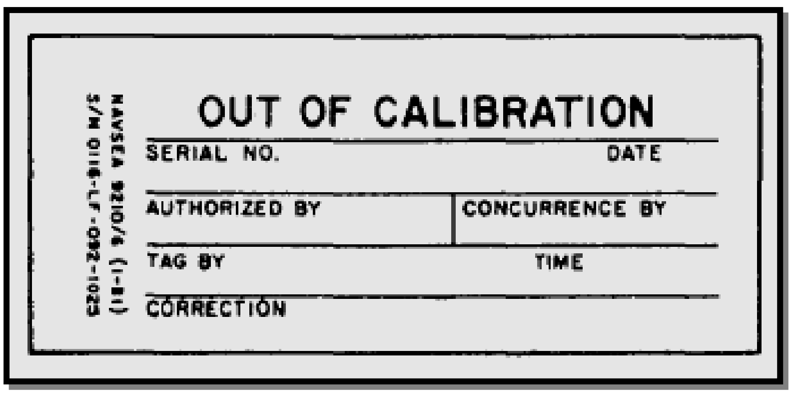


Figure 1-10.-Out-of-calibration label.

1.6.2.2 Out of Commission

OUT-OF-COMMISSION labels (NAVSHIPS 9890/7) are red labels (fig. 1-11) used to identify instruments that will not indicate correct measurements because they are defective or isolated from the system. This label indicates that the instrument cannot be relied on and must be repaired and recalibrated or be reconnected to the system before it can be used properly.

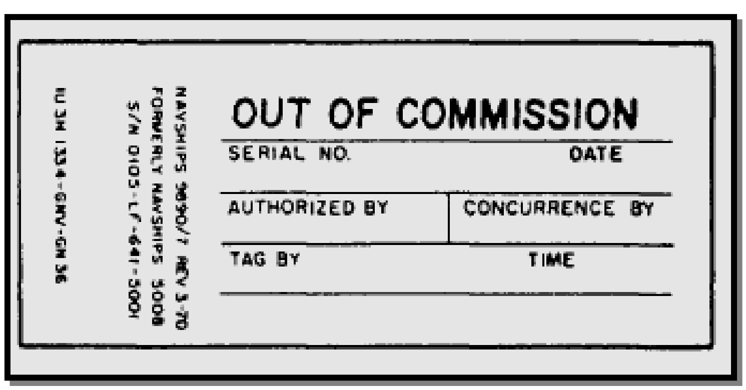


Figure 1-11.-Out-of-commission label.

1.7.0 SAFETY HAZARDS AND PRECAUTIONS

IC Electricians perform maintenance on equipment located throughout the ship. IC Electricians must be aware of the general and specific safety precautions involved in their work. The person who neglects to secure the power to the salinity system (circuit SB) when cleaning cells is as likely to be injured or killed as the one who doesn't properly use a safety harness when going aloft to align the anemometer (circuits HD and HE).

1.8.0 CHECKING FOR ENERGIZED CIRCUITS

Be sure electrical equipment is de-energized before working on it. To check a de-energized circuit, first connect the leads of a test instrument (a voltmeter or a voltage tester) across the power source terminals of a known energized circuit to ensure that the test instrument is working properly. Then connect the leads of the test instrument across the power source terminals of the equipment under test to make sure it is de-energized. Recheck the test instrument on the known energized circuit to ensure that it is still working properly.

When checking to see whether circuits are de-energized, check metering and control circuits, as well as power circuits. In many cases, metering and control circuits are connected to the supply side of a circuit breaker or supplied from a separate source. A check of power circuits on the load side of a circuit breaker may show that they are dead after the circuit breaker is opened, but such a check gives no assurance that associated metering and control circuits are de-energized.

1.9.0 LIVE CIRCUITS

Safe practice in most electrical or electronic maintenance and repair work dictates that all power supplies must be de-energized. However, there are times when de-energizing the circuits is neither desirable nor possible, such as in an emergency (damage control) condition or when de-energizing one or more circuits would seriously affect the operation of vital equipment or jeopardize the safety of personnel.

No work may be done on energized circuits without the approval of the commanding officer. The only exceptions to this policy are in those cases in which approved instructions issued by higher authority permit opening or inspecting equipment in the course of performing preventive maintenance, routine testing, taking measurements, or making adjustments that require equipment to be energized. Testing for voltage with a voltage tester is not to be considered working on live circuits or equipment unless entry into energized panels is required.

When working on live or hot circuits, you must be supervised and aware of the danger involved. The precautions you must take to insulate yourself from ground and to ensure your safety include the following actions (these precautions do not apply to circuits and equipment with less than 30 volts):

- Provide insulating barriers between the work and the live metal parts.
- Provide ample lighting in the immediate area.
- Cover the surrounding grounded metal with a dry insulating material, such as wood, rubber matting, canvas, or phenolic. This material must be dry, free of holes and imbedded metal, and large enough to give you enough work room.
- Coat metallic hand tools with plastisol or cover them with two layers of rubber or vinyl plastic tape, half-lapped. Insulate the tool handle and other exposed parts as practical. Refer to *NSTM*, chapter 631, for instructions on the use of plastisol. If you do not have enough time to apply plastisol or tape, cover the tool handles and their exposed parts with cambric sleeving, synthetic resin flexible tubing, or suitable insulation from scraps of electric cables; however, do this only in an emergency situation.
- Do not wear a wristwatch, rings, other metal objects, or loose clothing that could become caught in live circuits or metal parts.
- Wear dry shoes and clothing, and ALWAYS wear a face shield.
- Tighten the connections of removable test leads on portable meters. When checking live circuits, NEVER allow the adjacent end of an energized test lead to become unplugged from the meter.
- Be sure a person qualified to administer mouth-to-mouth ventilation and cardiac massage for electrical shock is in the immediate area.
- Be sure a person who is knowledgeable of the system is standing by to de-energize the equipment.
- Be sure a non-conducting safety line is tied around the worker’s waist to pull the person free if he/she comes in contact with a live circuit.
- Where work permits, wear rubber gloves on both hands. If this is not possible, work with one hand and wear a rubber glove on the other hand.

1.10.0 LEAKAGE CURRENTS

The electrical distribution systems found on Navy ships are ungrounded. The reason for using an ungrounded system is to achieve maximum system reliability and continuity of electrical power under combat conditions. If one line of the distribution system is grounded, due to battle damage or deterioration of the system insulation resistance, the circuit protective devices (circuit breakers, fuses, and so on) will not de-energize the circuit having the ground, and electrical power will continue to be delivered to vital load equipment without further damage to the system.

Shipboard ungrounded electrical systems are capacitively grounded to the extent that lethal currents can flow through a person's body if a live conductor is touched while in contact with ship's ground. The capacitance that causes this electrical ground leakage current to flow is inherent in the design of equipment and cable, and cannot be eliminated by practical technical means.

Many persons believe it is safe to touch one conductor since no electric current would flow. This is not true. It is NEVER safe to touch one conductor of the ungrounded shipboard system. This is because each conductor and the electrical equipment connected to the system have an effective capacitance to ground, which provides an electric current path between the conductors and the ship's hull. The higher the capacitance, the greater the current flow will be for your fixed body resistance. This situation occurs when one conductor of the ungrounded system is touched while your body is in contact with the ship's hull or other metal enclosures. When your body resistance is low due to wet or sweaty hands, for example, the inherent capacitance is sufficient to cause a FATAL electric current to pass through your body.

A perfect ungrounded system (fig. 1-12, view A) exists when the insulation is perfect on all cables, switchboards, circuit breakers, generators, and load equipment; no filter capacitors are connected between ground and the conductors; and none of the system equipment or cables have any inherent capacitance to ground. If all of these conditions were met, there would be no path for electrical current to flow from any of the system conductors to ground.

As shown in figure 1-12, view A, if a person touches a live conductor while standing on the deck, there would be no completed path for current to flow from the conductor through the person's body, and no electrical shock would occur. However, shipboard electrical power distribution systems DO NOT and CANNOT meet the above definition of a PERFECT ungrounded system.

In a shipboard real ungrounded system (fig. 1-12, view B) additional factors (resistances, R, and capacitances, C) must be considered, some of which are not visible.

The resistances, when combined in parallel, form the insulation resistance of the system, which is periodically measured with a 500-volt dc Megger. In figure 1-12, view B, there is a generator insulation resistance, an electric cable insulation resistance, and a load insulation resistance. The resistors cannot be seen as physical components, but are representative of small current paths through equipment and cable electrical insulation. The higher the resistance, the better the system is insulated; therefore, less current will flow between the conductor and ground.

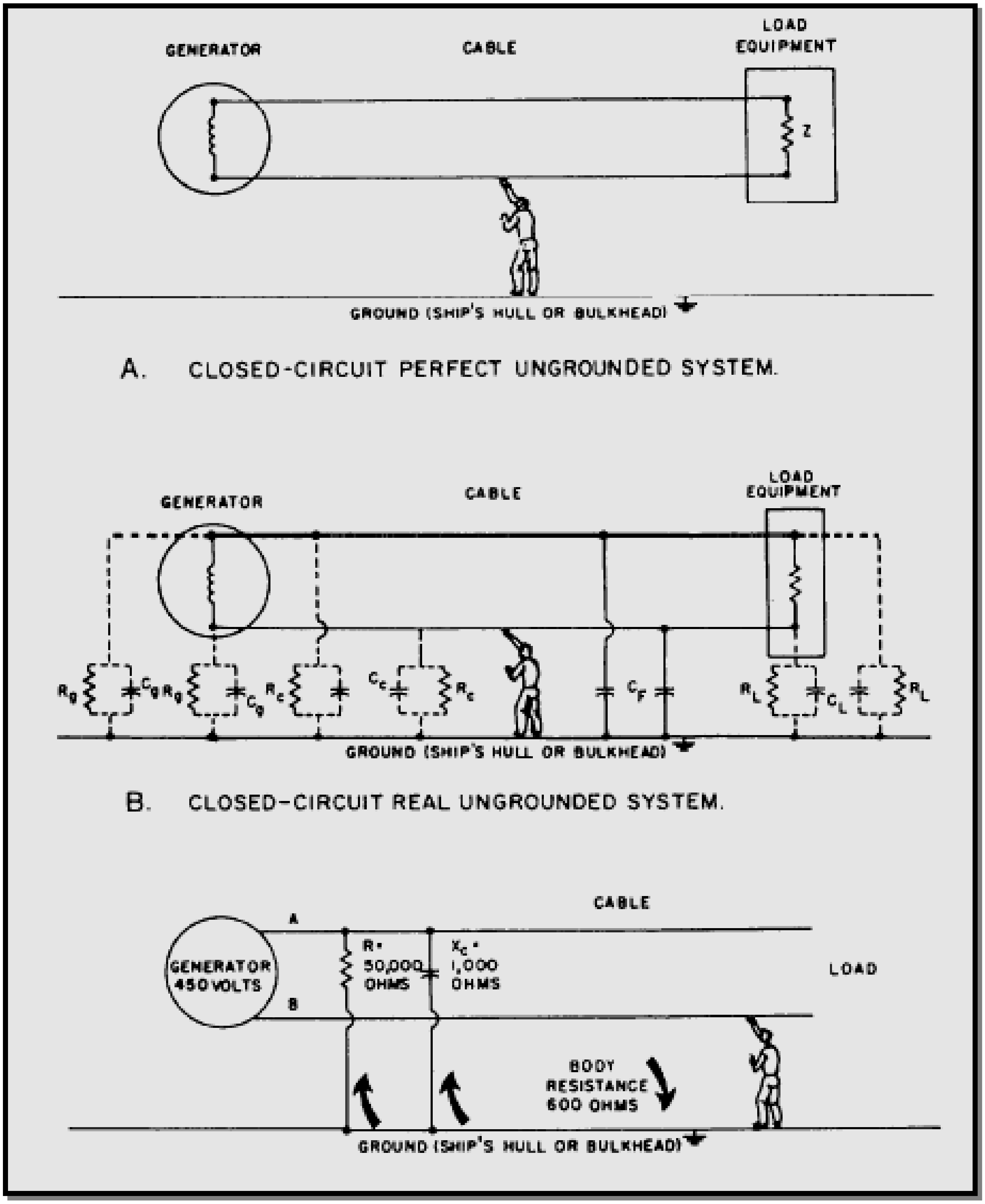


Figure 1-12.—DANGEROUS! BEWARE! Shipboard ungrounded electrical distribution systems are DEADLY.

Representative values of a large operating system can vary widely, depending on the size of the ship and the number of electrical circuits connected together.

Figure 1-12, view B, also shows the capacitance of the generator to ground, the capacitance of the distribution cable to ground, and the capacitance of the load equipment to ground. As stated before, these capacitances cannot be seen, since they are not actually physical components, but are inherent in the design of electrical equipment and cable.

The value of the capacitance generated between the conductor and ground is determined by the radius of the conductor, the distance between the conductor and the bulkhead, the dielectric constant of the material between the two, and the length of the cable.

Similar capacitance exists between the generator winding and ground and between various load equipment and ground. Since capacitors ideally have infinite impedance to direct current, their presence cannot be detected by a Megger or insulation resistance test. In addition to the non-visible system capacitance, typical shipboard electrical systems contain radio frequency interference (RFI) filters that contain capacitors connected from the conductors to ground. These filters may be a part of the load equipment, or they maybe mounted separately. Filters are used to reduce interference to communications equipment.

If physical contact is made between cable B and ground (fig. 1-12, view C), current will flow from the generator through the person’s body to ground and back through the system resistances and capacitances to cable A, thus completing the electrical circuit back to the generator. This presents a serious shock hazard. Suppose you check the system of figure 1-12, view C, for grounds with a Megger and get a reading of 50,000 ohms resistance. You can conclude that no low resistance grounds exist. Don’t assume that the system is a perfect ungrounded system without checking the circuit further. Do not forget the system capacitance that exists in parallel with the resistance.

It should be clear to you why you should NEVER touch a live conductor of an electrical system, grounded or ungrounded. Insulation resistance tests are made to ensure the system will operate properly, not to make the system safe. High insulation readings in a Megger test do not make the system safe—nothing does.

1.11.0 ISOLATED RECEPTACLE CIRCUITS

Isolated receptacle circuits are installed on all new construction ships. These receptacle circuits help reduce the inherent hazard of leakage currents where portable tools and appliances are plugged in and out, which is when personnel are more likely to get an electrical shock. These circuits are individually isolated from the main power distribution system by isolation transformers. Each circuit is limited to 1500 feet in length to reduce the capacitance to an acceptable level. This design is intended to limit ground leakage currents to 10 milliamperes, which would produce a nonlethal shock. To maintain a safe level of leakage currents, the isolated receptacle circuits must be free of all resistance grounds.

1.12.0 SHOCK-MOUNTED EQUIPMENT

Normally, on steel-hulled vessels, grounds are provided because the metal cases or frames of the equipment are in contact with one another and the vessel's hull. In some installations, grounds are not provided by the mounting arrangements, such as insulated shock mounts. In this case, a suitable ground connection must be provided.

CAUTION:
Before disconnecting a ground strap on equipment supported by shock mounts, be sure the equipment is de-energized and a danger/red tag is installed.

When the grounding strap is broken and the equipment cannot be de-energized, use a voltmeter from the equipment to ground to ensure that no voltage is present.

Maintenance of grounding cables or straps consists of the following preventive procedures:

- Clean all strap-and-clamp connectors periodically to ensure that all direct metal-to-metal contacts are free from foreign matter.

- Replace any faulty, rusted, or otherwise unfit grounding straps, clamps, connections, or components between the equipment and the ship's hull.

- When replacing a grounding strap, clean the metallic contact surfaces and establish electrical continuity between the equipment and the ship's hull. Check continuity with an ohmmeter (the reading must be according to PMS).

- Recheck to be sure the connection is securely fastened with the correct mounting hardware.

- If a voltage is present, and the equipment cannot be de-energized, wear electrical rubber gloves and use a rubber mat while replacing the grounding strap.

1.13.0 SWITCHBOARDS, SWITCHGEARS, AND ENCLOSED EQUIPMENT

Switchboards and precautions, operating switchgears must have safety instructions, wiring diagrams, and artificial ventilation instructions posted in their vicinity.

Switchboards, switchgears, and their access doors must also have DANGER HIGH VOLTAGE signs posted.

When removing or installing switchboard and control panel meters and instrument transformers, you must be extremely careful to avoid electrical shock to yourself and damage to the transformers and meters.

The secondary of a current transformer MUST be short-circuited before you disconnect the meter. An extremely high voltage buildup could be fatal to unwary maintenance personnel and it could damage the current transformer.

The primary of a potential transformer must be opened before you remove the meter to prevent damage to the primary circuit due to high circulating currents.

In most installations, potential transformer primaries are fused, and the transformer and associated meter cart be removed after you pull the fuses for the transformer concerned.

When disconnecting the transformer and meter leads, you should avoid contact with nearby energized leads and terminals.

1.14.0 INTERLOCKS

Most modern electronic equipment is provided with various built-in safety devices, such as interlock switches, to prevent technical and maintenance personnel from coming into contact with electrical potentials in excess of 30 volts rms or dc. However, some of these protective devices are removed or destroyed by personnel who tamper with, block open, or otherwise “override” them. The foregoing practices must NOT be performed unless authorized by the commanding officer for operational reasons. Then the equipment must be properly tagged to notify personnel of this condition.

Interlocks and other safety devices must NOT be altered or disconnected, except for replacement, and must NOT be modified without specific authority from the cognizant systems command. Periodic tests and inspections must be made to ensure the devices are functioning properly.

1.15.0 SAFETY SHORTING PROBE

Before you start working on de-energized circuits that have capacitors installed, you must discharge them with a safety shorting probe. When using a safety shorting probe, first connect the test clip to a good ground to make contact. If necessary, scrape the paint off the metal surface. Then, hold the safety shorting probe by the handle and touch the probe end of the shorting rod to the points to be shorted. The probe end can be hooked over the part or terminal to provide for a constant connection to ground. Never touch any metal parts of the shorting probe while grounding circuits or components. It pays to be safe—use the safety shorting probe with care.

NOTE:

Capacitors not electrically connected to the chassis ground must have their terminals shorted together to discharge then by the use of a shorting probe.

1.16.0 RUBBER GLOVES

There are four classes of rubber insulating gloves—class 0, class I, class II, and class III. The primary feature of each class is the wall thickness of the gloves and the maximum safe voltage. These features are identified by a color label on the glove sleeve. Only use rubber insulating gloves that are marked with a color label. Table 1-1 contains the maximum safe use voltage and label colors for insulating gloves approved for Navy use.

Before using rubber gloves, you should carefully inspect them for damage or deterioration. To inspect rubber gloves for tears, snags, punctures, or leaks that are not obvious, hold the glove downward, grasp the glove cuff, and flip the glove upward to trap air inside it. Roll or fold the cuff to seal the trapped air inside. Then, squeeze the inflated glove and inspect it for damage. For additional information on rubber gloves, refer to *NSTM*, chapter 300.

CLASS	MAXIMUM SAFETY VOLTAGE	LABEL COLOR
0	1,000 Volts	Red
I	7,500 Volts	White
II	17,000 Volts	Yellow
III	26,500 Volts	Green

Table 1-1.—Rubber Gloves

1.17.0 RUBBER FLOOR MATTING

You must use approved rubber floor matting in electrical and electronic spaces to eliminate electrical mishaps and afford maximum protection from electrical shock. Mishap investigations often show that the floors around electrical and electronic equipment had been covered with only general purpose black rubber matting. The electrical characteristics of this type of matting do not provide adequate insulation to protect against electrical shock. There are various types of electrical grade mats or sheet coverings that conform to the requirements set forth in Military Specification (MILSPEC) MIL-M-15562.

To ensure the matting is completely safe, you must promptly remove from the matting surfaces all foreign substances that could contaminate or impair its dielectric properties. The dielectric properties of matting can be impaired or destroyed by oil, imbedded metal chips, cracks, holes, or other defects.

If the matting is defective for any reason, cover the affected area with a new piece of matting. Cementing the matting to the deck is not required, but is strongly recommended. This prevents removal of the mat for inspection and cleaning, which would leave the area unprotected. If the mat is not cemented, stencil an outline of the proposed mat on the deck. Inside the mat outline, stencil “ELECTRIC-GRADE MAT REQUIRED WITHIN MARKED LINES.” Use 3/4 inch or larger letters.

Electrical insulating deck covering should be installed so there are no seams within 3 feet of an electrical hazard. Where this is not possible, thermoplastic deck coverings, such as vinyl sheet manufactured by Lonseal, Inc., should be fused chemically, heat welded, or heat fused with a special hot air gun. With rubber deck coverings, fusing with heat is not possible. A 3- or 4-inch wide strip of #51 Scotchrap 20-mil-thick polyvinyl chloride (PVC) tape (manufactured by Minnesota Mining and Manufacturing Company) should be installed beneath the seam. You may also use a 1-foot wide strip of electrical grade deck covering under rubber- or vinyl-type coverings instead of heat welding vinyl.

1.18.0 PORTABLE ELECTRIC-POWERED TOOLS

Safety is a very important factor in the use of portable power tools and cannot be overemphasized. The hazards associated with the use of portable power tools are electric shock, cuts, flying particles, explosions, and so on.

You should ensure portable electric-powered tools are clean, properly oiled, and in good operating condition.

Before you use any portable electrical equipment, you should visually examine the attached cable with plug (including extension cords, when used) to ensure it is in satisfactory condition. Replace promptly any cable that has tears, chafing, or exposed conductors, and any damaged plug. Use an approved tool tester or multimeter to test portable electrical equipment with its associated extension cord connected. When using the multimeter to check continuity of the ground conductor from the tool case to the dummy receptacle, be sure the meter reading is less than 1 ohm. With the multimeter still connected between the tool case and ground, bend or flex the cable to see if the meter resistance remains 1 ohm or less. If the resistance varies, you might have broken conductors in the cord or loose connections.

Other safe practices in the use of portable electric-powered tools include the following:

- Before you use a tool, inspect the tool cord and plug. Do not use the tool if the cord is frayed or its plug is damaged or broken. Never use spliced cables, except in an emergency.
- Before you use a tool, arrange the portable cables so you and others will not trip over them. The length of extension cords used with portable tools should not exceed 25 feet. Extension cords of 100 feet are authorized on flight and hangar decks. Extension cords of 100 feet are also found in damage control lockers, but are labeled FOR EMERGENCY USE ONLY.
- Do not use jury-rigged extension cords that have metal handy boxes on the receptacle ends of the cord. All extension cords must have nonconductive plugs and receptacle housings.
- When an extension cord is used with a portable electric tool, ALWAYS plug the tool into the extension cord before you insert the extension cord plug into a live receptacle.
- After using the tool, first unplug the extension cord from the live receptacle before you unplug the tool cord from the extension cord. Do not unplug the cords by yanking on them. ALWAYS remove the plug by grasping the plug body.
- When you use portable electric tools, always wear rubber gloves and eye protection.

- When defects are noted, return the tool to the ship's tool issue room (TIR).
- When tools produce hazardous noise levels, be sure personnel are wearing hearing protection.
- Never operate any portable power tools unless you are completely familiar with their controls and features.
- Make sure there is plenty of light in the work area. Never work with power tools in dark areas where you cannot see clearly.
- Before connecting power tools to a power source, be sure the tool switch is in the OFF position.
- When operating a power tool, give it your full and undivided attention.
- Do not distract or in any way disturb another person while they are operating a power tool.
- Never try to clear a jammed power tool until it is disconnected from the power source.
- After using a power tool, turn off the power, disconnect the power source, wait for all movement of the tool to stop, and then remove all waste and scraps from the work area. Store the tool in its proper place.
- Never plug the power cord of a portable electric tool into a power source before making sure that the source has the correct voltage and type of current called for on the nameplate of the tool.
- Do not allow power cords to come in contact with sharp objects (including watertight door knife edges), nor should they kink or come in contact with oil, grease, hot surfaces, or chemicals.
- Never use a damaged cord. Replace it immediately.
- Check electrical cables and cords frequently for overheating. Use only approved extension cords, if needed.
- See that all cables and cords are positioned carefully so they do not become tripping hazards.

- Treat electricity with respect. If water is present in the area of electrical tool operation, be extremely cautious and, if necessary, disconnect the power tool.

It is further suggested that, at the discretion of the commanding officer, a list be established of portable equipment requiring testing more or less often than once a month, depending on conditions in the ship. Where PMS is installed, tests should be conducted following the MRCs.

1.19.0 ELECTRIC SOLDERING IRONS

When using and handling an electric soldering iron, you can avoid burns or electrical shock by taking the following precautions:

- Grasp and hold the iron by its handle. Always assume a soldering iron is hot, whether it is plugged in or not. NEVER use an iron that has a frayed cord or damaged plug, or is missing a safety inspection tag.
- Hold small soldering workplaces with pliers or a suitable clamping device. NEVER hold the work in your hand.
- Always place the heated iron in its stand or on a metal surface to prevent fires or equipment damage.
- Clean the iron by wiping it across a piece of canvas placed on a suitable surface. DO NOT hold the cloth in your hand. DO NOT swing the iron to remove excess hot solder, as it could cause a fire in combustible materials or burn other personnel in the area.
- Before soldering electrical or electronic equipment, be sure it is disconnected from its power supply.
- After soldering, disconnect the iron from its power supply and let it cool before you store it.

1.20.0 TEST EQUIPMENT

Test equipment is precision equipment that must be handled with care if it is to perform its designed functions accurately.

Some hazards to avoid when using test equipment include rough handling, moisture, and dust. Bumping or dropping a test instrument may distort the calibration of the meter or short-circuit the elements of an electron tube within the instrument.

Moisture effects are minimized in some types of electronic test equipment, such as signal generators and oscilloscopes, by built-in heaters. These heaters should be operated for several minutes before high-voltage is applied to the equipment.

Meters are the most delicate parts of test equipment. You should protect a meter by ensuring that the amplitude of the input signal being tested is within the range of the meter.

Since the moving coils of the meter in electronic test equipment are of the limited-current type, they can be permanently damaged by excessive current. To avoid such an occurrence, you should observe the following safety precautions and procedures when using test equipment:

- Never place a meter near a strong magnetic field.
- Whenever possible, make the connections when the circuit is de-energized.
- When connecting an ammeter or the current coil of a wattmeter or other current-measuring device, always connect the coils in series with the load—NEVER ACROSS THE LINE.
- When voltmeters are used, they should always be connected in parallel with the line.
- Extend wires attached to an instrument over the back of the workbench or worktable on which the instrument is placed and away from observers—never over the front of the workbench.
- Place a mat or folded cloth under the test instrument when it is used in high-vibration areas.
- Remember that interlocks are not always provided and that they do not always work.
- Removal of the case or rear cover of an instrument not equipped with an interlock will allow access to circuits carrying voltages dangerous to human life.
- Do not change tubes or make adjustments inside equipment with the high-voltage supply energized.

- Under certain conditions, dangerous potentials may exist in circuits. With the power controls in the OFF position, capacitors can still retain their charge. Therefore, to avoid electrical shock, always de-energize the circuit, discharge the capacitors, and ground the circuit before working on it.

- Only authorized maintenance personnel with proper approval should be permitted to gain access to enclosures, connect test equipment, or test energized circuits or equipment.

- Circuits should be de-energized and checked for continuity or resistance, rather than energized and checked for voltage at various points.

- When a circuit or a piece of equipment is energized, NEVER service, adjust, or work on it without the assistance of another person.

1.21.0 HAND TOOLS

As an IC Electrician, you will be working with various hand tools on a daily basis. For your safety, you should take certain precautions when working with hand tools.

Keep your tools in good condition, and never use damaged tools. Tools having plastic or wooden handles that are cracked, chipped, splintered, or broken may result in injuries to personnel from cuts, bruises, particles striking the eye, and the like.

Use each tool only for the job for which it was designed. Be careful to avoid placing tools where they could fall into mechanical or electrical equipment.

Metallic tools used for working on electrical or electronic equipment must be covered with an electrical insulating material. The tools must be coated with plastisol or covered with tape, if tape is used, two layers of rubber or vinyl plastic tape, half-lapped, is required. Cover the handle and as much of the shaft of the tool as practical.

For more information on hand tools refer to *Tools and their Uses,* NAVEDTRA 14256.

1.22.0 BATTERIES

Lead-acid storage batteries are used as an emergency power source for IC systems, such as gyrocompasses and automatic telephone exchanges. Alkaline storage batteries are used in bus failure alarms and dry-cell batteries are used in various pieces of test equipment.

You must be careful when you use and maintain batteries, because of the electrical and chemical hazards involved. Chemic al hazards include both the possibility of explosion and handling of hazardous chemicals. As an IC Electrician, you will care for and maintain these batteries. *NSTM,* chapter 313, gives extensive coverage of battery care, tests, and safety precautions.

1.22.1 Lead-Acid Storage Batteries

Lead-acid storage batteries are rechargeable and, when cared for properly, will last for 4 or more years, depending upon type and use. When a lead-acid storage battery is not fit for further use, it must be surveyed and disposed of according to *NSTM,* chapter 593. The safety precautions for lead-acid storage batteries are as follows:

- Keep flames and sparks of all kinds away from the vicinity of storage batteries. A battery on charge always gives off a certain amount of hydrogen gas, which is extremely explosive.
- Be sure battery compartments that have been sealed are well ventilated before entering the compartment, turning on any lights, making or breaking any electrical connections, or doing any work in the compartment.
- You must ensure that the battery compartment ventilation system is operating properly before starting to charge batteries.
- Stop the charge if ventilation is interrupted, except in an emergency, and do not resume the charge until ventilation has been restored.
- Charge a battery at the rate given on its nameplate. Never charge a battery at a higher finishing rate than that given on its nameplate.
- When charging more than one battery at a time, make sure that the voltage of the charging line exceeds the total voltage of the batteries being charged and that the charging rate, in amperes, does not exceed the maximum charging rate of the battery having the lowest ampere-hour capacity in the line.
- Lower the charging rate as soon as the battery begins to gas or the temperature of the battery reaches 125°F (52°C). If the battery is not allowed to cool off, it will be permanently damaged.
- Keep the temperature of the battery compartment below 96°F (36°C).

- Make no repairs to battery connections when current is flowing. Never connect or disconnect batteries on the charging line without first turning off the charging current; death or severe injury could result.
- When using tools around a battery, be careful not to short-circuit the battery terminals.
- Always pour acid slowly into water, and never water into acid. Guard skin and eyes against splashes of acid. Wear a rubber apron, rubber boots, rubber gloves, chemical splash-proof goggles, and a full-face shield.
- Exercise proper care when handling acid.
- Do not add acid of greater specific gravity than 1.350 to a battery.
- Do not store sulphuric acid in places where freezing temperatures are possible.
- Keep the electrolyte level above the tops of separators.
- Add only pure distilled water to a battery.
- Do not, except in an emergency, discharge the battery below the given low-voltage limit.
- Never allow a battery to stand in a completely discharged condition for more than 24 hours.
- Do not operate the battery above 125°F (52°C).
- Avoid all sparks when removing or replacing batteries located in compartments that may contain gasoline vapors. Only tools with insulated handles should be used. Where batteries are used with one terminal grounded, the grounded terminal of the battery should be disconnected first when removing the battery and connected last when replacing the battery.
- Never allow salt water to enter a battery cell, as chlorine gas, which is extremely toxic, will be generated. Also, salt water should never be used to wash out battery cases and jars.
- Make sure all terminal connections are tight to prevent sparks due to loose connections.

NSTM, chapter 313, also states that you should wear fire-retardant engineering coveralls to provide flash and fire protection when working with and around fire and explosive hazards created by batteries.

1.22.2 Alkaline Storage Batteries

Alkaline storage batteries are also rechargeable. They use potassium hydroxide for the electrolyte as opposed to sulfuric acid used in lead-acid storage batteries. Defective or unserviceable alkaline storage batteries should not be thrown overboard, as they are considered to be potential pollutants. Disposal methods are contained in OPNAVINST 5100.19B, chapter B3, and *NSTM,* chapter 593. Use the same safety precautions for alkaline storage batteries that you do for lead-acid storage batteries.

1.22.3 Dry-Cell Batteries

Dry-cell batteries cannot be recharged after they are discharged. When these batteries are no longer usable, you simply replace them with new batteries. Do not throw the old batteries overboard, as they are also considered a potential pollutant. Disposal of dry-cell batteries should also be according to OPNAVINST 5100.19E, chapter B3, and *NSTM,* chapter 593. The safety precautions for dry-cell batteries are as follows:

- Dry-cell batteries should not be shipped or stored in the equipment with which they are to be used. They may become discharged, generating water in the cells, and the electrolyte may leak out and damage the equipment.
- When equipment operated by dry-cell batteries is to remain idle for more than 2 weeks, the batteries should be removed and then either scrapped or stored.
- When the batteries in a piece of equipment are no longer capable of operating it, they should be removed immediately to avoid damage to the equipment from electrolyte leakage.
- Never short-circuit the connections of a dry cell battery as some types of dry-cell batteries will explode when shorted out.

1.23.0 CATHODE-RAY TUBES

Cathode-ray tubes (CRTs) should always be handled with extreme caution. The glass encloses a high vacuum and, because of its large surface area, it is subject to considerable force caused by atmospheric pressure. The total force on the surface of a 10-inch CRT may exceed 4,000 pounds, with over 1,000 pounds exerted on its face alone.

The chemical phosphor coating of the CRT internal face is extremely toxic. When disposing of a broken tube, be careful not to come in contact with this compound. Certain hazardous materials may be released if the glass envelope of a CRT is broken. If contact is made, seek medical aid immediately. When handling a CRT, you should take the following precautions:

1. Avoid scratching or striking the surface of a CRT, particularly the rim.

2. Do not use excessive force when removing or replacing a CRT in its deflection yoke or its socket.

3. Do not try to remove an electromagnetic type of CRT from its yoke until the high voltage has been discharged from its anode connector (hole).

4. Never hold a CRT by its neck.

5. Always set a CRT with its face down on a thick piece of felt, rubber, or smooth cloth.

6. Always handle a CRT gently. Rough handling or a sharp blow on the service bench can displace the electrodes within the tube, causing faulty operation.

7. Safety glasses or goggles and protective gloves should always be worn when you are handling a CRT.

One additional procedure you should be aware of is the proper method of disposal of a CRT. When a CRT is replaced, the old CRT cannot be simply thrown over the side of the ship or placed in the nearest dumpster. When thrown over the side of a ship, a CRT will float; if it washes ashore, it is dangerous to persons who may come in contact with it. A CRT thrown in a dumpster represents a hidden booby trap.

- Therefore, always render the CRT harmless before disposing of it. Use the following simple procedure to render the CRT harmless:

- Place the CRT that is to be discarded face down in an empty carton and cover its side and back with protective material.

- Carefully break off the plastic locating pin from the base (fig. 1-13). This can be done by crushing the locating pin with a pair of pliers.

- Carefully break off the tip of the glass vacuum seal. This can be done with a small screwdriver or probe.

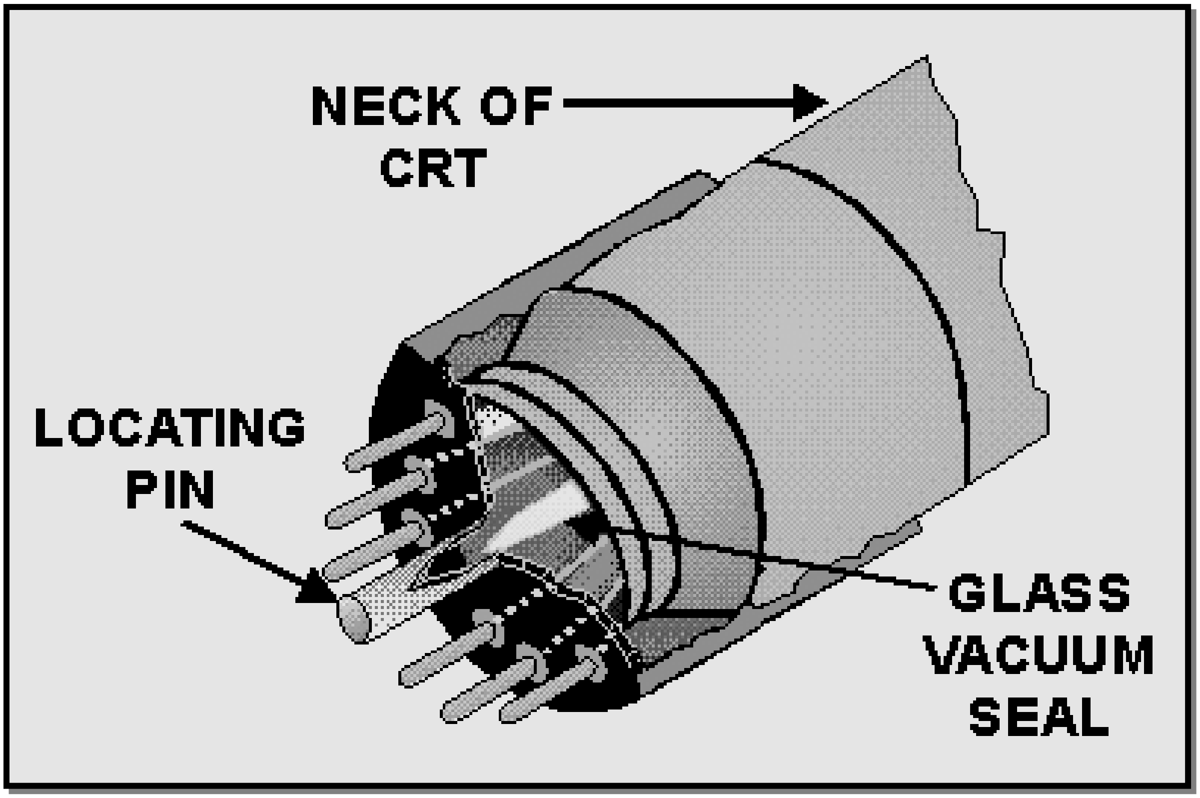


Figure 1-13.—Cathode-ray tube base structure.

1.24.0 AEROSOL DISPENSERS

By deviating or ignoring procedures prescribed for selecting, applying, storing, or disposing of aerosol dispensers, personnel have been poisoned, burned, or have suffered other physical injury. It is difficult to compile a list of specific precautions and safe practices for handling aerosol dispensers due to the variety of industrial sprays that are available in this kind of container. However, users of aerosol dispensers can guard against poisoning, fire, explosion, pressure, and other hazards by regarding all aerosols as flammable. You can prevent an injury or hazard by following basic rules:

Poisoning—Adequately ventilate closed spaces where poisonous (toxic) substances are sprayed. Use exhaust fans or portable blowers to supply these spaces with fresh outside air. Where ventilation is inadequate, do not spray unless you wear an air respirator or a self-contained breathing apparatus.

Burns—Avoid spraying your hands, arms, face, or other exposed parts of the body. Some liquid sprays are strong enough to burn the skin, while milder sprays may cause rashes.

Fire—Keep aerosol dispensers away from direct sunlight, heaters, and other sources of heat. Do not store dispensers in an area where the temperature can exceed the limit printed on the container. Do not spray volatile substances on warm or energized equipment.

Explosion—Do not puncture an aerosol dispenser, Discard used dispensers in approved waste receptacles that will not be emptied into an incinerator.

1.25.0 CLEANING SOLVENTS

Exposure to chemical/solvent hazards may cause significant health problems. Solvents are capable of damaging your respiratory system in cases of prolonged inhalation.

Chemicals and solvents come in the form of gas, vapor, mist, dust, or fumes. Materials ordinarily thought to be safe may be rendered hazardous under certain use conditions by the uninformed user.

Cleaning electrical and electronic equipment with water-based and nonvolatile solvents is an approved practice. These solvents do not vaporize readily.

NEVER clean with VOLATILE substances, such as gasoline, benzene, alcohol, or ether. Besides being fire hazards, they readily give off vapors that can injure the human respirator system if they are inhaled directly for a long time.

When using cleaning solvents in a non-ventilated compartment, always supply air into the compartment, using a blower with a canvas wind chute (elephant trunk). Open all usable portholes, and place wind scoops in them. Keep a fire extinguisher (COJ close by, and NEVER WORK ALONE in a poorly ventilated compartment.

You should avoid coming in contact with cleaning solvents. Always wear gloves and chemical splash-proof goggles, especially when you spray equipment. When spraying, hold the nozzle close to the equipment. DO NOT spray cleaning solvents on electrical windings or insulation.

Do not breathe directly over the vapor of any cleaning solvent for prolonged periods. Do not apply solvents to warm or hot equipment; this increases the toxicity hazard. Following is a list of other safety precautions that you should observe when using and handling chemicals/solvents:

- Review the Material Safety Data Sheet (MSDS) for any chemical before using or handling it.
- Do not work alone in a poorly ventilated space.
- Never use a halocarbon-based solvent, such as Freon, in the presence of any open flame.
- Place a fire extinguisher close by, ready for use.
- Dispose of solvent-soaked rags in a container designed for flammable disposal.
- Do not allow eating, drinking, smoking, open flames, or lights in the area where solvents are being used. Any chemicals or solvents should be handled with caution.

1.26.0 PAINTS AND VARNISHES

You must take special precautions when removing paint or repainting electrical equipment. In general, paint should not be removed from electrical equipment. Scraping or chipping tools may harm the insulation or damage relatively delicate parts. Paint dust, composed of abrasive and semiconducting materials, may also impair the insulation. Therefore, if paint is to be scraped, all electrical equipment, such as generators, switchboards, motors, and controllers, should be covered to prevent the entrance of the paint dust. After the paint is removed, the electrical equipment should be thoroughly cleaned, preferably with a vacuum cleaner. Sanding and grinding should not be the method of removal due to the potential of generating high levels of lead dust.

Electrical equipment should be repainted only when necessary to ward off corrosion. Painting should be confined only to the affected areas. General repainting of electrical equipment or enclosures for electrical equipment for the sole purpose of improving their appearance is not desirable. Insulating surfaces in electrical equipment should never be painted. NEVER PAINT OVER IDENTIFICATION PLATES.

Apply electrical insulating varnish to equipment only as necessary. Frequent applications of insulating varnish build up a heavy coating that may interfere with heat dissipation and develop surface cracks. Do not apply insulating varnish to dirty or moist insulation; the varnish will seal in the dirt and moisture and make future cleaning impossible.

Shellac and lacquer are forms of varnish, but MUST NOT be used for insulating purposes. The two types of insulating varnishes commonly used in the Navy are clear baking varnish (grade CB) and clear air-drying varnish (grade CA). Grade CB is the preferred grade; however, if it is not possible to bake the part to be insulated, grade CA may be used.

1.27.0 STEEL WOOL AND EMERY CLOTH/PAPER

Steel wool and emery cloth/paper are harmful to the normal operation of electrical and electronic equipment. The *NSTM CH. 300* and other technical publications warn you against the use of steel wool and emery cloth/paper on or near equipment. When these items are used, they shed metal particles. These particles are scattered by ventilation currents and attracted by the magnetic devices in electrical equipment. This could cause short circuits, grounds, and excessive equipment wear. Therefore, emery cloth/paper and steel wool should NEVER be used for cleaning contacts. Clean the contacts with silver polish, sandpaper, or burnishing tools. After cleaning, use a vacuum to remove any remaining dust.

1.28.0 WORKING ALOFT

As an IC Electrician, you will have to go aloft to perform maintenance on various IC circuits, such as the wind direction and wind speed detectors. You should be familiar with the hazards and the safety precautions involved.

Personnel must obtain written permission from the officer of the deck (OOD) before going aloft. The OOD must ensure that all energized radio and radar transmitters have been placed in the STANDBY position that the power has been secured to all radar antennas, and that their associated controls are tagged “SECURED: PERSONNEL ALOFT.” The OOD must also notify the engineer officer that personnel will be working aloft to prevent the lifting of boiler safety valves or the blowing of boiler tubes or steam whistles while workers are aloft. The OOD will coordinate with the OODs of adjacent ships to ensure that equipment on their respective ships will not present a danger to personnel going aloft.

After permission has been obtained to go aloft, at least two workers will be assigned to the work area, along with a ship’s Boatswain’s Mate who is qualified in rigging. When you go aloft, you must always be equipped with a parachute-type safety harness, safety lanyard equipped with Dyna-Brake, working lanyard, and climber safety device (if a climber safety rail is installed). Before each use, you should inspect the safety harness and lanyards for defects. NEVER use defective equipment.

While working aloft, you should secure all tools and equipment with lanyards to prevent dropping them and injuring personnel below. Keep both hands free for climbing, and be sure you always have good footing and hand grasp. You should wear well-fitted clothing. Loose or baggy clothes may become caught or entangled and cause you to lose your balance. Your assistant should stand clear of danger from falling objects below the work area. Your assistant should also keep all personnel clear of the work area.

After the work has been completed, the OOD should be notified immediately.

1.29.0 PERSONAL EQUIPMENT

No personal electrical equipment, such as radios, television sets, DVD players, CD players, Video games, and hobby equipment, will be used aboard ship without having received an electrical safety inspection and having an approval sticker or tag attached. The shipboard electricians are responsible for inspecting personal electrical equipment.

Electric shavers that have a completely insulated housing and isolated cutting blades and that have no cracks in the housing or cord are authorized for use aboard ship. If in doubt whether your electric shaver complies, have it checked by the ship's electricians. If the shaver ever falls into a wash bowl of water, let it go. Unplug the cord from its receptacle, and take the shaver to the electricians for a safety check. Do not use it again without first having it checked.

No personally owned electrical appliances, such as heating pads, space heaters, lights, or fans, are allowed aboard ship.

1.30.0 ELECTRICAL FIRES AND FIRE EXTINGUISHERS

When at sea, fire aboard a Navy vessel can be more fatal and damaging to both personnel and the ship itself than damage from battle. The Navy requires that all hands be damage control qualified within 6 months after reporting aboard ship. You must learn the types of fire-fighting equipment and the location and operating procedures of the equipment.

The following general procedures are used for fighting an electrical fire:

1. Promptly de-energize the circuit or equipment affected. Shift the operation of the affected circuit or equipment to a standby circuit or equipment, if possible.

2. Sound an alarm according to station regulations or the ship's fire bill. When ashore, notify the fire department; if afloat, notify the OOD. Give the location of the fire and state what is burning. If possible, report the extent of the fire; that is, what its effects are upon the surrounding area.

3. Secure all ventilation by closing compartment air vents or windows.

4. Attack the fire with portable CO2 extinguishers (or a CO2 hose reel system, if available) as follows:

- Remove the locking pin from the release valve.

- Grasp the horn handle by the insulated (thermal) grip; the grip is insulated against possible frostbite of the hand.
- Squeeze the release lever (or turn the wheel) to open the valve and release the carbon dioxide; at the same time, direct the discharge flow of the carbon dioxide toward the base of the fire.
- Aim and move the horn of the extinguisher slowly from side to side.
- Do not stop the discharge from the extinguisher too soon. When the fire has been extinguished, coat the critical surface areas involved with carbon dioxide "snow" to smother the fire by displacing oxygen, Do not lose positive control of the C02 bottle.

Table 1-2 is a list of the types of fire extinguishers that are normally available for use. Fire extinguishers of the proper type must be conveniently located near all equipment that is subject to fire danger, especially high-voltage equipment. You should be extremely careful when using fire-extinguishing agents around electrical circuits. A stream of salt water or foam directed against an energized circuit can conduct current. When water is broken into small particles, (nozzle fog patterns), there is little or no danger of it carrying electric current under normal conditions of fire fighting if the nozzles are operated at least 4 feet from the energized source. Nozzles and Navy all-purpose (NAP) applicators constitute a shock hazard to the fire fighter due to accidental shifting to a solid stream or by touching electrical equipment, particularly with the applicator.

Even after current is shut off, a potential may remain until an effective ground is established in some electronic equipment. It is emphasized that the nozzle should not be advanced any nearer to the power source than 4 feet. Avoid prolonged exposure to high concentrations of carbon dioxide in confined spaces since there is suffocation unless an oxygen breathing (OBA) is used.

EXTINGUISHER	USE
CO2 Gas	Effective on any type of fire, particularly electrical fires.
Potassium Bicarbonate (PKP)	Very effective on Class B fires. Not recommended for electrical fires because it causes corrosion of electrical and electronic components.
Soda-Acid	Effective only on Class A fires. Not recommended for electrical fires, as the compound is a good conductor of electricity. Not effective on burning compounds, such as oil and the like.
Foam	Very effective on burning compounds, such as oil and similar materials. Not satisfactory for electrical fires, as the compound is a good conductor of electricity.
Halon 1301	Effective on all classes of fire except Class D. It is a colorless, odorless gas that does not conduct electricity or leave a residue

Table 1-2.—Types of Fire Extinguishers

1.31.0 ELECTRICAL SHOCK

As an IC Electrician, you will be working in areas and on equipment that pose serious shock hazards. If you always follow the safety precautions outlined earlier, you can minimize the risk. However, you should remember that the possibility of electrical shock is always present. If you are at the scene of a mishap, you will be expected to help the victim as soon as possible.

When 60-Hz ac is passed through a human body and the current is gradually increased from zero, it could cause the following effects:

- 1 milliampere (0.001 ampere)—shock is perceptible.
- 10 milliamperes (0.01 ampere)—shock is of sufficient intensity to prevent the voluntary control of muscles. A person may not be able to release the circuit.
- 100 milliamperes (0.1 ampere)—shock is usually fatal if it is sustained for 1 second or more.

The danger of shock from 450-volt ac ship's service systems is well recognized by operating personnel as shown by the relatively few reports of serious shock received from this voltage. On the other hand, a number of shipboard fatalities have occurred because of contact with 115-volt circuits.

Despite a widespread but totally unfounded popular belief, low-voltage (115 volts and below) circuits are very dangerous and can cause death. Shipboard conditions contribute to the severity of shock because the body is likely to be in contact with the ship's metal structure and the body resistance may be low because of perspiration or damp clothing.

Keep your clothing, hands, and feet dry if at all possible. When you must work in a wet or damp location, use a dry, wooden platform to sit or stand on, and place a rubber mat or other nonconductive material between you and the wood surface. When you are required to work on exposed electrical equipment, use insulated tools and a nonmetallic flashlight.

1.32.0 RESCUE

When a victim is rendered unconscious by electrical shock, and the victim is no longer breathing, you should start artificial ventilation as soon as possible. You should also check the victim's pulse, since electrical shock may also cause the heart to stop.

The person nearest the victim should start artificial ventilation without delay and call or send others for assistance and medical aid. The only logical permissible delay is that time required to free the victim from contact with the electricity in the quickest, safest way. This step must be done with great care, otherwise there may be two victims instead of one. If contact is with a portable electric tool, light, appliance, equipment, or portable extension cord, turn off the bulkhead supply switch or remove the plug from its bulkhead receptacle. If the switch or bulkhead receptacle cannot be quickly located, the suspected electric device may be pulled free of the victim by grasping the insulated flexible cable to the device and carefully withdrawing it clear of its contact with the victim. Other persons arriving on the scene must be clearly warned not to touch the suspected equipment until it is unplugged. Aid should be enlisted to unplug the device as soon as possible.

Where a victim is in contact with stationary equipment, such as a bus bar or electrical connections, pull the victim free if the equipment cannot be quickly de-energized or if the ship's operations or survival prevent immediate securing of the circuits. To save time in pulling the victim free, improvise a protective insulation for the rescuer. For example, instead of hunting for a pair of rubber gloves to use in grasping the victim, you can safely pull the victim free (if conditions are dry) by grasping the victim's slack clothing, leather shoes, or by using your belt. Instead of trying to locate a rubber mat to stand on, use non-conducting materials, such as deck linoleum, a pillow, a blanket, a mattress, dry wood, or a coil of rope. At no time during the rescue should any part of your body directly touch the hull, metal structure, furniture, or victim's skin.

1.33.0 RESUSCITATION

Methods of resuscitating or reviving an electrical shock victim include artificial ventilation (to reestablish breathing) and cardiopulmonary resuscitation (to reestablish heartbeat and blood circulation).

1.33.1 Artificial Ventilation (Respiration)

A person who has stopped breathing is not necessarily dead, but is in immediate critical danger. Life depends on oxygen that is breathed into the lungs and then carried by the blood to every body cell. Since body cells cannot store oxygen, and since the blood can hold only a limited amount (and only for a short time), death will surely result from continued lack of breathing.

The heart may continue to beat and the blood may still be circulated to the body cells for some time after breathing has stopped. Since the blood will, for a short time, contain a small supply of oxygen, the body cells will not die immediately. Thus, for a very few minutes, there is some chance that the person’s life may be saved. A person who has stopped breathing, but who is still alive, is said to be in a state of respiratory failure. The first-aid treatment for respiratory failure is called artificial ventilation/respiration.

The purpose of artificial ventilation is to provide a method of air exchange until natural breathing is reestablished. Artificial ventilation should be given only when natural breathing has stopped; it must NOT be given to any person who is still breathing. Do not assume that breathing has stopped merely because a person is unconscious or because a person has been rescued from an electrical shock. Remember, DO NOT GIVE ARTIFICIAL VENTILATION TO A PERSON WHO IS BREATHING NATURALLY. There are two methods of administering artificial ventilation: mouth-to-mouth and mouth-to-nose.

1.33.2 Cardiopulmonary Resuscitation

When there is a complete stoppage of heart function, the victim has suffered a cardiac arrest. The signs include the absence of a pulse, because the heart is not beating, and the absence of breathing. In this situation, the immediate administration of cardiopulmonary resuscitation (CPR) by a rescuer using correct procedures greatly increases the chances of a victim’s survival.

CPR consists of external heart compression and artificial ventilation. The compressions are performed by pressing the chest with the heel of your hands, and the lungs are ventilated either by mouth-to-mouth or mouth-to-nose techniques. To be effective, CPR must be started within 4 minutes of the onset of cardiac arrest.

CAUTION:
CPR should NOT be attempted by a rescuer who has NOT been properly trained. Improperly done, CPR can cause serious damage to a victim. Therefore, CPR is NEVER practiced on a healthy individual. For training purposes, a training aid is used instead. To learn CPR, you should take an approved course from a qualified CPR instructor.

1.34.0 WOUNDS

A wound, or breaking of the skin, is another problem that could be the result of an electrical shock. An IC Electrician could accidentally come in contact with an energized circuit, causing a loss of balance. This could result in a minor or serious injury. Because you could be in a critical situation to save someone's life, or even your own, you should know the basics of first aid.

Wounds are classified according to their general condition, size, location, how the skin or tissue is broken, and the agent that caused the wound.

When you consider the manner in which the skin or tissue is broken, there are four general kinds of wounds: abrasions, incisions, lacerations, and punctures.

1.34.1 Abrasions

Abrasions are made when the skin is rubbed or scraped off. Rope burns, floor burns, and skinned knees or elbows are common examples of abrasions. There is usually minimal bleeding or oozing of clear fluid.

1.34.2 Incisions

Incisions, commonly called cuts, are wounds made with a sharp instrument, such as a knife, razor, or broken glass. Incisions tend to bleed very freely because the blood vessels are cut straight across.

1.34.3 Lacerations

Lacerations are wounds that are torn, rather than cut. They have ragged, irregular edges and masses of torn tissue underneath. These wounds are usually made by blunt forces, rather than sharp objects. They are often complicated by crushing of the tissues as well.

1.34.4 Punctures

Punctures are caused by objects that penetrate some distance into the tissues while leaving a relatively small surface opening. As a rule, small punctures do not bleed freely; however, large puncture wounds may cause severe internal bleeding.

A puncture wound can be classified as penetrating or perforating. A perforation differs from a penetration in that it has an exit as well as an entrance site.

1.35.0 BLEEDING

The first-aid methods that are used to stop serious bleeding depend upon the application of pressure. Pressure may be applied in three ways: (1) directly to the wound, (2) at key pressure points throughout the body, and (3) with a tourniquet.

1.35.1 Direct Pressure

You should try the direct-pressure method first to control bleeding. Place a sterile first-aid dressing, when available, directly over the wound. Tie the knot only tight enough to stop the bleeding, and firmly fasten it in position with a bandage. In the absence of sterile dressings, use a compress made with a clean rag, handkerchief, or towel to apply direct pressure to the wound, as in figure 1-14. If the bleeding does not stop, firmly secure another dressing over the first dressing, or apply direct pressure with your hand or fingers over the dressing. Under no circumstances is a dressing to be removed once it is applied.

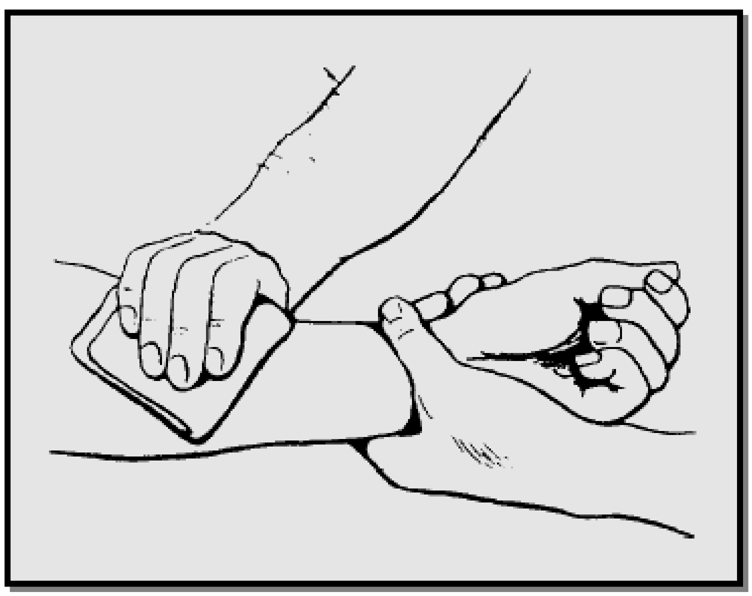


Figure 1-14.-Direct pressure.

1.35.2 Pressure Points

If the direct-pressure method does not stop the bleeding, use the pressure point nearest the wound, as shown in figure 1-15. Bleeding from a cut artery or vein may often be controlled by applying pressure to the appropriate pressure point. A pressure point is a place where the main artery to the injured part lies near the skin surface and over a bone. Pressure at such a point is applied with the fingers or with the hand; no first-aid materials are required. Pressure points should be used with caution, as they may cause damage to the limb as a result of an inadequate flow of blood. When the use of pressure points is necessary, do not substitute them for direct pressure; use both.

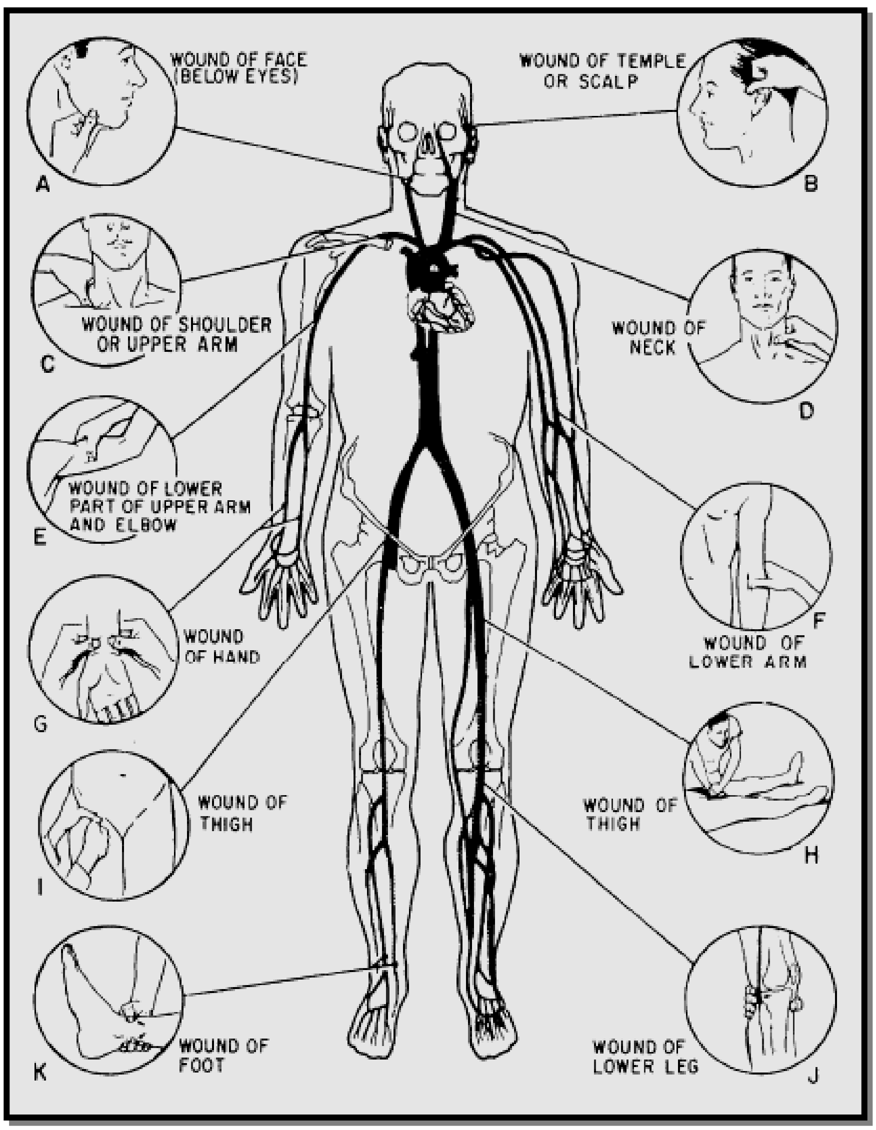


Figure 1-15.-Pressure points for control of bleeding.

1.35.3 Use of a Tourniquet

A tourniquet is a constricting band that is used to cut off the supply of blood to an injured limb. It cannot be used to control bleeding from the head, neck, or body, since its use in these locations would result in greater injury or death. A tourniquet should be used on an injured limb only as a last resort for severe, life-threatening hemorrhaging that cannot be controlled by any other method. A tourniquet must be applied ABOVE the wound—that is, towards the trunk-and it must be applied as close to the wound as practicable.

Any long, flat material can be used as a band for a tourniquet—belts, stockings, flat strips of rubber, or a neckerchief. Only tighten the tourniquet enough to stop the flow of blood. Use a marker, skin pencil, crayon, or blood, and mark a large T on the victim's forehead.

WARNING:
Remember, a tourniquet is ONLY used as a last resort to control bleeding that cannot be controlled by other means. Tourniquets should be removed as soon as possible by medical personnel only.

1.36.0 BURNS

The causes of burns are generally classified as thermal, electrical, chemical, or radiation. Whatever the cause, shock always results if the burns are extensive.

Thermal burns are caused by exposure to intense heat, such as that generated by fire, bomb flash, sunlight, hot liquids, hot solids, and hot gases. Their care depends upon the severity of the burn and the percentage of the body area involved.

Electrical burns are caused by electric current passing through tissues or the superficial wound caused by electrical flash. They may be far more serious than they first appear. The entrance wound may be small; but as electricity penetrates the skin, it burns a large area below the surface. Usually there are two external burn areas: one where the current enters the body and another where it leaves.

Chemical burns for the most part are not caused by heat, but by direct chemical destruction of body tissues. When acids, alkali's, or other chemicals come in contact with the skin or other body membranes, they can cause injuries that are generally referred to as chemical burns. The areas most often affected are the extremities, mouth, and eyes. Alkali burns are usually more serious than acid burns, because they penetrate deeper and burn longer. When chemical burns occur, emergency measures must be carried out immediately. Do not wait for the arrival of medical personnel.

Radiation burns are the result of prolonged exposure to the ultraviolet radiation. First- and second-degree burns may develop. Treatment is essentially the same as that for thermal burns.

1.36.1 Classification of Burns

Burns are classified in several ways: by the extent of the burned surface, by the depth of the burn, and by the cause of the burn. The extent of the body surface burned is the most important factor in determining the seriousness of the burn and plays the greatest role in the victim's chances of survival.

Burns may also be classified as first, second, or third degree, based on the depth of skin damage (fig. 1-16). First-degree burns are mildest. Symptoms are reddening of the skin and mild pain. Second degree burns are more serious. Symptoms include blistering of the skin, severe pain, some dehydration, and possible shock. Third-degree burns are worst of all. The skin is destroyed and possibly the muscle tissue and bone in severe cases. The skin may be charred or it may be white or lifeless. This is the most serious type of burn, as it produces a deeper state of shock and will cause more permanent damage. It is usually not as painful as a second-degree burn because the sensory nerve endings have been destroyed.

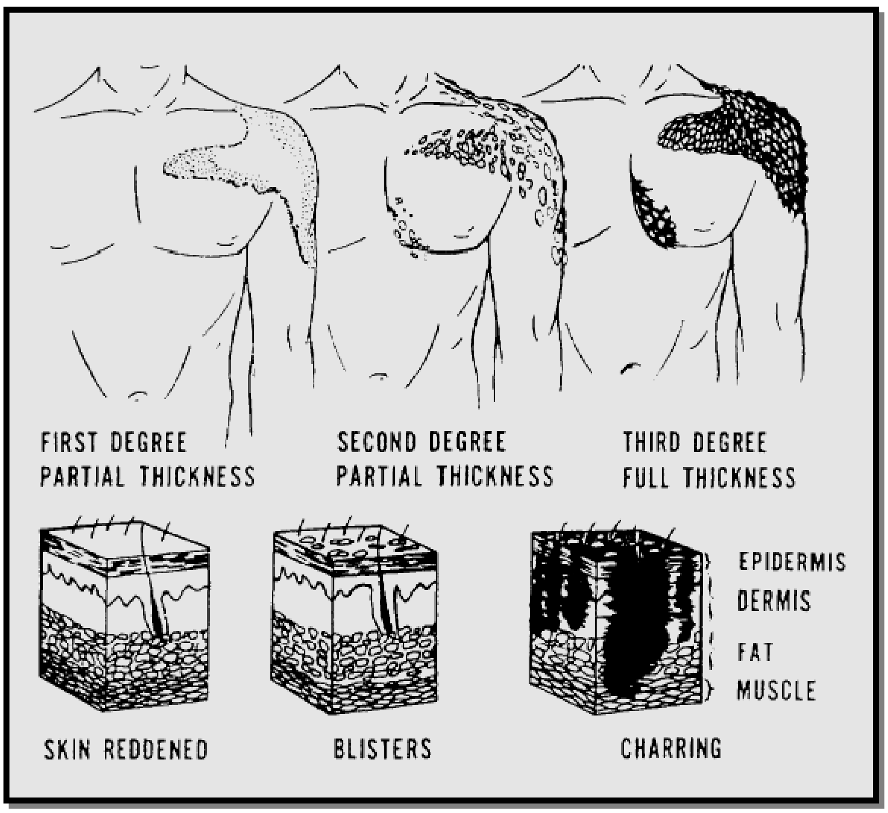


Figure 1-16.-First-, second-, and third-degree burns.

1.36.2 Emergency Treatment of Burns

The degree of the burn, as well as the skin area involved, determines the procedures used in the treatment of burns. Large skin areas require a different approach than small areas.

To estimate the amount of skin area affected, the extent of burned surface, the "Rule of Nines" (fig. 1-17) is used. These figures aid in determining the correct treatment for the burned person.

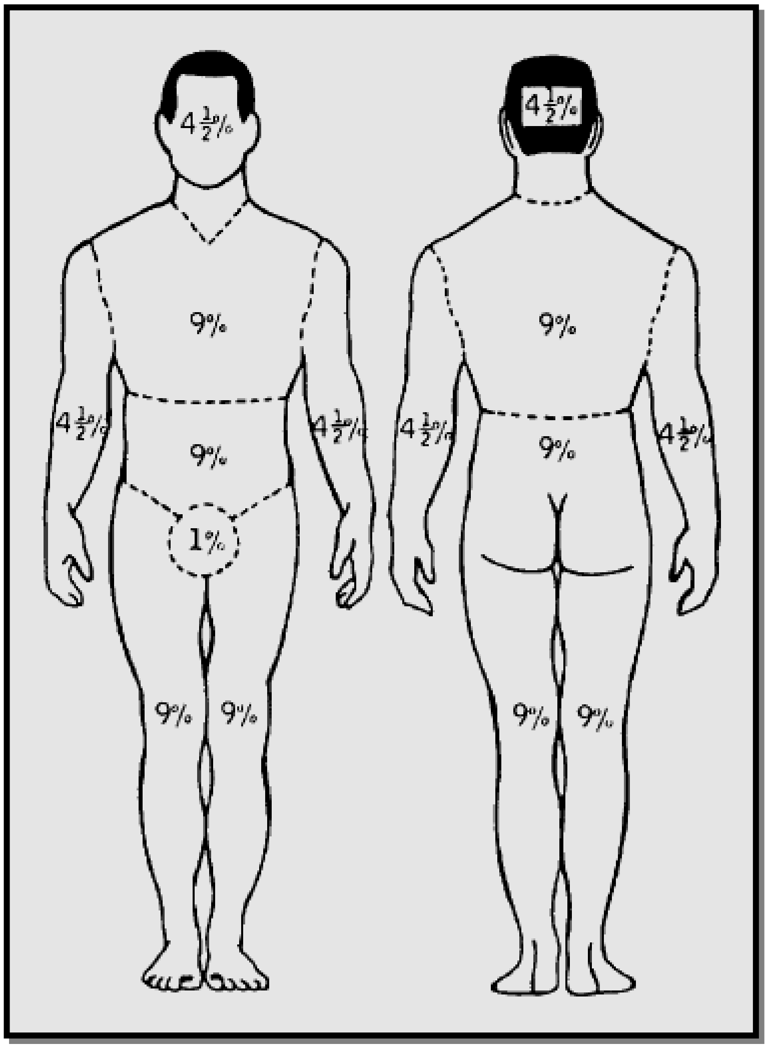


Figure 1-17.—Rule of Nines.

As a guideline, consider that burns exceeding 15 percent of the body surface will cause shock; burns exceeding 20 percent of the body surface endanger life; and burns covering more than 30 percent of the body surface are usually fatal if adequate medical treatment is not received.

Minor burns, such as first-degree burns over less than 20 percent of the body area and small second degree burns, do not usually require immediate medical attention unless they involve the facial area.

THERMAL BURNS.— When emergency treatment of the more serious thermal burns is required, first check the victim for respiratory distress. Burns around the face or exposure to hot gases or smoke may cause the airway to swell shut. If facial burns are present, place the victim in a sitting position to further ease breathing. Transport the victim with facial burns to a medical facility as soon as possible.

Remove all jewelry and similar articles, even from unburned areas, since severe swelling may develop rapidly.

To relieve pain initially, apply cold compresses to the affected area or submerge it in cold water. Cold water not only minimizes pain, but also reduces the burning effects in the deep layers of the skin. Gently pat dry the area with a lint-free cloth or gauze.

Cover the burned area with a sterile dressing, clean sheet, or unused plastic bag. Coverings such as blankets or other materials with a rough texture should not be used because lint may contaminate and further irritate the injured tissue. When hands and feet are burned, dressings must be applied between the fingers and toes to prevent skin surfaces from sticking to each other.

Do not attempt to break blisters, and do not remove shreds of tissue or adhered particles of charred clothing. Never apply greasy substances (butter, lard, or petroleum jelly), antiseptic preparations, or ointments.

If the victim is conscious and not vomiting, prepare a weak solution of salt (1 teaspoon) and baking soda (1/2 teaspoon) in a quart of warm water. Allow the victim to sip the drink slowly. Aspirin is also effective for the relief of pain.

Treat for shock. Maintain the victim’s body heat, but do not allow the victim to become overheated. If the victim’s hands, feet, or legs are burned, elevate them higher than the heart.

ELECTRICAL BURNS.— In electrical shock cases, burns may have to be ignored temporarily while the patient is being revived. After the patient is revived, lightly cover the burn with a dry, preferably sterile, dressing, treat for shock, and transport the victim to a medical facility.

CHEMICAL BURNS.— To treat most chemical burns, you should begin flushing the area immediately with large amounts of water. Do not apply the water too forcefully. If necessary, remove the victim's clothing, including shoes and socks, while flushing.

Water should not be used for alkali burns caused by dry lime, unless large amounts of water are available for rapid and complete flushing. When water and lime are mixed they create a very corrosive substance. Dry lime should be brushed from the skin and clothing.

Isopropyl or rubbing alcohol should be used to treat acid burns caused by phenol (carbolic acid). Phenol is not water soluble; therefore, water should only be used after first washing with alcohol or if alcohol is not available.

For chemical burns of the eye, flush immediately with large amounts of fresh, clean water. Acid burns should be flushed at least 15 minutes, and alkali burns for as long as 20 minutes. If the victim cannot open the eyes, hold the eyelids apart so water can flow across the eyes. After thorough irrigation, loosely cover both eyes with a clean dressing.

The after care for all chemical burns is similar to that for thermal burns. Cover the affected area and get the victim to a medical facility as soon as possible.

RADIATION BURNS.— For first- and second degree sunburns, treatment is essentially the same as for thermal burns. If the burn is not serious and the victim does not need medical attention, apply commercially prepared sunburn lotions and ointments.

1.37.0 HEARING CONSERVATION AND NOISE ABATEMENT

Historically, hearing loss has been recognized as an occupational hazard related to certain trades, such as blacksmithing and boilermaking. Modern technology has extended the risk to many other activities: using presses, forging hammers, grinders, saws, internal combustion engines, or similar high-speed, high-energy processes. Exposure to high-intensity noise occurs as a result of either impact noise, such as gunfire or rocket fire, or from continuous noise, such as jet or propeller aircraft, marine engines, and machinery.

Hearing loss has been and continues to be a source of concern within the Navy, both ashore and afloat. Hearing loss attributed to such occupational exposure to hazardous noise, the high cost of related compensation claims, and the resulting drop in productivity and efficiency have highlighted a significant problem that requires considerable attention. The goal of the Navy Hearing Conservation Program is to prevent occupational noise-related hearing loss among Navy personnel. The program includes the following elements:

- Work environments will be surveyed to identify potentially hazardous noise levels and personnel at risk.

- Environments that contain, or equipment that produces, potentially hazardous noise should be modified to reduce the noise to acceptable levels whenever technologically and economically feasible. When this is not feasible, administrative control and/or hearing protection devices should be used.

- Periodic hearing testing must be conducted to monitor the effectiveness of the program.

- Navy personnel must be educated on the Hearing Conservation Program to ensure the overall success of the program.

1.37.1 Identifying and Labeling of Noise Areas and Equipment

Hazardous noise areas and equipment must be so designated and appropriately labeled. Areas and equipment that produce continuous and intermittent sound levels greater than 84 dB (A) or impact or impulse levels of 140 dB peak are considered hazardous.

An industrial hygienist with a noise level meter will identify the noise hazardous areas. Noise hazardous areas will be labeled using a hazardous noise warning decal, NAVMED 6260/2 (fig. 1-18). This decal will be posted at all accesses. Hazardous noise labels, NAVMED 6260/2A, are the approved labels for marking portable and installed equipment.

All personnel that are required to work in designated noise hazardous areas or with equipment that produces sound levels greater than 84 dB (A) or 140 dB sound/pressure levels are entered in the hearing conservation program.

Figure 1-18.-Hazardous noise warning decal.

You will find further information on hearing conservation in OPNAVINST 5100.23G, *Navy Occupational Safety and Health (NAVOSH) Program Manual* and OPNAVINST 5100.19E, *Navy Occupational Safety and Health (NAVOSH) Program Manual for Forces Afloat.*

1.37.2 Monitoring Hearing Tests

All naval personnel receive an initial or reference audiogram shortly after entering the service. Thereafter, a hearing test will be conducted at least annually while you are assigned to a noise hazardous environment. Hearing tests will also be conducted when there are individual complaints of difficulties in understanding conversational speech or a sensation of ringing in the ears. The annual audiograms will be compared to the reference (baseline) to determine if a hearing threshold shift has occurred.

1.37.3 Hearing Protective Devices

Hearing protective devices should be worn by all personnel when they must enter or work in an area where noise levels are greater than 84 dB (A). A combination of insert earplugs and circumaural muffs, which provides double protection, should be worn in all areas where noise levels exceed 104 dB (A). Personnel hearing protective devices should be issued to suit each situation.

1.38.0 HEAT STRESS CONTROL PROGRAM

Heat stress may occur in many work spaces throughout the Navy. Heat stress is any combination of air temperature, thermal radiation, humidity, airflow, and workload that may stress the human body as it attempts to regulate its temperature. Heat stress becomes excessive when your body's capability to adjust is exceeded. This results in an increase in body core temperature. This condition can readily produce fatigue, severe headaches, nausea, and poor physical and/or mental performance. Prolonged exposure to heat stress could cause heatstroke or heat exhaustion and severe impairment of the body's temperature regulating ability. Heatstroke can be life-threatening if not immediately and properly treated. Recognizing personnel with heat stress symptoms and getting them prompt medical attention is an all-hands responsibility.

Everyone's role in the command's Heat Stress Control Program involves adhering to the command's program and reporting heat stress conditions as they occur.

Primary causes that increase heat stress conditions are as follows:

- Excessive steam and water leaks
- Boiler air casing leaks
- Missing or deteriorated lagging on steam piping, valves, and machinery
- Clogged ventilation systems or an inoperative fan motor
- Operating in hot or humid climates

To determine heat stress conditions, permanently mounted dry-bulb thermometers are installed at key watch and work stations. Their readings should be recorded at least once a watch period. When a reading exceeds 100°F (38°C), a heat stress survey must be ordered to determine the safe stay time for personnel.

A heat stress survey is taken with a wet-bulb globe temperature (WBGT) meter. You should compare these readings to the physiological heat exposure limits (PHEL) chart. After comparing the readings with the PHEL chart, you will be able to determine the safe stay time for personnel.

Everyone should have a working knowledge of all aspects of the Heat Stress Program so you can recognize heat stress conditions if they occur and take the proper corrective actions. Further information and guidance of the Navy Heat Stress Control Program is contained in OPNAVINST 5100.19E, *Navy Occupational Safety and Health (NAVOSH) Program Manual for Forces Afloat.*

1.39.0 SUMMARY

In this chapter, we have described your responsibilities regarding general and electrical safety.

We have identified various sources of safety information that are available to you, and provided you with general and specific safety precautions to assist you in your day-to-day work as an IC Electrician.

We have discussed the danger of electrical shock, how to rescue a victim from electrical shock, and the procedures for giving first aid to the victim. We have also briefly discussed the Navy's Hearing Conservation, Noise Abatement, and Heat Stress Control programs.

Think safety! Always remain alert to possible danger.

2 SWITCHES, PROTECTIVE DEVICES, AND CABLES

Upon completion of this chapter, you will be able to do the following:

- Describe the characteristics, construction features, applications, and maintenance procedures of the various types of switches, relays, and solenoids.
- Identify the characteristics, functions, and maintenance procedures of the various types of protective devices on IC equipment.
- Identify electrical cables by classification, type and size designation, ratings, and characteristics.
- Describe the proper procedures for installing and connecting cables.
- Identify the purpose and the installation and maintenance procedures of radio-frequency coaxial cable.

2.0.0 INTRODUCTION

As an Interior Communications (IC) Electrician, you will be working with sophisticated circuitry consisting of complex equipment, multiconductor cables and connectors, and a variety of switching and protective devices. This chapter will give you a basic understanding of the hardware that is in general use with interior communications systems. You will be able to recognize installations and, with limited supervision, you will be able to install this hardware aboard ship. It should be understood that, due to the vast numbers of components used, not every component is discussed, but rather the common installations. For more detailed information concerning the operation and theory of circuit switching and protective devices, consult NEETS, Module 3, and NAVEDTRA 14175.

2.1.0 SWITCHES

A basic understanding of switches and their uses is a necessity for the IC Electrician. The Navy uses hundreds of different types of switches.

A switch is a device used for making, breaking, or changing connections in an electrical circuit. Switches are rated in amperes and volts; the rating refers to the maximum allowable voltage and current of the circuit in which the switch is to be used. Since it is placed in series, all the circuit current will pass through the switch; because it opens the circuit, the applied voltage will appear across the switch in the open circuit position. Switch contacts should be opened and closed quickly to minimize arcing; therefore, switches normally use a snap action.

2.2.0 TYPES OF SWITCHES

There are many types and classifications of switches. A common designation is by the number of poles, throws, and positions. The number of poles indicates the number of terminals at which current can enter the switch. The throw of a switch signifies the number of circuits each blade or contactor can complete through the switch. The number of positions indicates the number of places at which the operating device (toggle, plunger, and so on) will come to rest.

Another means of classifying switches is the method of actuation; that is, knife, toggle, push button, or rotary. Further classification includes a description of switch action, such as on-off, momentary on-off, and on-momentary off. Momentary contact switches hold a circuit closed or open only as long as the operator deflects the actuating control.

2.2.1 Knife Switches

Knife switches are basic power switches from which most modern switches have been developed. A single-pole, single-throw (SPST) knife switch consists of a single copper blade hinged at one end and designed to fit tightly between two copper jaws, or clips, at the other end. An insulated handle is fastened to the copper blade to open and close the switch. Terminals are provided for connecting the leads.

A double-pole, single-throw (DPST) knife switch (fig. 2-1, view A) has two blades with one set of clips for each blade and an insulated handle that operates both blades simultaneously. Double-throw switches (fig. 2-1, view B) have two sets of clips (one set at each end) so the blades can be thrown into either set of clips to shift from one circuit to another.

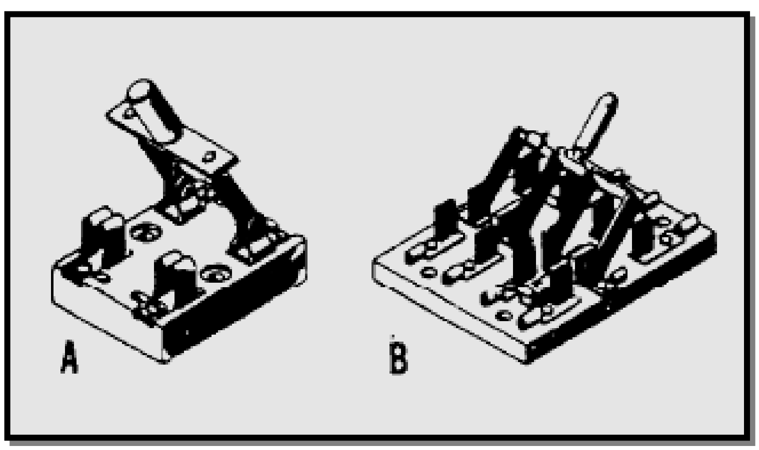


Figure 2-1.—Knife switches.

2.2.2 Toggle Switches

Representative examples of toggle switches are shown in figure 2-2, with the schematic symbols shown beneath each switch. View A of figure 2-2 shows a SPST toggle switch, rated at 20 volts and 20 amperes, and having two solder terminals. This type of switch opens and closes electric circuits.

View B of figure 2-2 shows a single-pole, double-throw (SPDT) switch, rated at 250 volts and 1 ampere, and having three screw terminals. One use of this switch is to turn a circuit on at one place and off at another place. It is sometimes called a 2-way switch.

View C of figure 2-2 shows a DPST switch, rated at 250 volts and 1 ampere, and having four solder terminals.

View D of figure 2-2 shows a double-pole, double-throw (DPDT) switch, rated at 125 volts and 3 amperes, and having six solder terminals.

The following types of switches are also used:
3-pole, single-throw (3PST); 3-pole, double throw (3PDT): 4-pole, single-throw (4PST); and 4-pole, double-throw (4PDT). The voltage ratings range from 20 volts to 600 volts, and the amperage ratings range from 1 ampere to 30 amperes.

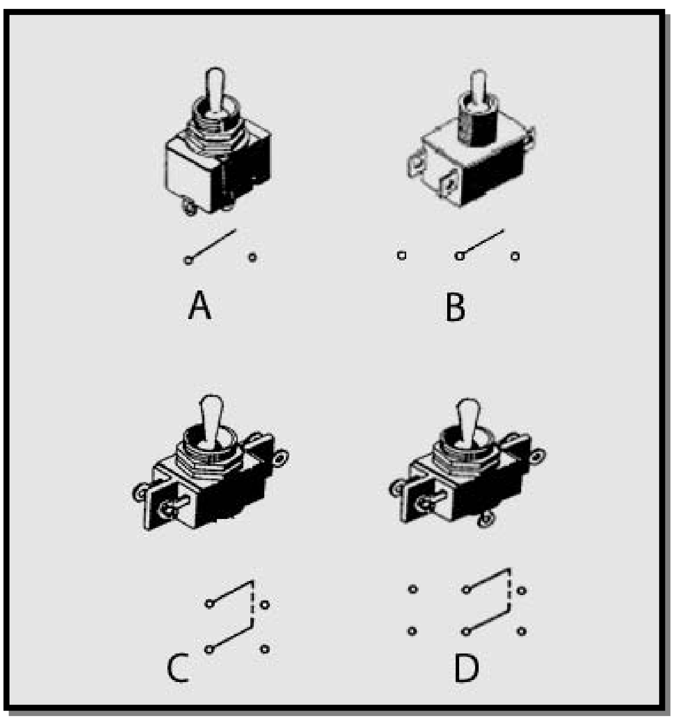


Figure 2-2.—Toggle switches.

2.2.3 Push-Button Switches

The normal contact arrangement of a push-button switch is either make or break, as shown by the schematic symbols in figure 2-3, view A. View B of figure 2-3 is a picture of a push-button switch. The make type of switch is usually a start switch; the break type of switch is usually a stop switch. Either switch may be locking or non-locking. There is also a break-make push-button switch (not shown).

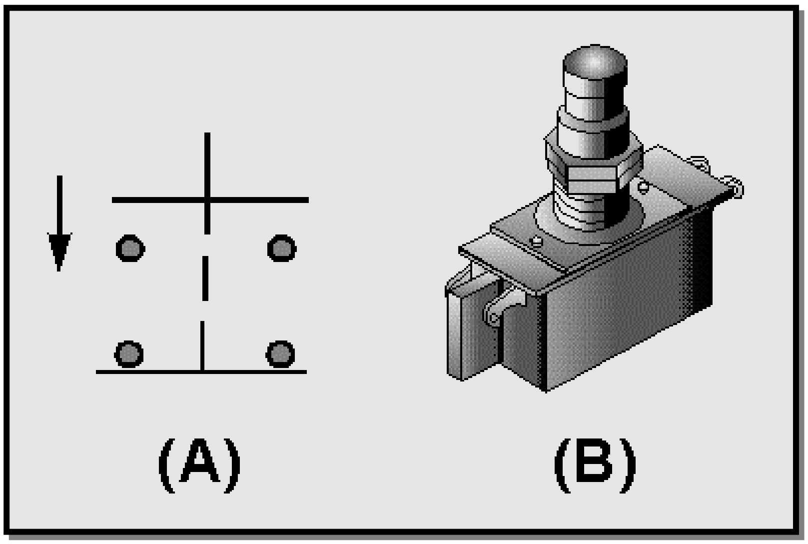


Figure 2-3.—Push-button switch.

2.2.4 Rotary Snap Switches

Rotary snap switches are devices that open or close circuits with a quick motion. A type SR rotary snap switch (fig. 2-4) consists of one or more sections, each of which has a rotor and a stationary member. Movable contacts are mounted on a bushing, and stationary contacts are mounted on insulated disks, which are arranged one beneath the other in pancake style along the switch shaft. This type of construction has the advantages of shock-proofness, compactness, flexibility of circuit arrangements, and protection to the operator. The operator, by rotating the switch handle, triggers a spring and cam arrangement, which, in turn, operates the switch contacts. If the spring should break, further rotation of the handle will eventually cause a projection on the shaft of the handle to contact a projection on the operating shaft to operate the switch. However, the switch-driving shaft and handle will be misaligned from its normal position, and the characteristic snap action will not be apparent.

Snap switches are available in a wide variety of amperage ratings (from 10 to 200), poles, and mountings (bulkhead or panel mounting).

The switch type designation indicates its current rating (1SR is 10 amperes, 3SR is 30 amperes, and so on); number of poles (3SR3 is 30 amperes, 3 poles); switching action (1SR3A is single-throw; that is, on-off); mounting style (1SR3A1 is front-mounted, back-connected); and enclosure (3SR4B1-3 is watertight). (An exploded view of a type 6SR snap switch is illustrated in fig. 2-5.)

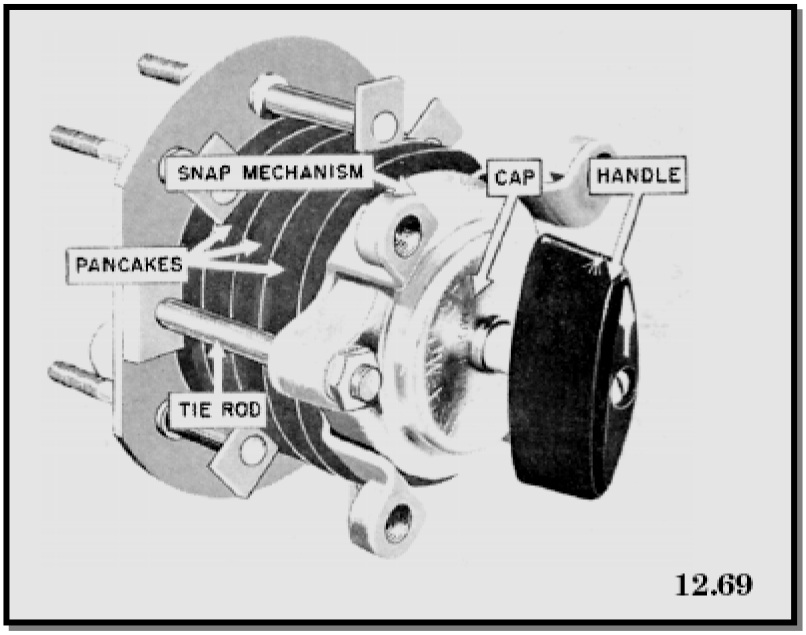


Figure 2-4.—Type SR rotary snap switch (1SR, 10 ampere size).

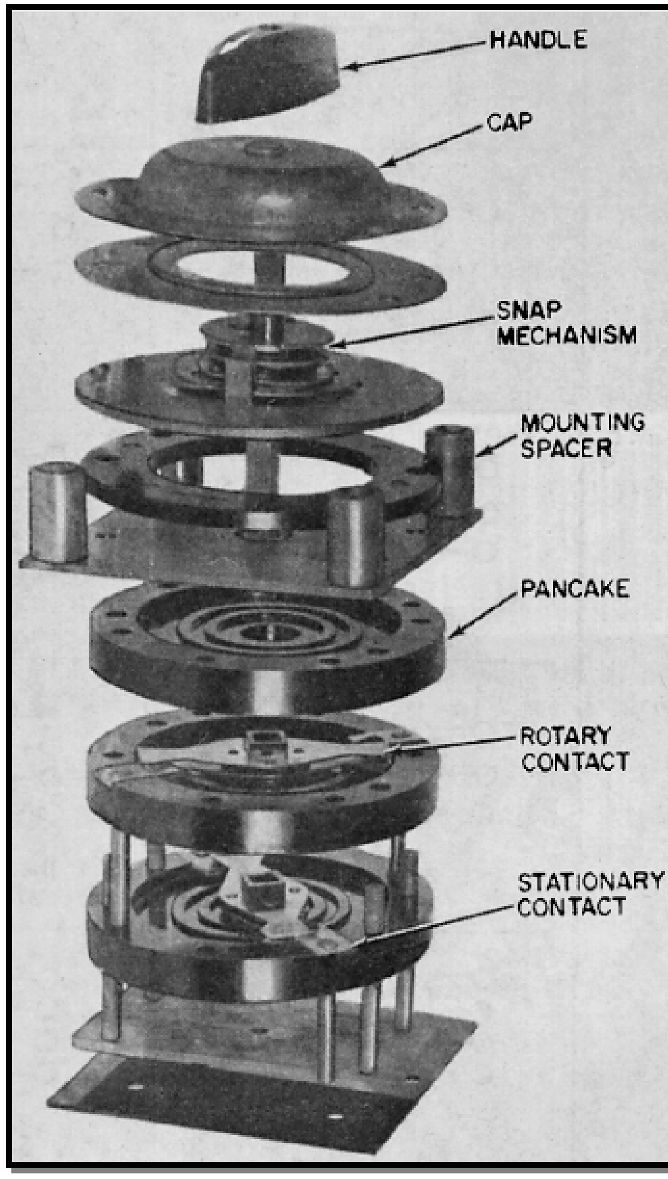


Figure 2-5.—Type 65R snap switch-exploded view.

Most snap switches are suitable for 450-volt, 60-Hz ac and 250-volt dc operation. Present 10-ampere switches are suitable for 120-volt operation only, although the switches are sometimes used at higher voltages where the currents are very small. Care must be exercised in the application of Multi-throw (double-throw and triple-throw) switches.

The movable blade, in some cases, is so wide that in moving from one stationary contact to a second, the two stationary contacts will be momentarily bridged by the arc and movable blade, causing a short circuit.

Therefore, each time a multi-throw switch is to be installed, a careful check should be made on both the switch and the intended circuit to make sure that a switch of the proper current and voltage ratings is used.

2.2.5 Pile Switches

Pile switches are constructed so they open or close one or more electrical circuits. The contacts are arranged in leaf, or pileup, fashion and maybe actuated by a rotary, pushing, or sliding motion. The various basic forms of the contact arrangements in pile switches are shown in figure 2-6, view A. These basic forms are used by themselves or in combination to makeup the contact assembly of a pile switch. View B of figure 2-6 shows a contact assembly made by combining two break-make contact arrangements to make form C. This switch is, therefore, designated 2C. When the armature is moved upward by the rotary motion of the cam lobe (fig. 2-6, view B), two circuits are opened and two are closed. This type of switch is commonly used in relays, key switches, and jacks in low-voltage signal circuits.

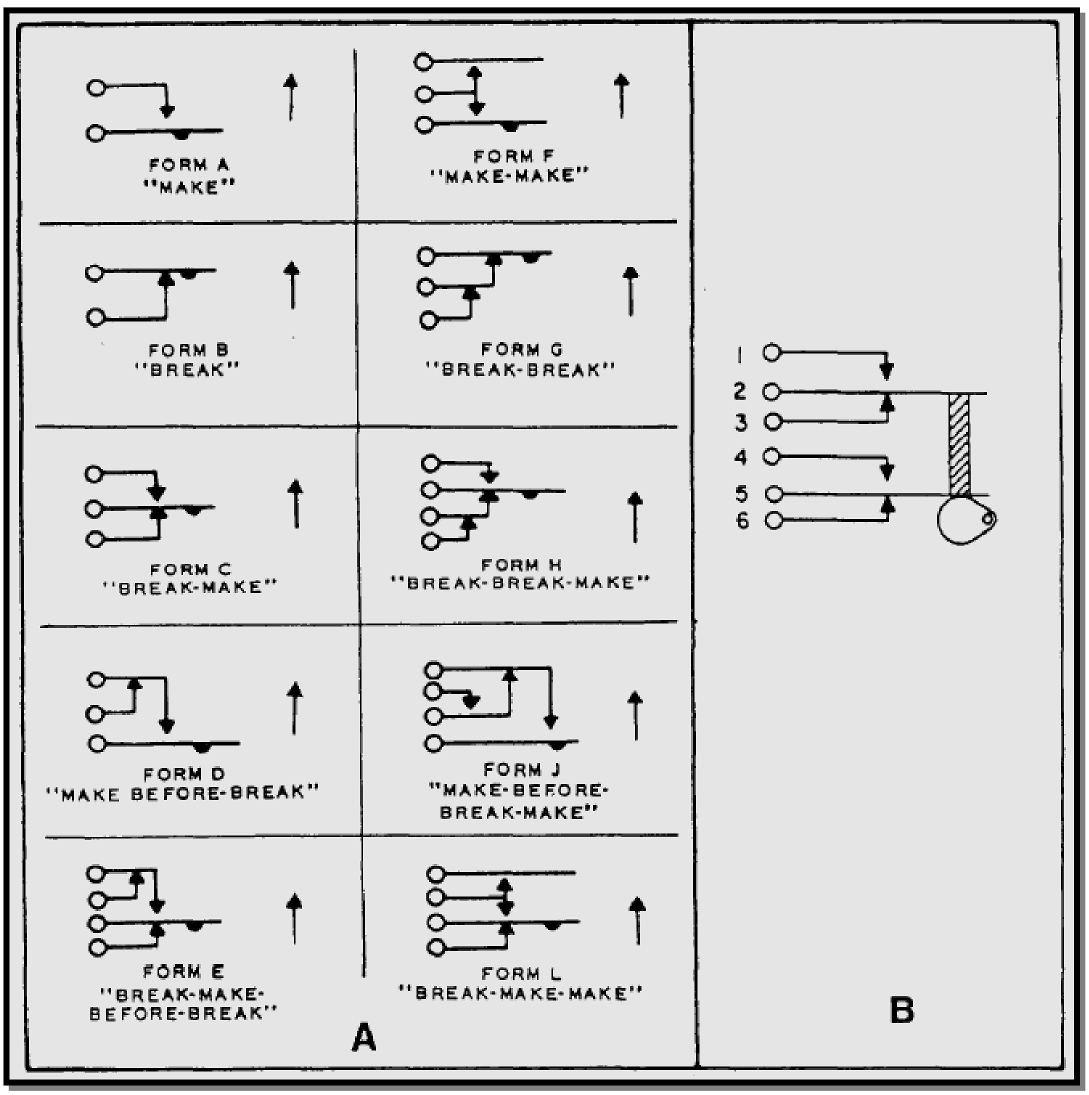


Figure 2-6.-Pile switches.

2.2.6 Rotary Selector Switches

Rotary selector switches may perform the functions of a number of switches. As the knob or handle of a rotary selector switch is rotated, it opens one circuit and closes another. In figure 2-7, the contact is from A to E. If the switch is rotated clockwise, as viewed, the circuit from A to E is opened and the circuit from A to D is completed. Some rotary switches have several layers of pancakes or wafers. With additional wafers, the switch can operate as several switches. Oscilloscope and voltmeter selector switches are typical examples of this type. These switches are more common in civilian equipment than in military hardware.

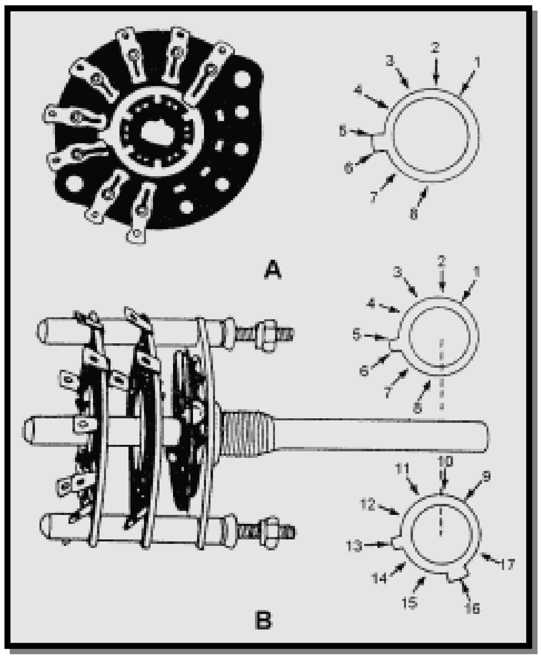


Figure 2-7.—Rotary selector switch.

TYPE J.— The type J multiple rotary selector switch (fig. 2-8) consists of an equal number of rotors and pancake sections. The number of sections required in the switch is determined by the individual application. A shaft with an operating handle extends through the center of the rotors. The movable contacts are mounted on the rotors, and the stationary contacts are mounted on the pancake sections. Each section consists of eight contacts, designated A to H, and a rotor with two insulated movable contacts spaced 180° apart. Each movable contact is arranged to bridge two adjacent stationary contacts. The switch has eight positions. A detent mechanism is provided for proper alignment of the contacts in each position of the operating handle.

In one position, the rotor contacts bridge segments AB and E-F, in the next position; the rotor contacts bridge segments B-C and F-G. Diagonally opposite pairs of contacts are subsequently bridged for the remaining positions.

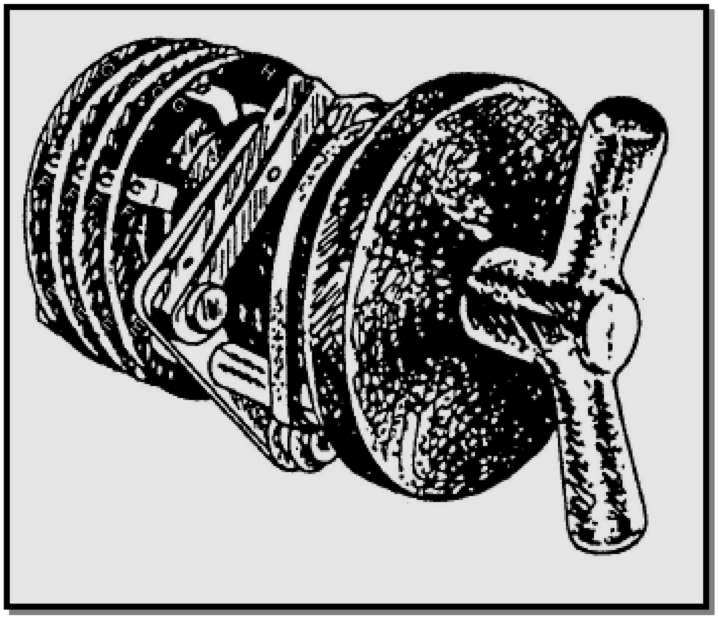


Figure 2-8.—Type J switch.

TYPE JR.— The type JR switch (fig. 2-9) is installed on recent IC switchboards. This switch is smaller than the J switch. This feature saves switchboard space. This feature also makes disassembly a lot easier. Remember, however, that a faulty switch should be repaired only when immediate replacement is not possible, and it should be replaced at the earliest opportunity. The JR switch is divided into four types: 1JR, 2JR, 3JR, and 4JR.

The 1JR switch has only one movable contact per section. This movable contact bridges two adjacent stationary contacts.

The 2JR switch has two movable contacts per section, 180° apart. Each movable contact bridges two adjacent stationary contacts.

The 3JR switch uses one of the stationary contacts as a common terminal. This stationary contact is connected, in turn, to each of the other stationary contacts of the section by a single-wiper contact. The 3JR switch is used for selecting one of several (up to seven) inputs.

The 4JR switch is designed as an either or both switch with two movable contacts per section. Each movable contact bridges three adjacent stationary contacts. This switch is used to select either or both of two indicators or synchros. The positions for energizing two indicators are as follows:

> 90° right—both indicators energized.
> 45° right—indicator 1 energized only.
> 0°—off.
> 45° left—indicator 2 energized only.

When the 4JR switch is in the OFF position, both indicators are connected together, but they are disconnected from the power supply.

The designations of JR switches are determined by the type of section (rotary and stationary contacts) followed by the number of sections in the switch. For example, a 2JR10 switch denotes a JR switch with ten 2JR sections.

The JR switch is stocked in multiples of five sections (up to 25 sections). In some cases, a switch with a number of sections (not a multiple of five) has been installed. If this switch must be replaced, a switch with the next largest number of sections that is a multiple of five should be installed, if space permits.

Type JR switches are rated at 120 volts, 60 Hz, 10 amperes. The switch should not be used on dc circuits because of the possibility of severely burned contacts when the switch is operated slowly (teased). The switch is the non-shorting type. Although the blade bridges two adjacent contacts simultaneously (for example, contacts 1 and 2 when the switch is operated), the blade breaks contact 1 before making the next alternate contact 3 (for example, in the 2JR switch, alternate terminals may be connected to an independent source of ac power without danger of short circuit during movement of the switch blade).

Barriers are also provided between sections to prevent terminals from turning and shorting to adjacent terminals.

If the sections are not uniform, the switch will be designated by JRSP followed by the number of sections.

The JR switch has a stop deck, which permits setting the switch to the number of positions desired. Pins or screws inserted in the stop deck immediately after the desired last position will limit the switch movement to the positions between these points.

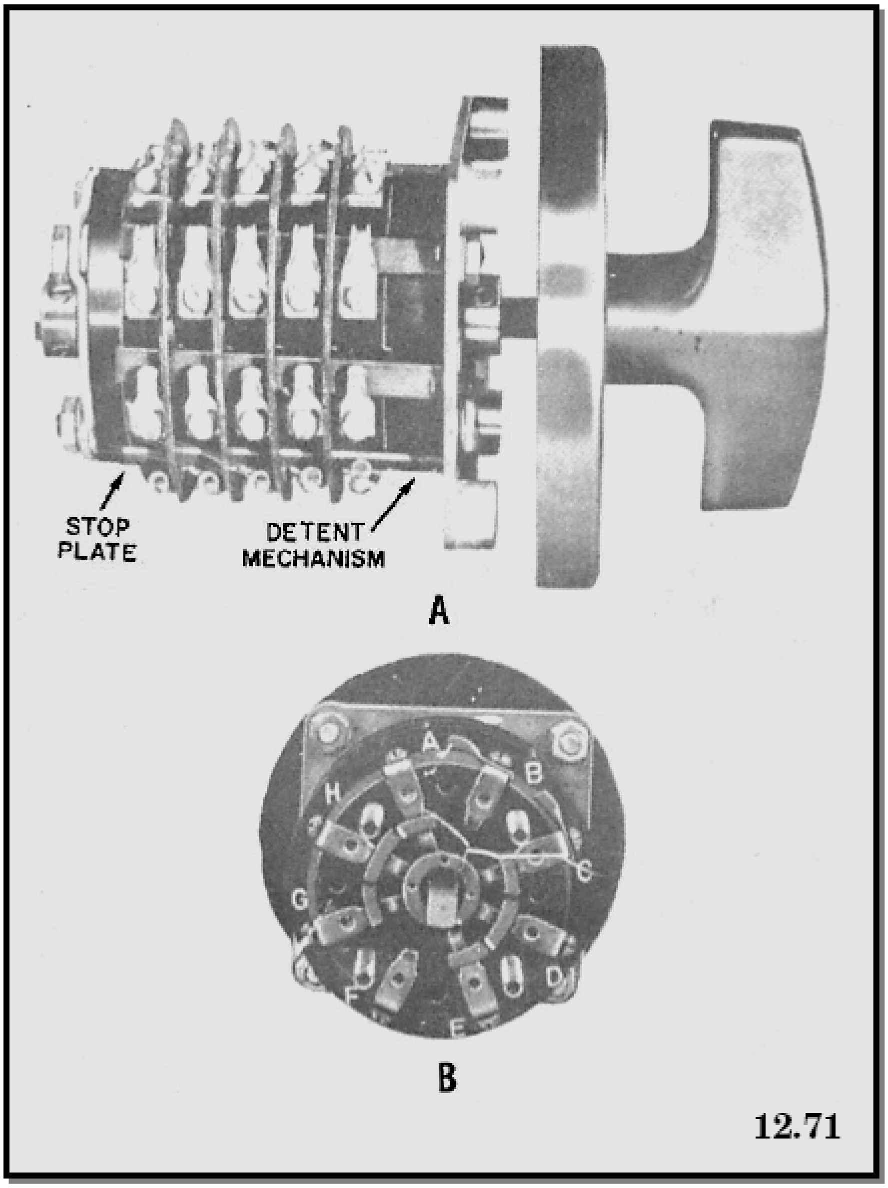


Figure 2-9.—Type JR switch (4JR).

TYPE JL.— The JL switch is identical to the JR, except in size, mounting facility, and electrical rating. The diameter of the JL deck is approximately 1 ¾ inches, whereas the diameter of the JR deck is approximately 2 1/4 inches. The rating of the JL switch is 120 volts, 60 Hz, 5 amperes. Standard types are available in three, five, and ten sections. The JL switch has a threaded bushing for single-hole mounting.

TYPE JA.— The JA switch (fig. 2-10) was developed primarily for circuit selection in sound-powered telephone applications. It provides a greater number of selections and is a smaller switch than the JR switch. The JA switch is furnished only with common rotor sections. Sixteen-position and 30-position JA switches permit selection of 16 and 30 circuits, respectively. With the JR switch, the maximum number of possible selections is seven.

The JA switch also provides lower contact resistance by using either silver or silver-overlay contacts. With brass or copper, an insulating film forms over the contacts, which is only broken down if appreciable voltage and power are available in the circuit. However, in sound-powered telephone circuits, there is insufficient power to break down the film and relatively high resistance results. The silver-to-silver contacts of the JA switch consist of pure silver welded to beryllium copper. Silver or silver-coated contacts are now being used for the latest type JA switches and other low-current switches. In larger switches, silver (unless alloyed with other metals) is unsatisfactory because it vaporizes too readily due to arcing.

The JA switch is available in two, six, and ten sections. An example of the switch designation is JA6C(16) for a 6-section, 16-position switch; here the first number designates the number of sections, the C indicates common rotor, and the number in parentheses indicates the number of positions.

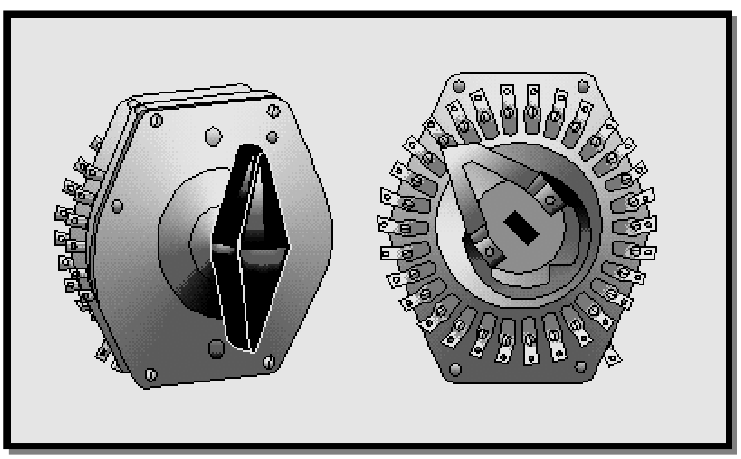


Figure 2-10.—Type JA switch.

TYPE JF.— The JF switch (fig. 2-11) was developed primarily to replace toggle switches in the 10- and 20-switch boxes for sound-powered telephone applications.

Because of the problems in making toggle switches watertight, it was necessary to provide a cover with a gasket for the 10- and 20-switch boxes, which contained the toggle switches. The cover had to be open when the switches were operated. Therefore, the switch box was not watertight, leading to possible malfunctioning of the switches. In addition, the lack of a strong contact wipe action in toggle switches and the low voltage and current in sound-powered circuits resulted in the formation of an insulating film on the contacts. This film resulted in open circuits or, if required, several operations of the toggle switch handle before the circuit was initially made.

The JF switch replacement uses silver-to-silver contact surfaces and provides a strong wiping action in moving between positions. Open circuit problems have been eliminated in this manner. The blade arrangement provides for a circuit between two adjacent contacts, such as in the 2JR switch previously discussed. The type 2JF has two such blade arrangements per switch deck. The standard switches have one, three, and five switching decks, which are indicated in the type designation by the number following JF.

The original production of the switches had a detent to limit the switching action to two positions. The present design has a 12-position detent arrangement with adjustable stops. The stops can be adjusted by removing the four screws on the back plate and arranging the stop arms mounted on the switch shaft to give the number of positions desired.

An O-ring on the switch shaft within the mounting bushing prevents water from entering the switch. An O-ring is also provided on the outside of the mounting bushing to give a watertight seal against the panel in which the switch is mounted. These features have eliminated the need for a watertight cover over the switch.

The JF switch is satisfactory for 120-volt ac applications up to 1 ampere. It is being used in sound-powered telephones, loudspeakers, microphone stations, and similar low-current equipment.

CAUTION:
The switch decks are made of molded nylon material. Be careful in soldering the leads to the switch contacts. Too much heat passing back to the switch deck will destroy the switch deck or damage the insulation between adjacent contacts.

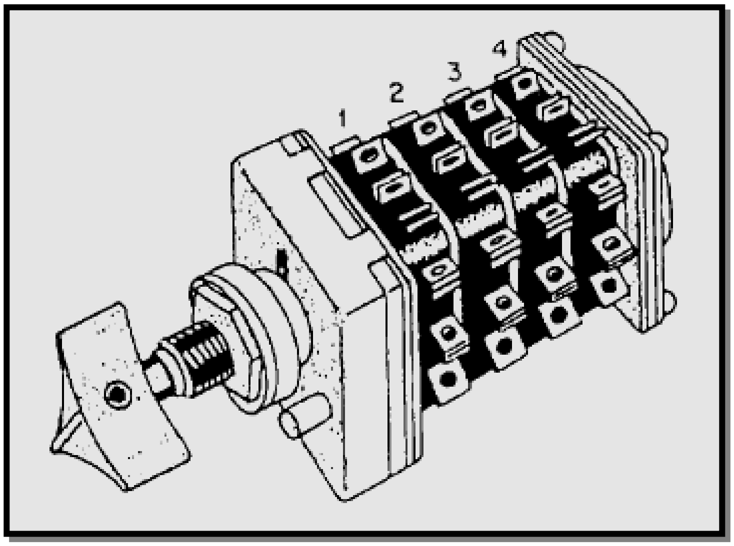


Figure 2-11.—Type JF switch.

2.2.7 Lever-Operated Switches

Many types of lever-operated switches are used in Navy alarm and warning systems to complete an electric circuit to various types of audible and visual alarm signals. The type depends upon the circuit in which it is installed.

Most lever-operated switches use JR interiors (fig. 2-12). These switches are operated by a lever with a suitable locking plate. In the interests of standardization, two types of interiors are available, each containing three 2JR sections. One type is the JRM-300, which has a spring return mechanism; and the other type is the JR-304, which has a positive detent mechanism. Through slightly different arrangements of pins, lever, and locking plate, various types of switches can be obtained.

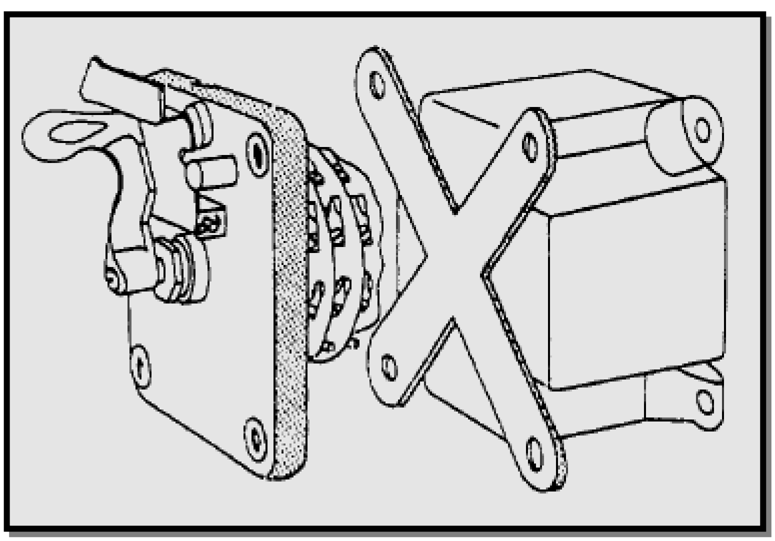


Figure 2-12.—Lever-operated switch.

Special switches are used where the standard switches cannot be used. For example, the diving alarm switch on the submarine bridge must be pressure-proof. For submarine service, a distinctive shape is used for the operating lever knob or heads of alarm switches in the conning tower and the control room (where illumination is low) to avoid the possibility of confusion in operating the proper switch. A square-shaped knob is used for the diving alarm switch, a star-shaped head for the collision alarm switch, and a standard rounded head for the general alarm.

Lever-operated switches are available in 1-, 2-, and 3-ganged types. These switches are used in such systems as the fire room emergency signal, general alarm, chemical-attack alarm, steering emergency signal, whistle operation, lifebuoy-release, and flight-crash signal.

2.2.8 IC/L Pressure Switches

Pressure-operated switches are normally SPST, quick-acting switches. Each contains either a bellows or a diaphragm that works against an adjustable spring. The spring causes the contacts to close automatically when the operating pressure falls below a specified value. The pressure at which the switches operate is adjustable within ranges, such as 0-15, 15-50, and 50-100. Make this adjustment at the screw marked HIGHER (fig. 2-13). These switches can be used also to indicate an increase in pressure above a predetermined point.

Pressure-operated switches are used with the lubricating oil, low-pressure alarm system; air pressure alarm system; and booster-feed pressure alarm system.

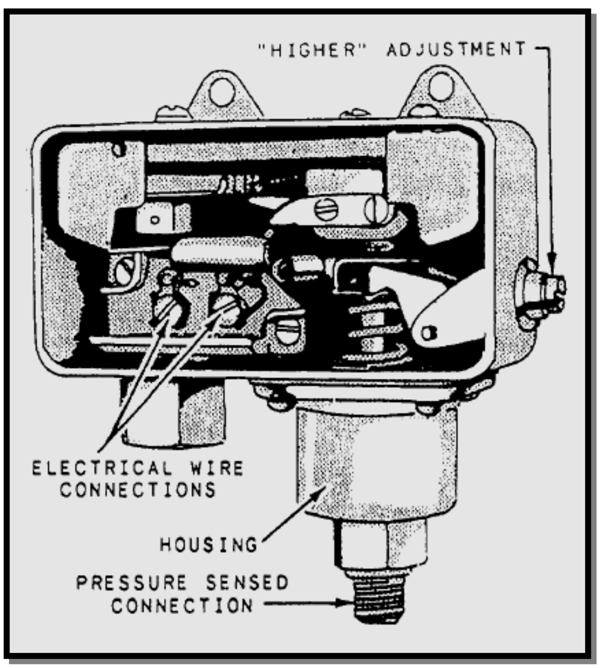


Figure 2-13.—Type IC/L pressure switch.

2.2.9 IC/N Thermostatic Switches

Thermostatic, or temperature-operated, switches are usually SPST, quick-acting, normally open switches. Each switch contains a bellows that works against an adjustable spring, Y (fig. 2-14). The spring causes the contacts to close automatically when the operating temperature exceeds a specified value. The bellows motion is produced by a sealed-in liquid that expands with rising temperature. The sensitive element containing this liquid may be built into switch or located in a remote space and connected to the switch by a capillary tube. The temperature range at which the switches operate is adjustable at X (fig. 2-14).

Temperature-operated switches are used with the circulating-water, high-temperature alarm system; cruising-turbine exhaust alarm system; and generator-air, high-temperature alarm system.

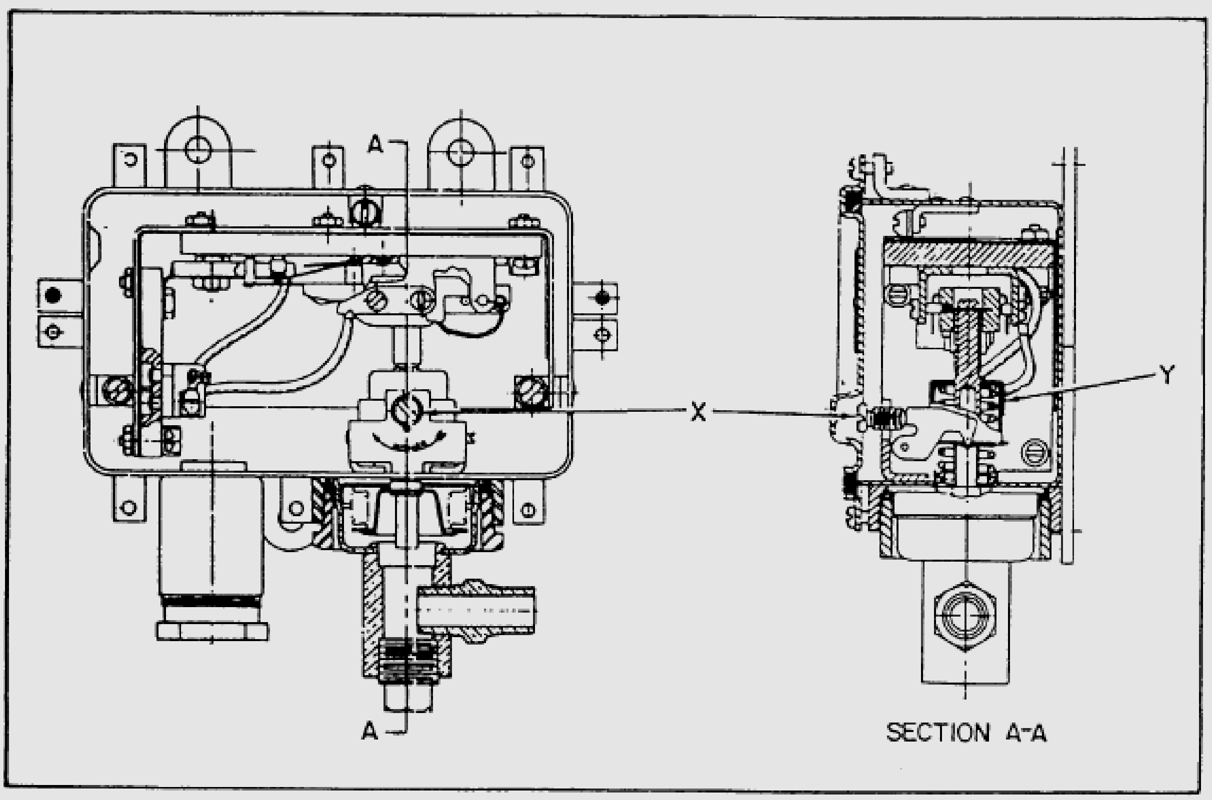


Figure 2-14.—Type IC/N pressure switch.

2.2.10 Mechanical Switches

Mechanically operated switches are used in many types of installations, such as wrong direction alarms and valve-position indicators.

Widely used because of their small size and excellent dependability, they are commonly called “micro switches, ” or properly called sensitive switches. (“MICRO SWITCH” is a trademark of MICRO SWITCH Division, Honeywell Inc.)

These switches will open or close a circuit with a very small movement of the tripping device. They are usually of the push-button variety, and depend on one or more springs for their snap action. For example, the spring of the sensitive switch is a beryllium copper spring, heat-treated for long life and unfailing action. The simplicity of the one-piece spring contributes to the long life and dependability of this switch. The basic sensitive switch is shown in figure 2-15.

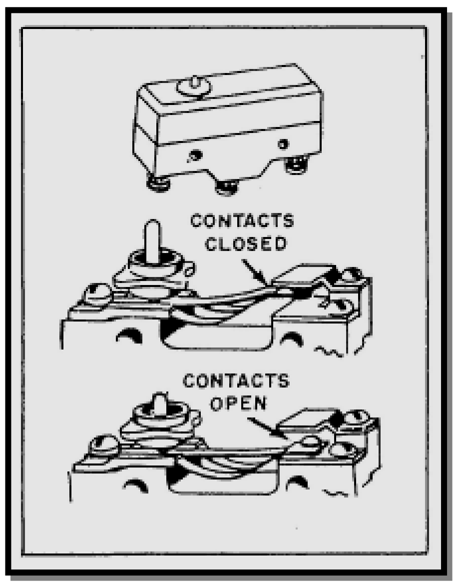


Figure 2-15.—Sensitive switch.

The types of mechanically operated switches are the push-action (type A-S) and the cam-action (types P and P41). The push-operated switch, provided for bulkhead mounting, is a single-throw or multiple-throw, momentary action, normally open push switch. The push-action mechanism uses a straight-line movement of the shaft to operate the electrical contacts. The cam-action switch consists of two SPDT sensitive switches operated by two adjustable cams mounted on the rotor shaft (fig. 2- 16).

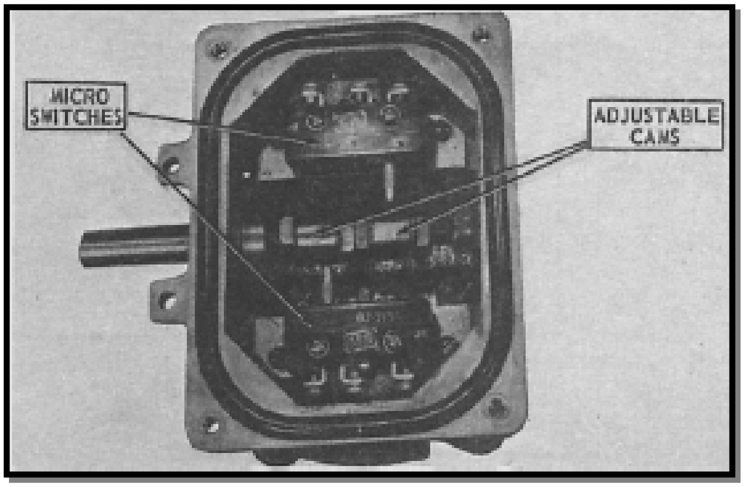


Figure 2-16.—Cam-action mechanical switch.

The cam-action mechanism uses a rotary motion of the shaft to move cams, which in turn operate sensitive switches. The points of operation of the sensitive switches are varied by adjusting the angular positions of the cams with respect to the shaft on which they are mounted. Mechanical switches are used with the following systems:

QA	Air-lock indicator
PW	Clutch-position indicator
SP	Shaft-position alarm
LS	Submersible steering-gear alarm
DW	Wrong-direction alarm
TR	Hull-opening indicator
VS	Valve-position indicator

2.2.11 Water Switch

A water switch consists of a pair of terminals mounted in an insulated base within a cast fitting (fig. 2-17). There is a 7000-ohm, 5-watt resistor connected across the two terminals, which limits the current to the required value for the supervisory circuit when the switch casting is dry. The switch is mounted in the magazine flooding system, and a sprinkling control valve is installed between the switch and the firemain. When the sprinkling control valve is opened, water floods the switch casting and shorts out the 5-watt resistor. With the supervisory resistor shorted, a current of sufficient value to operate the alarm will flow in the circuit.

A water switch is used principally in sprinkling alarm systems (circuit FH).

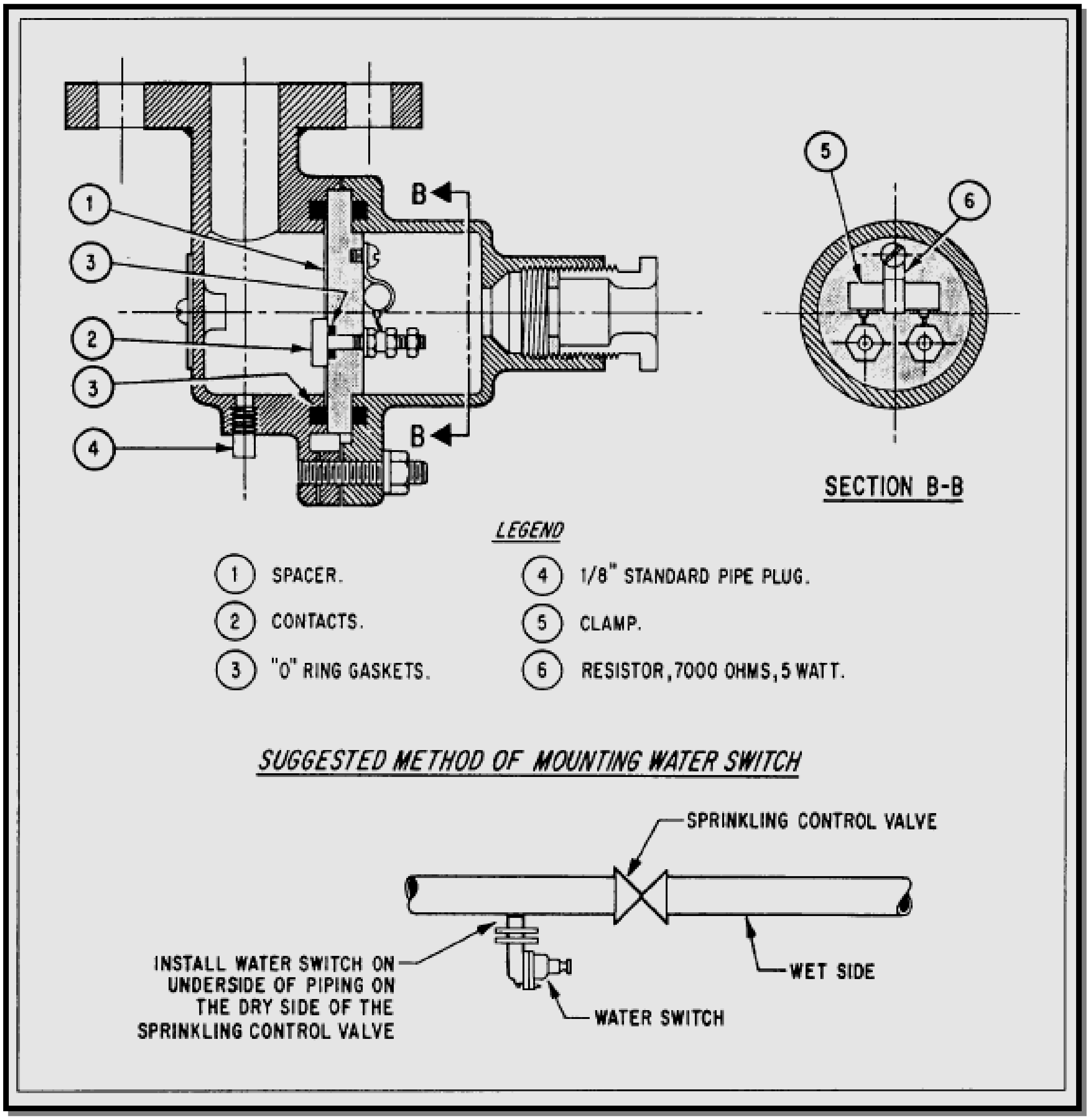


Figure 2-17.—Water switch.

2.2.12 Liquid-Level Float Switch

Can be found in tank- and bilge-level alarms, this float switch has a doughnut-shaped, floatable magnetic core operating over an encapsulated reed switch. The entire assembly can be mounted at any predetermined level, and the switch can be made normally open or closed by reversal of the core. Level conditions are indicated as normal, above normal, or below normal.

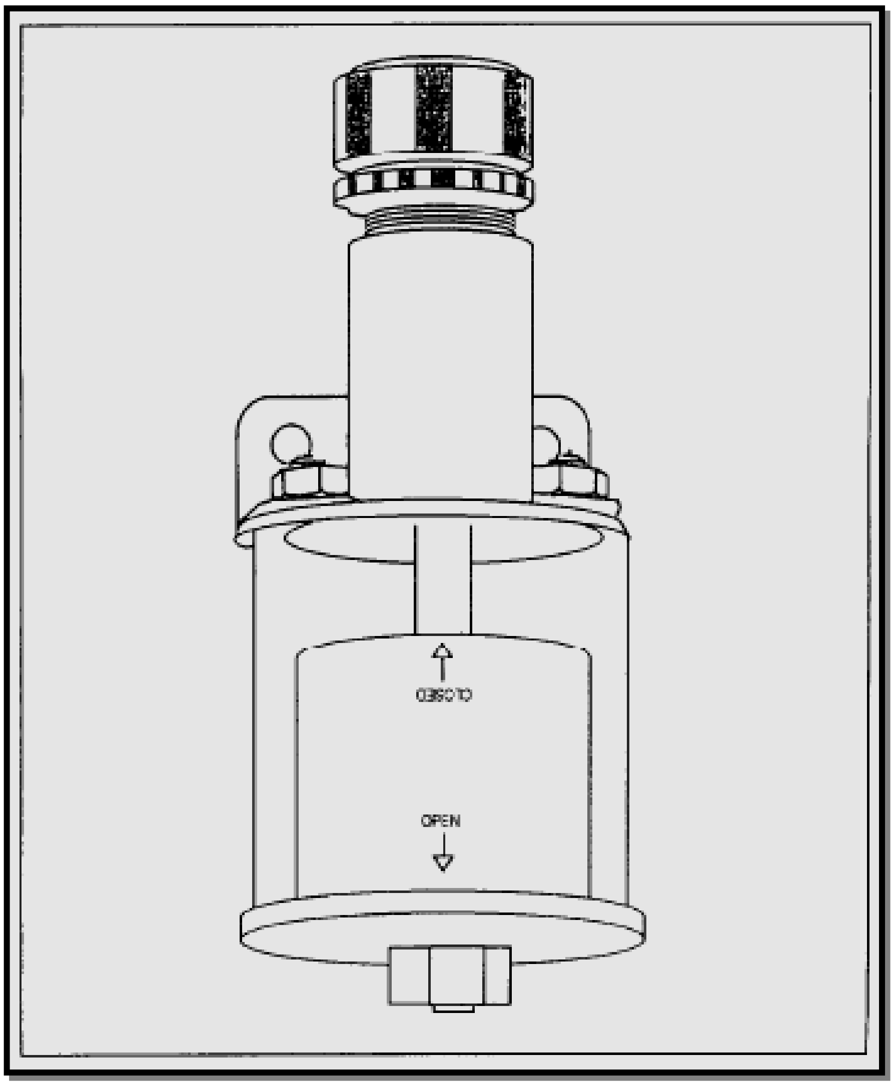


Figure 2-18.—Liquid-level float switch.

2.2.13 Maintenance of Switches

Switches should be checked periodically to ensure that all electrical connections and mechanical fastenings are tight. Lock-washers must be in place. Avoid over-tightening the packing and nut on watertight rotary switches, as excessive pressure on the switch shaft will cause improper positioning of the switch.

Remove dirt and grease from switch and relay contacts with a cloth moistened with an approved solvent. No lubricants of any kind should be applied to the contacts. Use a burnishing tool for dressing small light contacts.

Clean burned copper contacts with fine sandpaper. Do not use emery cloth. Badly burned contacts should be replaced. Always replace contacts in pairs, rather than replacing a single contact.

Silver contacts require very little maintenance. Removal of the tarnish that forms on silver contacts due to arcing is no longer recommended, as this blackened condition improves the operation of the contacts.

When replacing a switch, take great care in tagging the leads to ensure proper replacement. Close supervision and proper checkout by an electrical petty officer can ensure against personal injury and equipment damage.

2.3.0 RELAYS

Relays are electrically operated switches. The operating coil can be connected in series with a supply line to the load or shunted across the line.

The coil design is influenced by the manner in which the relay is used. When the relay is designed for series connection, the coil is usually wound with a fairly small number of turns of large wire because the load current will be flowing through the winding. When the relay is designed for shunt connection, the coil is wound with a large number of turns of small wire, which will increase the resistance and thus lower the current through the coil.

Because the contacts of relays may open or close when energized, they can be used as protective devices or control devices or both simultaneously.

The basic difference between ac and dc relays lies in the armature and magnet core construction. The armature and magnet cores of an ac relay are made up of laminations, and those of a dc relay are of solid material. The use of laminations in an ac relay reduces the heating due to eddy currents. In addition, a copper strap or ring (called a shorted turn) is placed near the end of the pole piece of an ac relay to reduce chatter during operation.

Because the ac is going through a peak, dropping to zero, going through a peak in the opposite direction, and then dropping to zero again during each complete cycle, the coil tends to release the armature each time the current drops to zero and attracts the armature each time it reaches a peak. The shorted turn acts as the secondary of a transformer, the primary of which is the relay operating coil. The current in the shorted turn is out of phase with the current of the operating coil because the copper ring has low-inductive reactance. Thus, when the operating coil flux is zero, the flux produced by the shorted coil is different from zero, and the tendency of the relay to chatter is reduced.

In general, a relay consists of a magnetic core and associated coil, contacts, springs, armature, and the mounting. Figure 2-19 illustrates the fundamental construction of a relay. When the coil is energized, the flow of current through the coil creates a strong magnetic field that pulls the armature downward to contact C1, completing the circuit from the common terminal to C1. At the same time the circuit to contact C2 is opened.

Relays are classified according to their use as control relays or power relays.

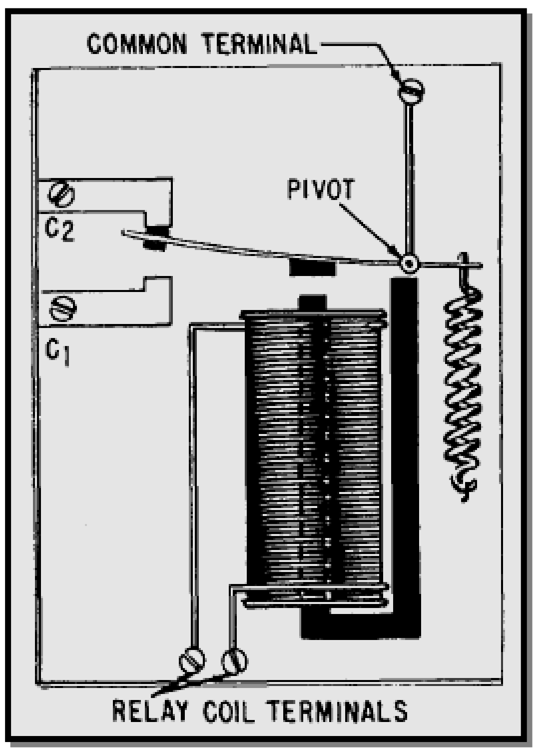


Figure 2-19.—Relay construction.

2.3.1 Control Relays

Control relays are usually known simply as relays. They are frequently used in the control of low-power circuits or other relays, although they also have many other uses. Where multi-pole relays are used, several circuits may be controlled simultaneously. In automatic relaying circuits, a small electrical signal may set off a chain reaction of successively acting relays, which then perform various functions.

Control relays can also be used in so-called lockout action to prevent certain functions from occurring at the improper time. In some equipment, control relays are used to sense under-voltage and overvoltage, reversal of current, excessive currents, and so on.

Control relays are also classified as open, semi-sealed, or sealed. Figure 2-20 illustrates the various types of relays used today. Relays E, G, and H are examples of open relays. The mechanical motion of the contacts can be observed and the relays are easily available for maintenance. Relays B, C, and F are semi-sealed relays. The covers provide protection from dust, moisture, and other foreign material, but can be removed for maintenance. Relays A and D are examples of hermetically sealed relays. These relays are protected from temperature or humidity changes as well as dust and other foreign material. The covers cannot be removed, thus making the relay tamperproof.

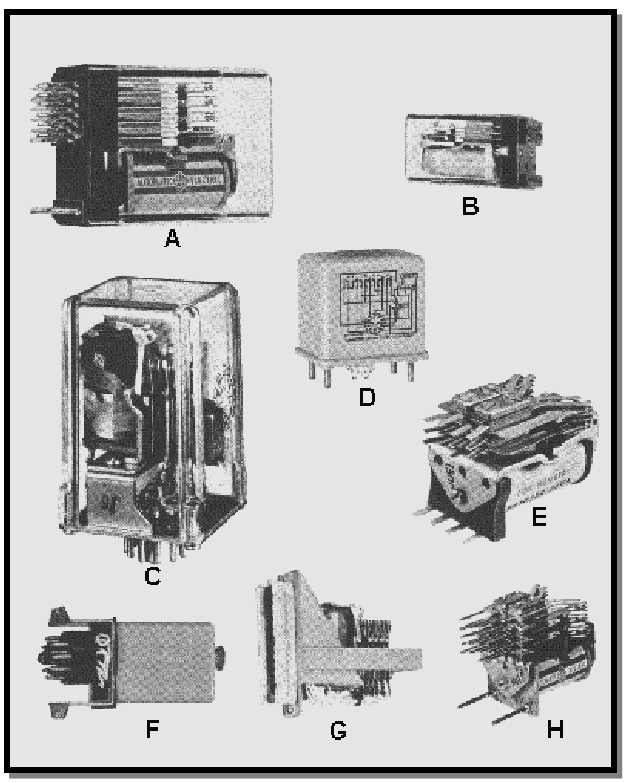


Figure 2-20.—Relay enclosures.

2.3.2 Clapper Relay

The clapper relay (fig. 2-21) has multiple sets of contacts. As the circuit is energized, the clapper is pulled to the magnetic coil. Pulling the arm of the clapper forces the movable contact upward to move the pushrod and the upper movable contact. This action could be repeated for as many sets of contacts as required. Thus, it is possible to control many different circuits simultaneously. To the maintenance person, this type of relay can be a source of trouble. The motion of the clapper arm does not necessarily assure the tandem movement of all the movable contacts. If the pushrod was broken, the clapper arm would push the lower movable contact upward but would not move the upper moveable contact, thereby not completing the circuit.

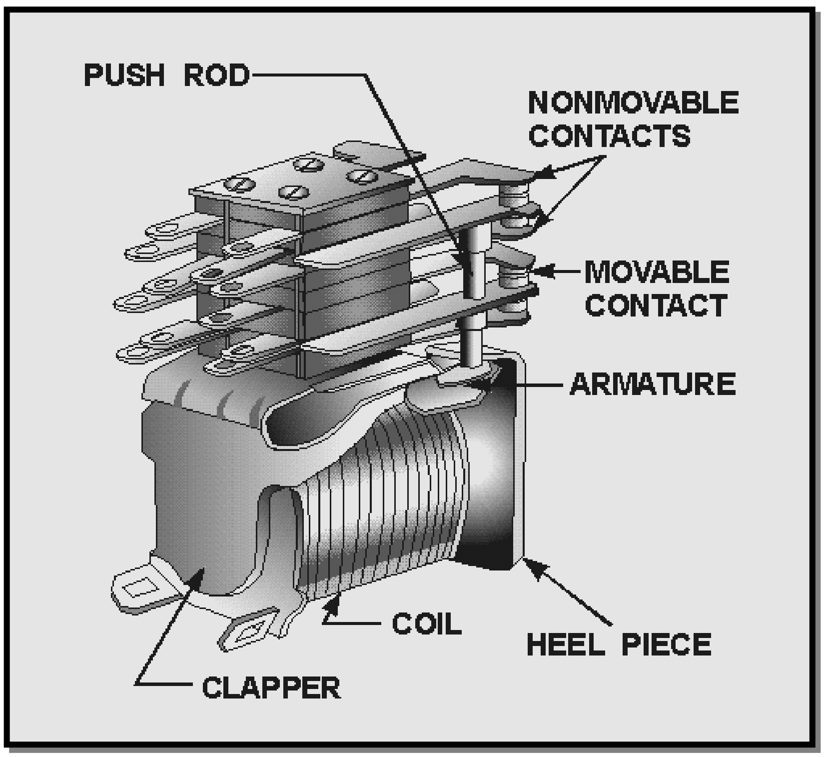


Figure 2-21.—Clapper relay.

2.3.3 Thermal Time Delay Relay

A thermal time delay relay (fig. 2-22) is constructed to produce a delayed action when energized. Its operation depends on a thermal action, such as that of a bimetallic element being heated. The element is made by welding together two strips of different metals having different thermal expansion rates.

A heater is mounted around, or close to, the element, with the contacts mounted on the element itself. As the heat causes the element to bend (because of the different thermal expansion rates), the contacts close to operate a relay. The delay time of the bimetallic strips is usually from 1/2 to 1 1/2 minutes and is varied by using metals with different expansion rates or by increasing or decreasing the distance between the fixed and moving contacts.

One common form of time delay relay uses a lag coil, which is usually a large copper slug located at one end of the winding or a tubular sleeve located between the winding and the core. The lag coil (slug) acts as a short-circuited secondary for the relay coil. The counter magnetomotive force (mmf), due to the current induced in the coil by the changing coil current, delays the flux buildup or decay in the air gap and hence the closing or opening of the armature. A short slug near the armature end of the core has relatively more effect on the operating time, and one at the heel end has more effect on the release time.

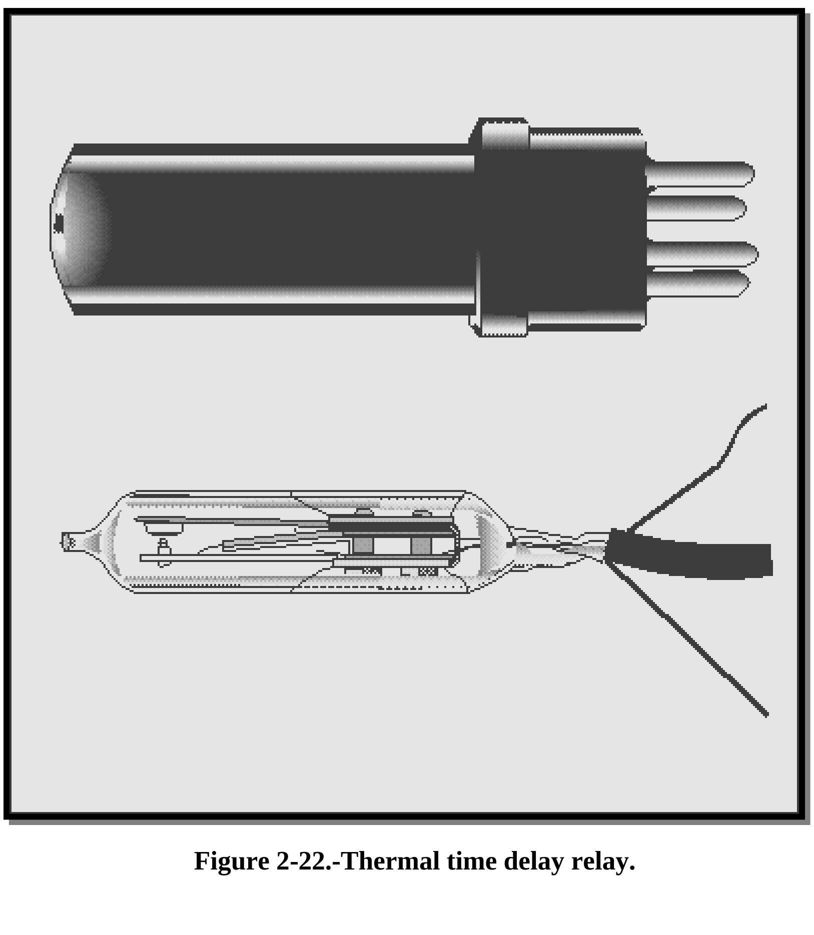


Figure 2-22.-Thermal time delay relay.

2.3.4 Latch-In Relay
Another type of relay is the latch-in relay. This relay is designed to lock the contacts in the de-energized position until the relay is either manually or electrically reset. Two windings are used: the trip coil and the reset coil. When the trip coil is energized, it acts on a spring-loaded armature. The movable contacts of the relay are mounted on this armature. After the contacts open they are held in the open position by a mechanical latch. The mechanical latch is unlatched when the reset coil is energized, thus allowing the relay's contact to close again.

2.3.5 Ac Shunt Relay
An ac shunt relay is illustrated in figure 2-23. The basic function of the relay is to make or break an electrical control circuit when the relay coil is energized. To do this, voltage is applied to the operating coil, 2 (connected across the line), which attracts the armature, 3. When the armature is pulled down, it closes the main contacts, 4.

The pull-in and dropout current values may be adjusted. In figure 2-24 the various adjustment points of the ac shunt-type relay are indicated. The spring, A, and the setscrew, E, control the pickup and dropout values. Before the relay is adjusted, the screw, F, should be set to clear the armature when the armature is in the closed position. The pull-in value can be raised by increasing the spring tension or by increasing the armature gap.

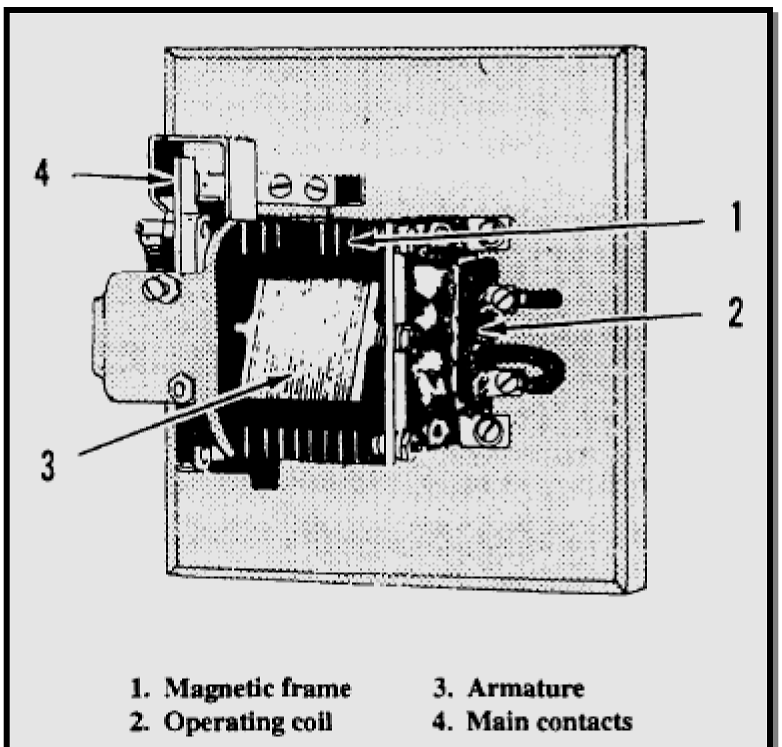


Figure 2-23.—Ac shunt relay.

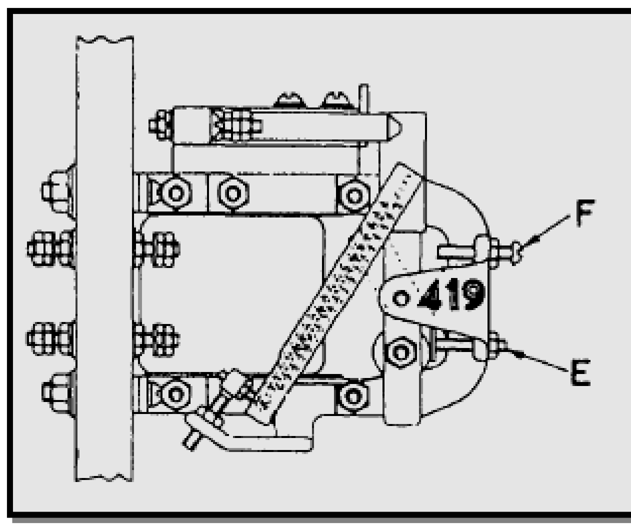


Figure 2-24.-Adjustment points of an ac shunt relay.

2.3.6 Series-Type Relays

The series-type relays are operated by circuit current flowing through the coil or coils. This feature makes it possible to use the relay as a field failure relay or for any application where the relay operation is in response to changes in circuit current flow.

There are two adjustments on the two-coil relay. One adjustment sets the difference between the opening and closing current values. The other adjustment sets the range of operating values. Usually, the operating adjustment is the only one required.

2.3.7 Power Relays

Power relays, also known as contractors, use a relatively small amount of electrical power to control the switching of a large amount of power. The relay permits you to control power at other locations in the equipment, and the heavy power cables need be run only through the power relay contacts.

Only lightweight control wires are connected from the control switches to the relay coil. Safety is also an important reason for using power relays, since high-power circuits can be switched remotely without danger to the operator.

2.3.8 Maintenance of Relays

Relays are some of the most dependable electromechanical devices in use; but like any other mechanical or electrical device, they occasionally wear out or become inoperative.

Relay contact surfaces must be kept clean and in good operating condition. Contact clearances or gap settings must be maintained according to the relay’s operational specifications.

Under normal operating conditions, most relay contacts spark slightly; this will cause some minor burning and pitting of the contacts.

The buildup of film on the contact surfaces of a relay is another cause of relay trouble. Carbon buildup, which is caused by the burning of a grease film or other substance (during arcing), also can be troublesome. Carbon forms rings on the contact surfaces; and as the carbon rings build up, the relay contacts are held open.

When current flows in one direction through a relay, the contacts may be subjected to an effect called cone and crater. The crater is formed by the transfer of the metal of one contact to the other contact, the deposit being in the form of a cone. This condition is shown in figure 2-25, view A.

Some relays are equipped with ball-shaped contacts which, in many applications, are superior to the flat contacts. Dust or other substances do not collect as readily on a curved surface. In addition, a ball-shaped contact can penetrate film more easily than a flat contact. Figure 2-25, view B, shows a set of ball-shaped contacts.

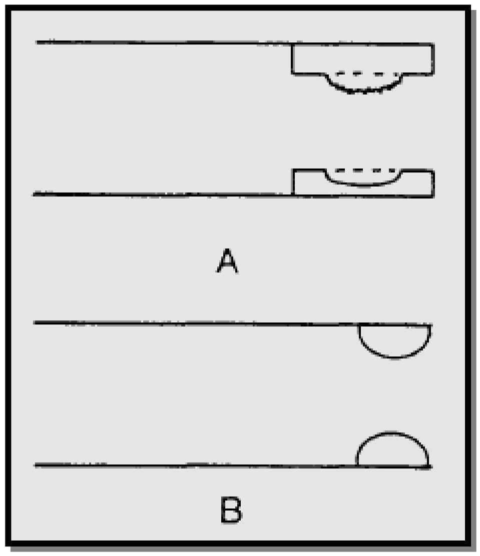


Figure 2-25.—Relay contacts.

When you clean or service ball-shaped relay contacts, be careful to avoid flattening or otherwise altering the rounded surfaces of the contacts. A burnishing tool should be used to clean relay contacts. Be sure you do not touch the surface of the tool that is used to clean the relay contacts. After the burnishing tool is used, clean it with alcohol. Never use sandpaper or emery cloth to clean relay contacts. Many relays have been damaged or ruined because the contact points were cleaned with sandpaper or emery cloth instead of a burnishing tool. The use of sandpaper or emery cloth may cause bending of the contact springs and other damage. Excessively burned and pitted contacts cannot be repaired by burnishing.

When a relay has bent contacts, you should use a point bender (fig. 2-26) to straighten the contacts. The use of any other tool could cause further damage, and the entire relay would then have to be replaced.

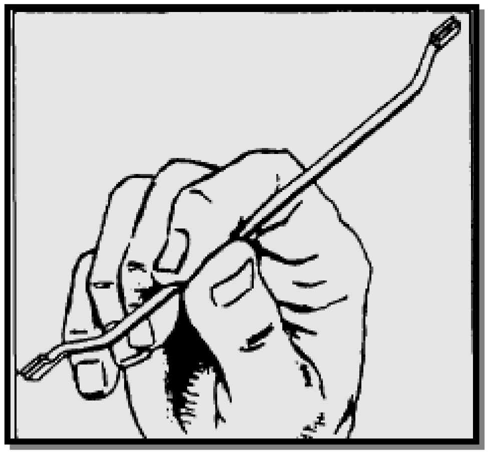


Figure 2-26.—Point bender.

Relays similar to the shunt relay (fig. 2-23) have replaceable contacts that should be maintained similar to switch contacts. See Maintenance of Switches at the beginning of this chapter for further information.

During preventive maintenance you should check for charred or burned insulation on the relay and for darkened or charred terminal leads. Both of these conditions indicate overheating, and further investigation should be made to determine the cause. One possible cause for overheating is loose power terminal connections, allowing arcing at the connection.

Covers should not be removed from semi-sealed relays in the field. Removal of a cover in the field, although it might give useful information to a trained eye, may result in entry of dust or other foreign material that may cause poor contact or an open circuit. Removal of the cover may also result in loss of or damage to the cover gasket. When the relay is installed in a position where there is a possibility of contact with explosive fumes, extra care should be taken with the cover gasket. Any damage to, or incorrect seating of, the gasket increases the possibility of igniting the vapors.

Should an inspection determine that a relay has exceeded its safe life; the relay should be removed immediately and replaced with another of the same type. The replacement relay must have the same characteristics or ratings, such as voltage, amperage, type of service, number of contacts, or continuous or intermittent duty.

Relay coils usually consist of a single coil. If a relay fails to operate, the coil should be tested for open circuit, short circuit, or short to ground. An open coil is a common cause of relay failure.

2.4.0 SOLENOIDS

Solenoids are electromagnets formed by a conductor wound in a series of loops in the shape of a helix (spiral), Inserted within this spiral or coil is a soft-iron core and a movable plunger. The soft-iron core is pinned or held in position and therefore is not movable. The movable plunger (also soft iron) is held away from the core by a spring when the solenoid is de-energized (fig. 2-27).

When current flows through the conductor, a magnetic field is produced. This field acts in every respect like a permanent magnet having both a north and a south pole. The total magnetic flux density produced is the result of the generated mmf and the permeability of the medium through which the field passes.

In much the same way that electromotive force (emf) is responsible for current in a circuit; emf is responsible for external magnetic effects. The emf that produces the magnetic flux in a solenoid is the product of the number of turns of wire and the current through the coil. If the current is expressed in amperes, the emf is expressed in ampere-turns.

From this it can be seen that a prescribed mmf can be produced by using either a few turns of large wire (high current) or many turns of small wire (low current).

The soft-iron core will also influence the strength of the magnetic flux produced by the coil. The strength of the field is greatly increased by the use of a soft-iron core due to the greater permeability of iron in respect to air. Consequently, by using an iron core, a greater flux density can be produced for a given number of ampere-turns.

The magnetic flux produced by the coil will result in establishing north and south poles in both the core and the plunger. These poles have such a relationship that the plunger is attracted along the lines of force to a position of equilibrium when the plunger is at the center of the coil. As shown in figure 2-27, the de-energized position of the plunger is partially out of the coil due to the action of the spring. When voltage is applied, the current through the coil produces a magnetic field that draws the plunger within the coil, thereby resulting in mechanical motion. When the coil is de-energized, the plunger returns to its normal position by the spring action. It is interesting to note that the effective strength of the magnetic field on the plunger varies with the distance between the two. For short distances, the strength of the field is strong; and as distances increase, the strength drops off quite rapidly.

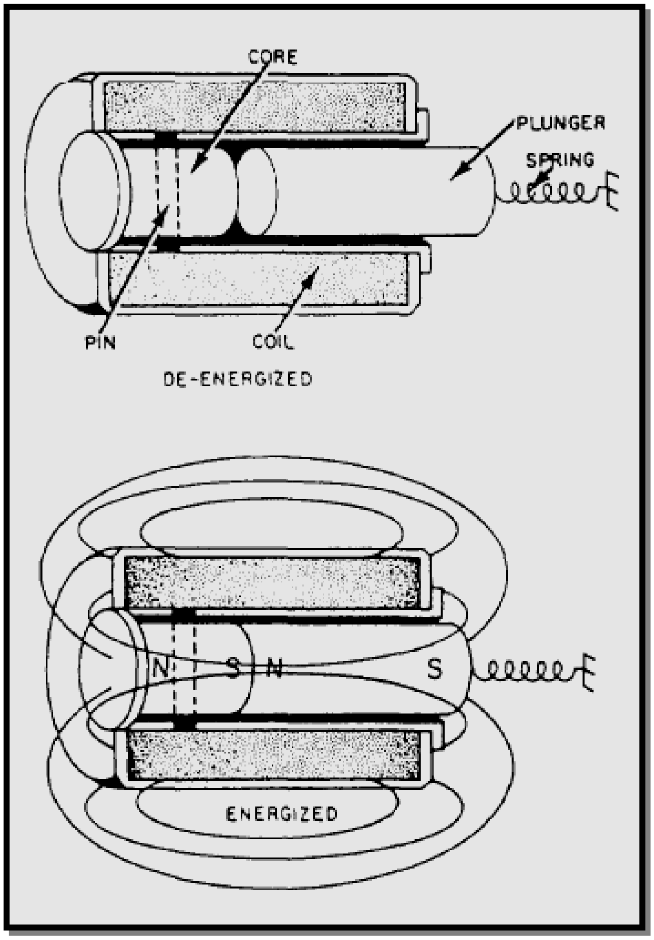


Figure 2-27.-Solenoid action.

2.4.1 Uses of Solenoids

Solenoids are used for electrically operating hydraulic valve actuators, carbon pile voltage regulators, power relays, and mechanical clutches. They are also used for many other purposes where only small movements are required. One of the distinct advantages in the use of solenoids is that a mechanical movement can be accomplished at a considerable distance from the control. The only link necessary between the control and the solenoid is the electrical wiring for the coil current.

2.4.2 Maintenance of Solenoids

The first step to be taken in checking an improperly operating solenoid is a good visual inspection. The connections should be checked for poor soldering, loose connections, or broken wires.

The plunger should be checked for cleanliness, binding, mechanical failure, and improper alignment adjustment. The mechanism that the solenoid is to actuate should also be checked for proper operation.

The second step should be to check the energizing voltage by use of a voltmeter. If this voltage is too low, the result would be less current flowing through the coil and thereby a weak magnetic field. A weak magnetic field can result in slow, ineffective operation. It could also possibly result in chatter or in-operation. If the energizing voltage is too high, it will in all probability damage the solenoid by either overheating or arcing. In either case, the voltage should be reset to the proper value so further damage or failure will not result.

The solenoid should then be checked for opens, shorts, grounds, and correct resistance with an ohmmeter. If when you check the resistance of the solenoid the ohmmeter indicates infinity, the solenoid is open-circuited and should be replaced. If the ohmmeter reads zero or less than the specified resistance, the coil is shorted and should be replaced. However, if the resistance of the coil is higher than specified (but not infinity), look for a poor contact or a damaged conductor. If the fault cannot be found or corrected, replace the solenoid. Another check possible with the ohmmeter is to determine if the coil is grounded. If the coil is grounded, re-insulate the solenoid.

2.5.0 PROTECTIVE DEVICES

Most protective devices are designed to interrupt the power to a circuit or unit under abnormal conditions, such as short circuits, overloads, high or low voltage, and excessive current. The most common types of protective devices are fuses, circuit breakers, and overload relays.

2.5.1 Fuses

A fuse is a protective device used to open an electric circuit when the current flow exceeds a safe value. Fuses are made in many styles and sizes for different voltages and currents, but they all operate on the same general principle. Each fuse contains a soft-metal link that melts and opens the circuit when overheated by excessive currents.

2.5.1.1 Cartridge Fuses

A cartridge fuse (fig. 2-28) consists of a zinc-alloy link enclosed in a fiber, plastic, ceramic, or glass cylinder. Some fiber and plastic fuse cylinders are filled with non-conducting powder. The smaller fuses are used in circuits up to 60 amperes and are made in the ferrule, or round-end cap, type. Large sizes with short flat blades attached to the end caps are rated from 65 to 200 amperes. These blades fit tightly into clips on the fuse block similar to knife-switch clips.

Cartridge fuses are made in capacities of 1 through 1000 amperes for voltages of 125, 250, 500, 600, and 1000 volts. Fuses intended for 600- and 1000-volt service are longer and do not fit the same fuse holders intended for lower volt service. Fuses of different ampere capacity are also designed for different sizes of holders. For example, fuses of 1 through 30 amperes fit one size of holder, and fuses with capacities of 35 through 60 amperes fit a different size holder.

Cartridge fuses in IC equipment are of various sizes, such as the miniature FO2 or FO3 (1 1/4- by 1/4-inch) fuse rated from 0.1 to 30 amperes at 125 volts and the midget FO9 (1 1/2- by 13/32-inch) fuse rated for 0.1 through 30 amperes at 125 volts. The standard 2- by 9/16-inch fuse is rated from 1 to 30 amperes, 500 volts for ac service and 250 volts for dc service. Fuses above 60-ampere capacity have knife-blade contacts and increase in diameter and length as the capacity increases.

Before fuses of greater than 10-ampere capacity are pulled, the switch for the circuit should be opened. Whenever possible, this precaution should be taken before any size fuse is pulled or replaced. Approved fuse pullers must be used for removing fuses. Fuses should never be short-circuited or replaced with fuses of larger current capacity.

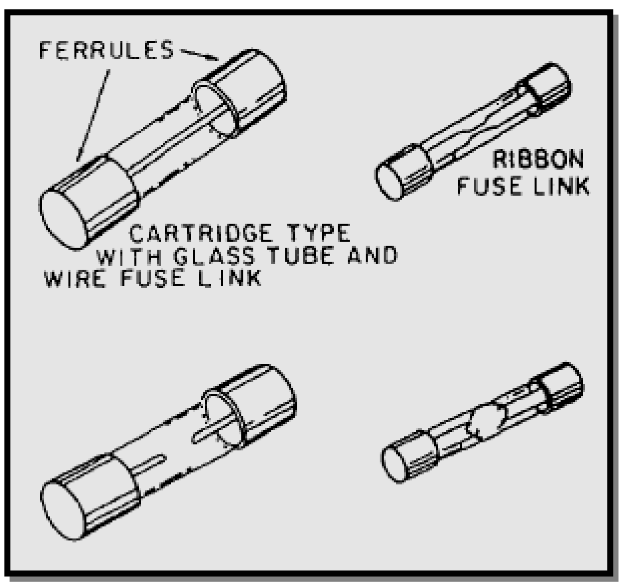


Figure 2-30.-Cartridge fuse.

2.5.1.2 Time-Delay Fuses

Time-delay fuses are used in motor supply circuits, for example, where overloads and motor-starting surges of short duration exist. A conventional fuse of much higher rating would be required to prevent blowing of the fuse during surges. Because of its high rating, this fuse could not provide necessary protection for the normal steady-state current of the circuit.

Time-delay fuses are rated as to their time lag characteristics with a minimum blowing time at some overload current. A typical rating is 12 seconds minimum blowing time at 200 percent rated current.

2.5.2 Selection of Proper Fuses

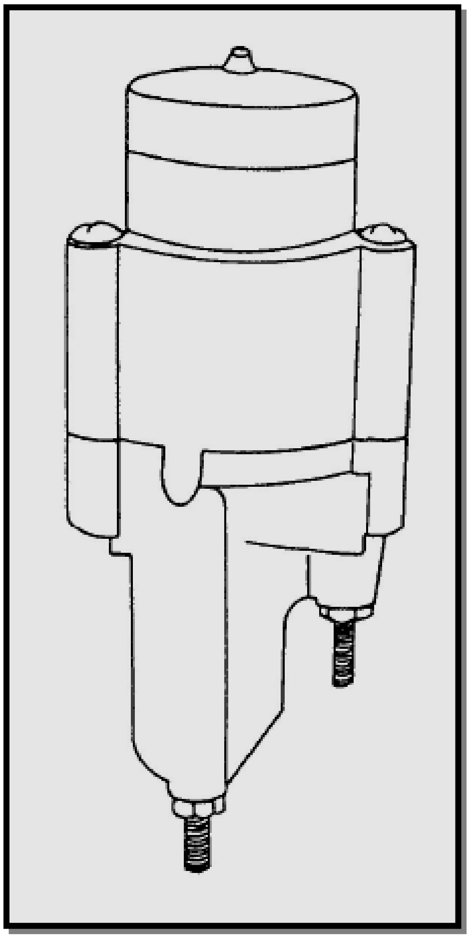
Individual fuses are provided on the IC switchboards for each associated circuit. A separate fuse in each line of each circuit has the effect of considerably increasing the maximum short-circuit current that the fuses can safely interrupt. It also provides greater protection to the remaining circuits energized from the same bus in case of a possible defect in one fuse.

In general, fuse ratings should be approximately 10 percent above the maximum continuous connected load. In circuits, such as call bell systems and alarm systems where only a small portion of the circuit is likely to be operated at any one time, the fuse rating should be 10 percent greater than the load of one associated group of signals operated, or 15 percent of the total connected load, whichever is greater. Where the circuit incorporates branch fuses, such as those associated with the fire-control (FC) switchboards, the rating of the fuses on the IC switchboard should be 20 percent above the maximum connected load to provide sufficient margin so branch fuses will always blow before the main fuses. In no case should the fuse rating be greater than 2 1/2 times the rated capacity of the smallest cable in the circuit. If too large a fuse were used, a fire hazard would exist.

2.5.3 Fuse Holders

The type EL-1 fuse holder consists of a base and a plug, as shown in figure 2-29. The base extends behind the panel, and the plug containing the fuse is screwed into the base. Behind a hole in the plug cap is a small neon lamp that serves as a blown-fuse indicator, lighting when the energized circuit through the holder is interrupted by the blowing of a fuse. Series resistors of different values are used with the lamp on 125- and 250-volt circuits, except for the midget holder, which is rated for 125 volts only.

The types FHL10U, FHL11U, and FHL12U (fig. 2-30) consist of a fuse holder body and a fuse carrier. The body is mounted on the panel, and the carrier with the fuse placed in the clips is inserted into the body in a manner similar to inserting a bayonet-type lamp into a socket.



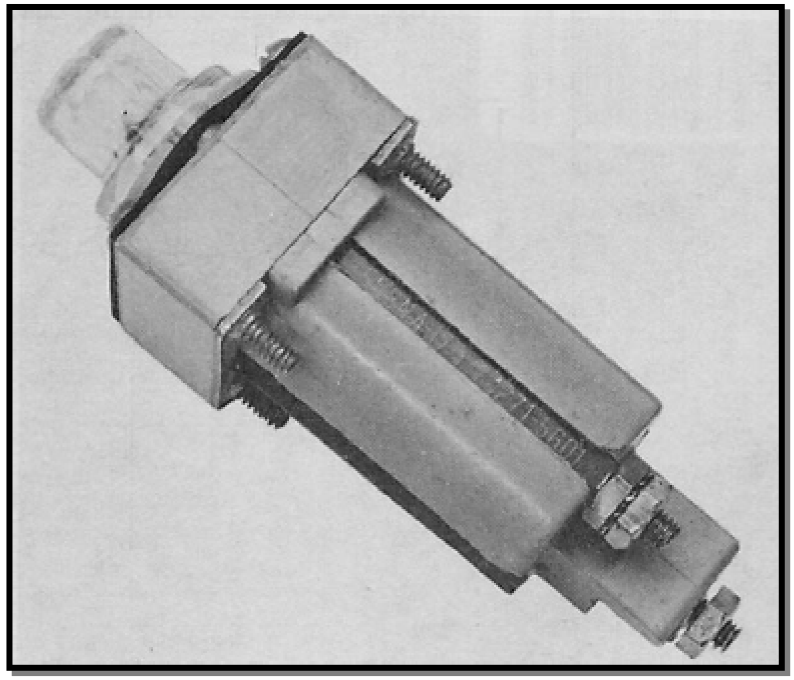


Figure 2-30.—Type FHL12U fuse holder.

Figure 2-29.—Type EL-1 fuse holder.

Removal of the fuse is accomplished by pushing and turning the fuse carrier in a counterclockwise direction, again similar to the removal of a bayonet-base lamp. The types FHL10G and FHL11G accommodate 1 1/4- by 1/4-inch fuses. The type FHL10G will hold two fuses and can therefore be used to fuse both sides of the line, or, in conjunction with a type FHL11G, will fuse a 3-phase line. Type FHL12G will accommodate 1 1/2- by 13/32- inch fuses. When these fuse holders are mounted in a drip-proof enclosure, they maintain the drip-proof integrity. They also possess the ruggedness and the vibration and high-impact shock resistance necessary for shipboard use.

The extensive use of low-voltage power supplies has required the use of incandescent lamps in place of neon glow lamps in some indicator light circuits. A modification of the FHL10U fuse holder provides a third terminal connected to a 28-volt incandescent lamp in the cap. By insertion of a suitable resistor between the load terminal and the added terminal, the lamp will be energized by a sufficient voltage to become visible when the fuse has blown. In some low-voltage fuse holders the resistor and lamp are included within the clear plastic cap. Low-voltage fuse holders should not be used in sensitive, low-current equipment. Where an overload condition occurs and the fuse blows, the low-resistance indicator circuit may pass sufficient current to damage the equipment.

Due to the design of certain fuses and in cases where space does not permit indicator-type fuse holders, separate indicator light circuits are mounted on a panel and connected in parallel with separately mounted fuses and fuse clips. In some cases an alarm circuit in the form of a bell or buzzer takes the place of the indicator light.

2.5.4 Troubleshooting Fuse Circuits

An electrical system may consist of a comparatively small number of circuits or, in the larger systems, the installation may be equal to that of a fair-sized city.

Regardless of the size of the installation, an electrical system consists of a source of power (generators or batteries) and a means of delivering this power from the source to the various loads (lights, motors, and other electrical equipments).

From the main power supply the total electrical load is divided into several feeder circuits, and each feeder circuit is further divided into several branch circuits. Each final branch circuit is fused to safely carry only its own load, while each feeder is safely fused to carry the total current of its several branches. This reduces the possibility of one circuit failure interrupting the power for the entire system. The feeder distribution boxes and the branch distribution boxes contain fuses to protect the various circuits.

The distribution wiring diagram showing the connections that might be used in a lighting system is illustrated in figure 2-31. An installation might have several feeder distribution boxes, each supplying six or more branch circuits through branch distribution boxes.

Fuses F1, F2, and F3 (fig. 2-31) protect the main feeder supply from heavy surges, such as short circuits or overloads on the feeder cable. Fuses A-A_1 and B-B_1 protect branch No. 1. If trouble develops and work is to be done on branch No. 1, switch S1 may be opened to isolate this branch. Branches 2 and 3 are protected and isolated in the same manner by their respective fuses and switches.

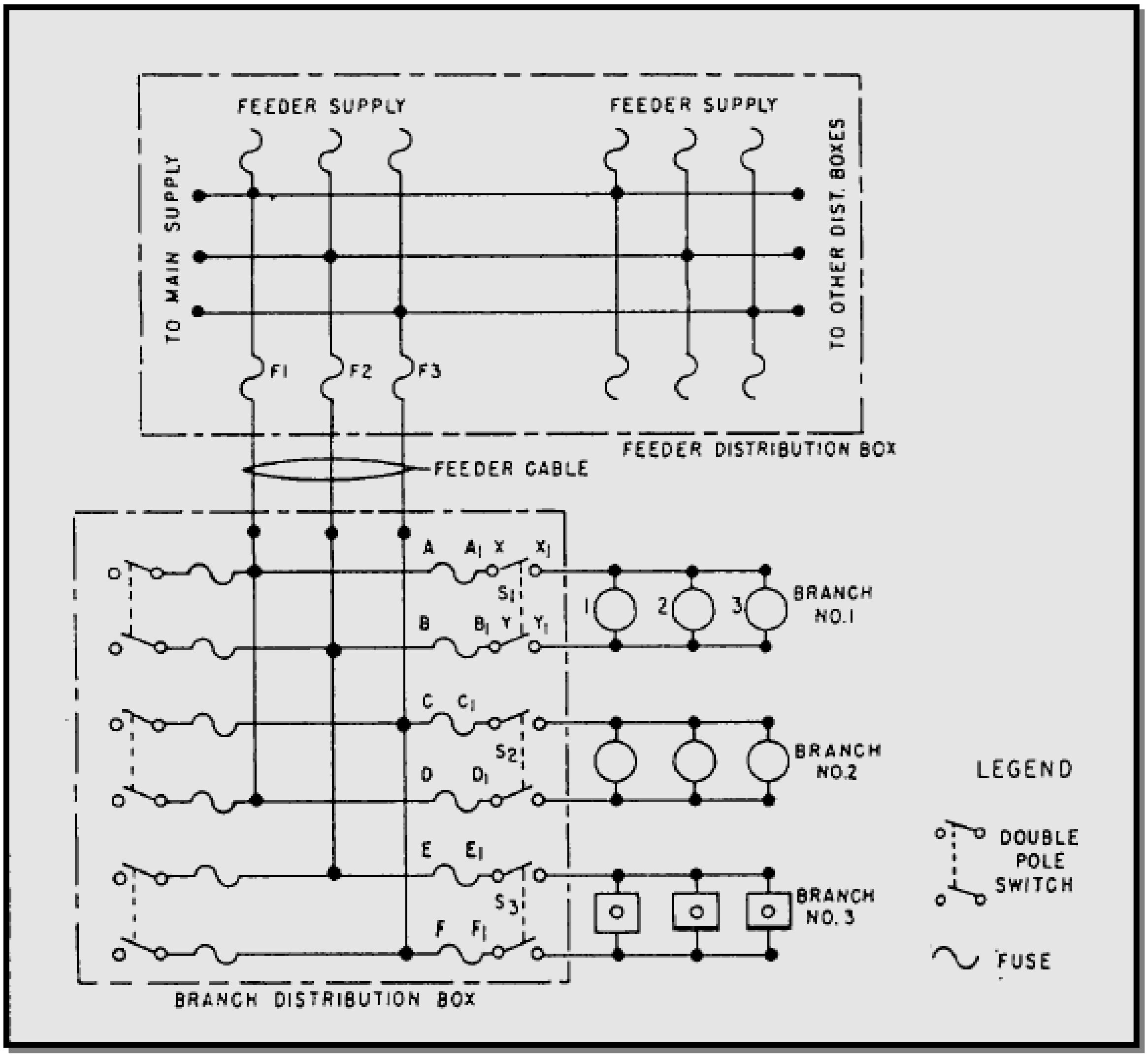


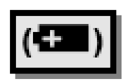
Figure 2-31.—Three-phase distribution wiring diagram.

2.5.5 FLUKE Multimeter Series III (Models 77/75/23/21)

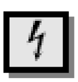
An instrument designed to measure electrical quantities. A typical multimeter can measure alternating- and direct-current potential differences (voltages), current, and resistance, with several full-scale ranges provided for each quantity.

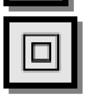
2.5.6 Safety Information

- Never use the meter if the meter or test leads look damaged.
- Be sure the test leads and switch are in the correct position for the desired measurement.
- Never measure resistance in a circuit when power is applied.
- Never touch the probes to a voltage source when the test leads are plugged into the 10 A or 300 mA input jack.
- Never apply more than the rated voltage between any input jack and earth ground.
- Be careful when working with voltages above 60 V dc or 30 V ac rms. Such voltages pose a shock hazard.
- Keep your fingers behind the finger guards on the test probes when making measurements.

Warning:
To avoid false readings, which could lead to possible electric shock or personal injury, replace the battery as soon as the battery indicator appears. 

2.5.7 Symbols

 Dangerous Voltage May Be Present

 Double Insulation

Overvoltage Installation Category per IEC 1010:	
CAT II	Typical locations include; main wall outlets, local appliances, and portable equipment.
CAT III	Typical locations include switches in the fixed installation and equipment for industrial use permanently connected to the fixed installation.

2.5.8 Input Jacks

See Specifications for overload protection.

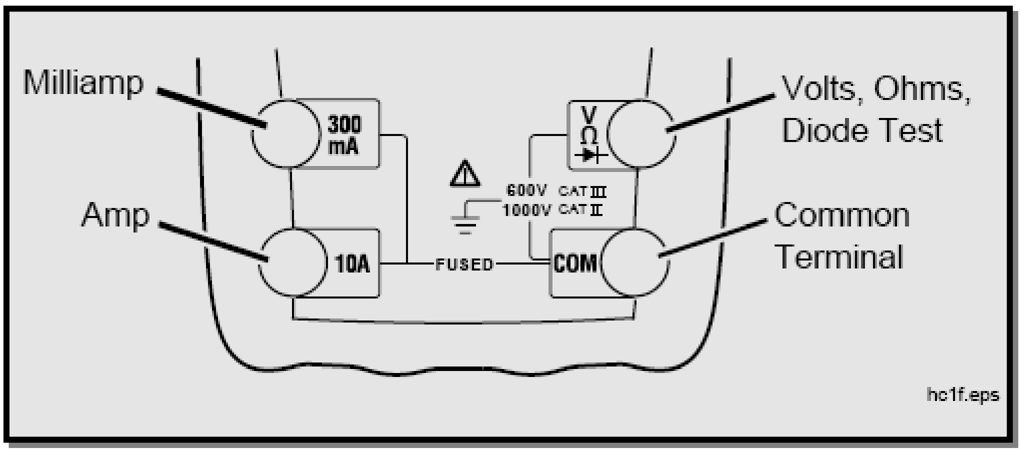


Figure 2-32.—FLUKE Input Jack Locations.

2.5.9 Autorange

The meter defaults to autorange when you turn on the meter.

2.5.10 Manual Range

Manual ranging is available in V ac, V dc, ohms, A ac, and A dc.

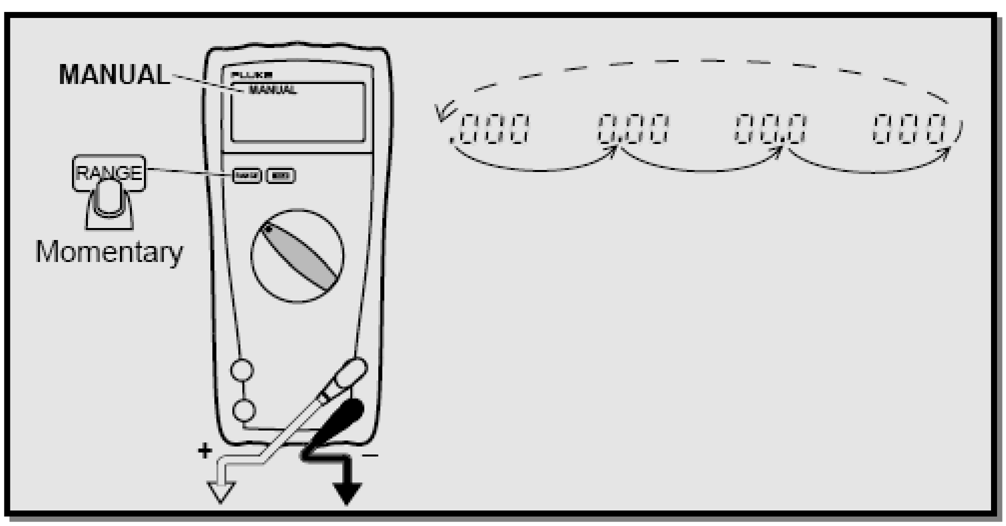


Figure 2-33.—FLUKE Manual Range Settings.

To return to autorange, press **RANGE** for 1 second or turn the rotary switch.

2.5.11 Automatic Touch Hold Mode

The Touch Hold mode automatically captures and displays stable readings for all functions.

When the meter captures new input, it beeps and a new reading is displayed.

Warning:
To avoid electric shock, do not use the Touch Hold mode to determine if a circuit with high voltage is dead. The Touch Hold mode will not capture unstable or noisy readings.

Note:
Stray voltages can produce a new reading.

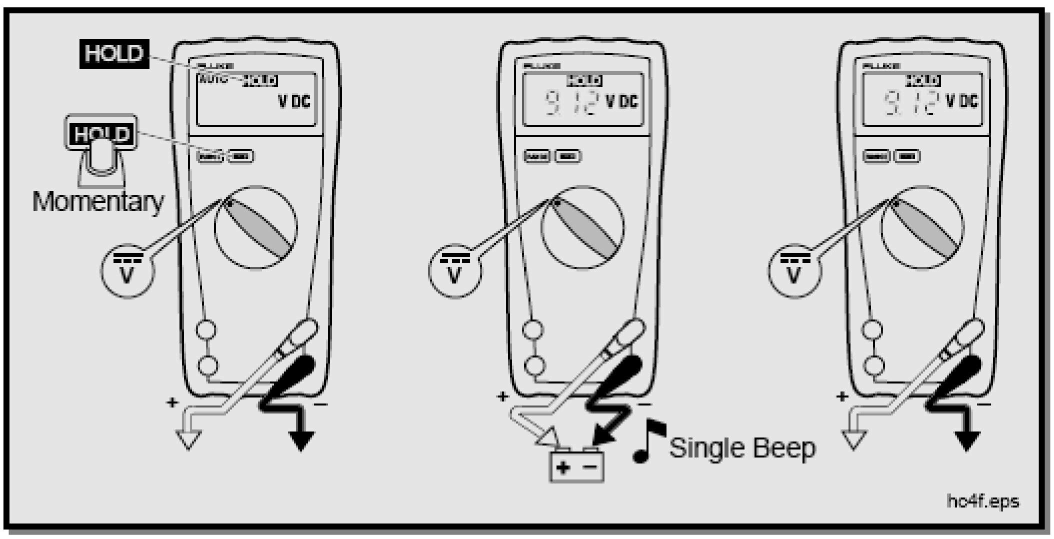
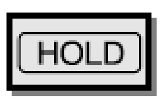


Figure 2-34.—FLUKE Auto Touch Hold.

To exit the Touch Hold mode, press 

momentarily or turn the rotary switch.

2.5.12 Bar Graph

The bar graph shows readings relative to the full scale value of the displayed measurement range and indicates polarity.

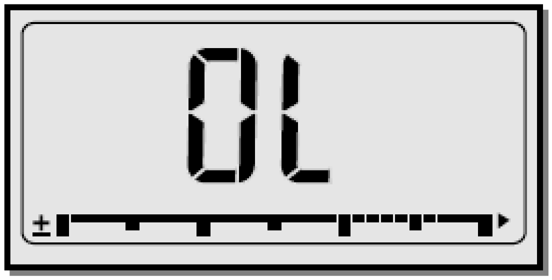


Figure 2-35.—FLUKE Bar Graph reading.

2.5.13 Standby

If the meter is on but is inactive for an hour (20 minutes in diode test), the display goes blank and displays four bar graph segments. To resume operation, turn the rotary switch or press a button.

2.5.14 AC and DC Voltage (Ṽ V̄ mV̄)

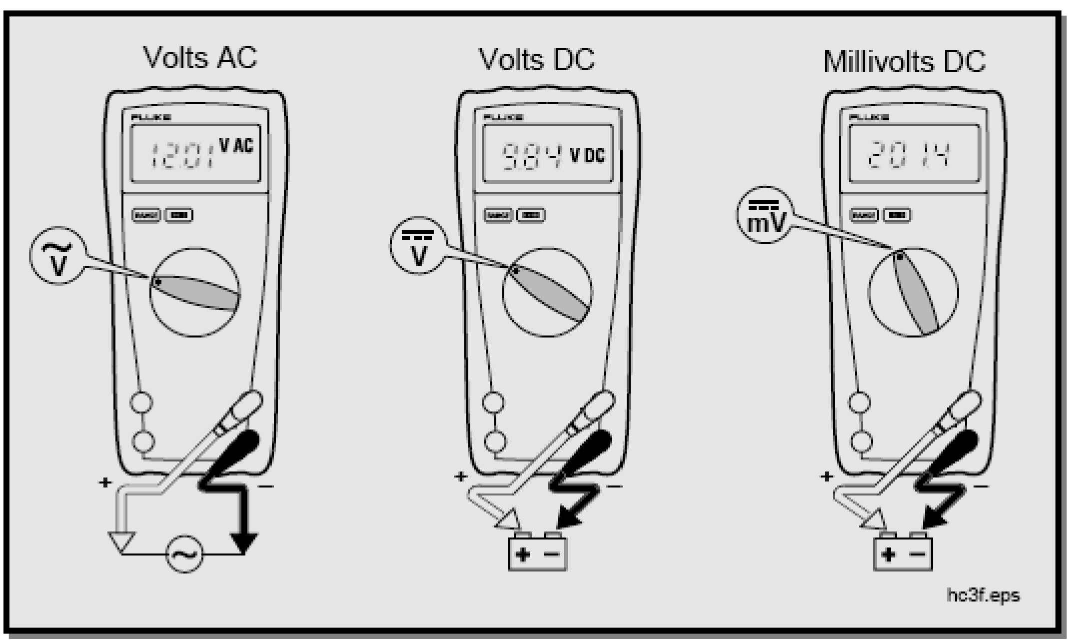


Figure 2-36.—FLUKE Voltage Settings.

2.5.16 Resistance (Ω)

Turn off the power and discharge all capacitors. An external voltage across a component will give invalid resistance readings.

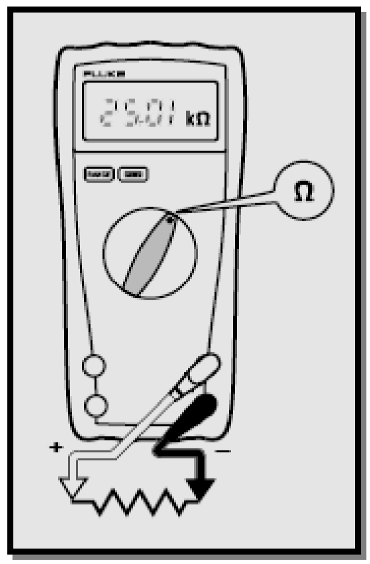


Figure 2-37.—FLUKE Resistance Setting.

2.5.17 Diode Test (→+)

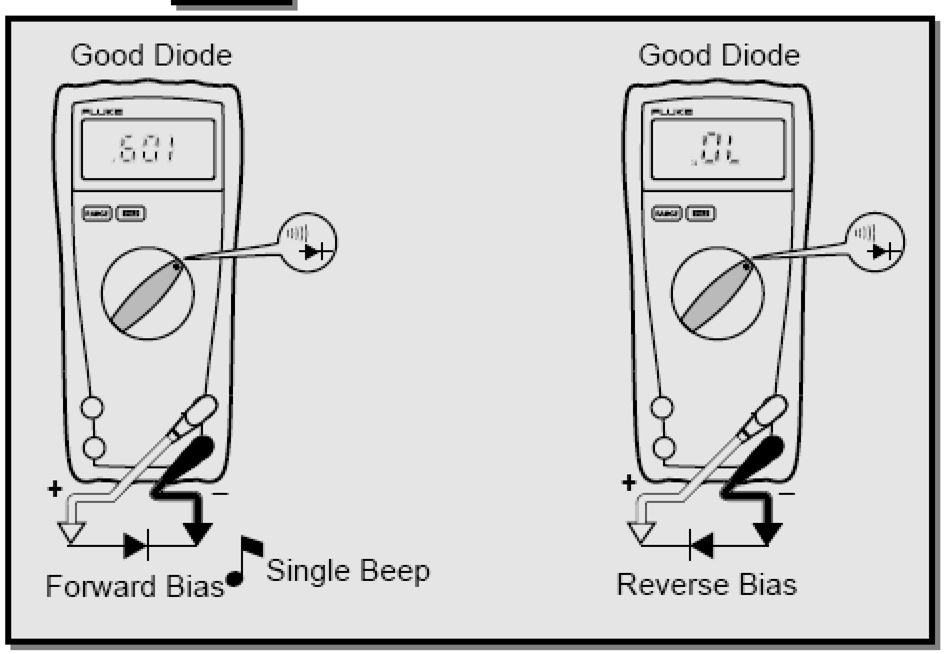


Figure 2-38.—FLUKE Diode Testing.

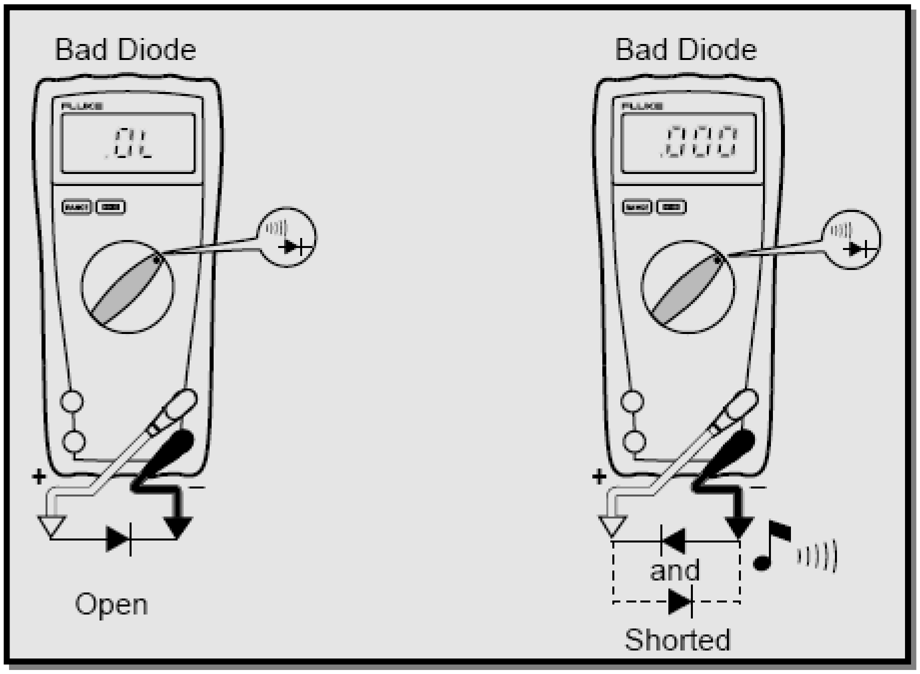
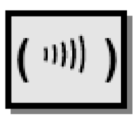


Figure 2-38 (Cont'd).—FLUKE Diode Testing.

2.5.18 Continuity Test



If continuity exists (resistance < 210 Ohms for Models 21/75 and <270 Ohms for Models 23/77), the beeper sounds continuously. The meter beeps twice if it is in Touch Hold mode.

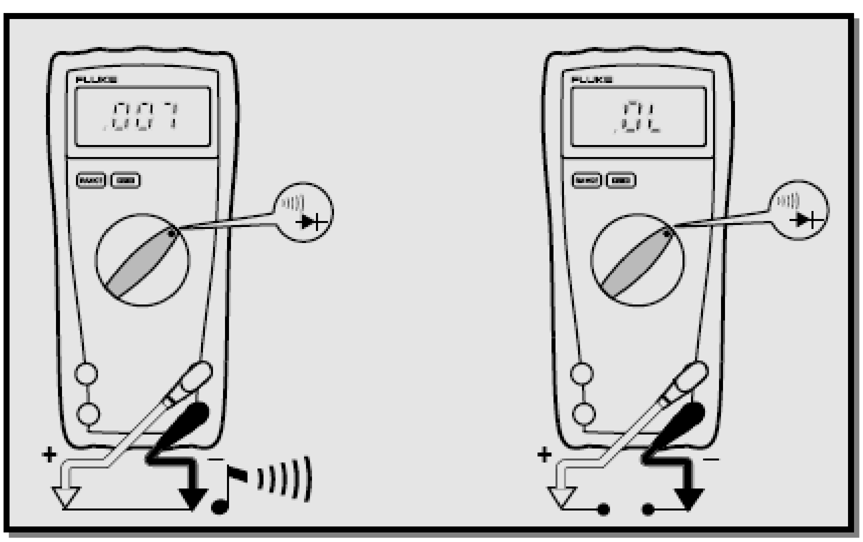
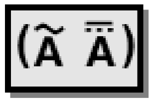


Figure 2-39.—FLUKE Continuity Test.

2.5.19 Current 

To avoid blowing an input fuse, use the 10 A jack until you are sure that the current is less than 300 mA.

Turn off power to the circuit. Break the circuit. (For circuits of more than 10 amps, use a current clamp.) Put the meter in series with the circuit as shown and turn power on.

Warning:
To avoid injury, do not attempt a current measurement if the open circuit voltage exceeds the rated voltage of the meter.

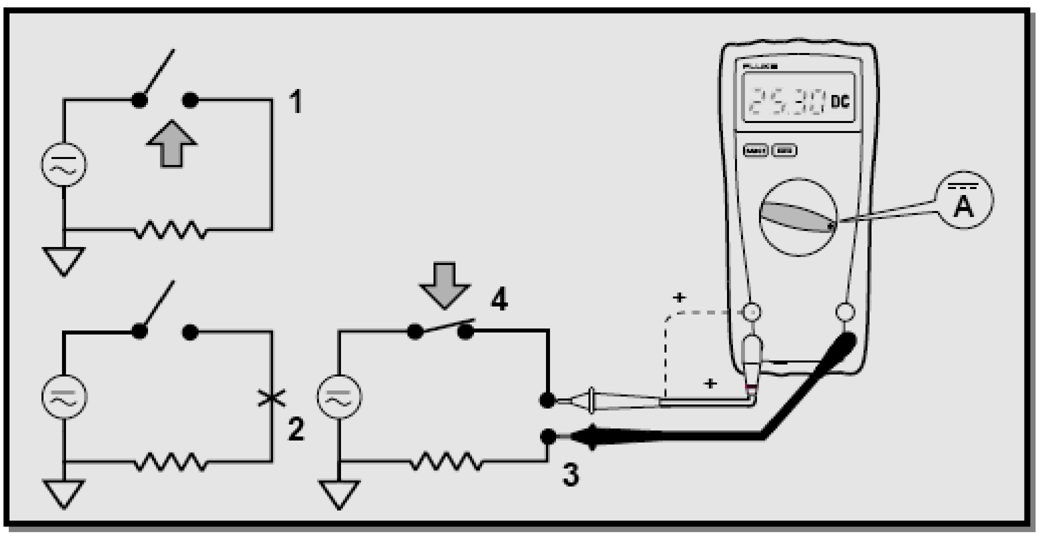


Figure 2-40.—FLUKE Current Setting.

2.5.20 Probe Holder

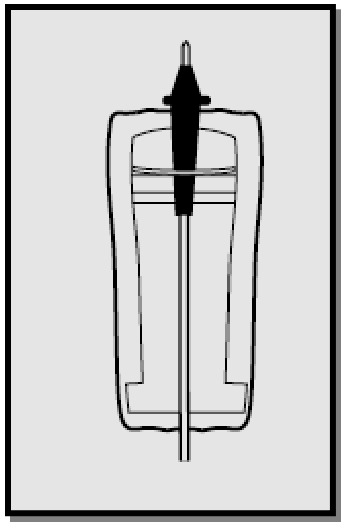


Figure 2-41.—Probe Holder.

2.5.21 Maintenance

Warning:

To avoid electric shock, remove the test leads before opening the case, and close the case before using the meter. To prevent fire and possible arc-flash, use fuses with ratings shown on the back of the meter.

Caution:

To avoid contamination or static damage, do not touch the circuit board without proper static protection.

2.5.21.1 Internal Fuse Test

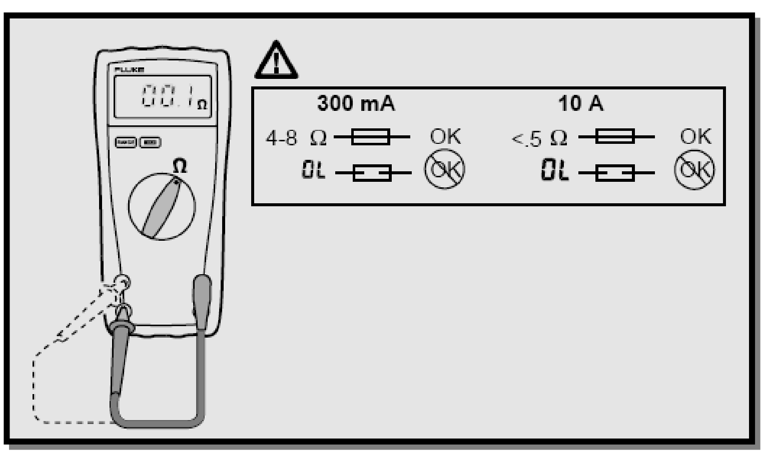


Figure 2-42.—Fuse Test.

2.5.21.2 Battery and Fuse Replacement

Before opening the case, make sure the test leads are removed and the rotary switch is turned to OFF.

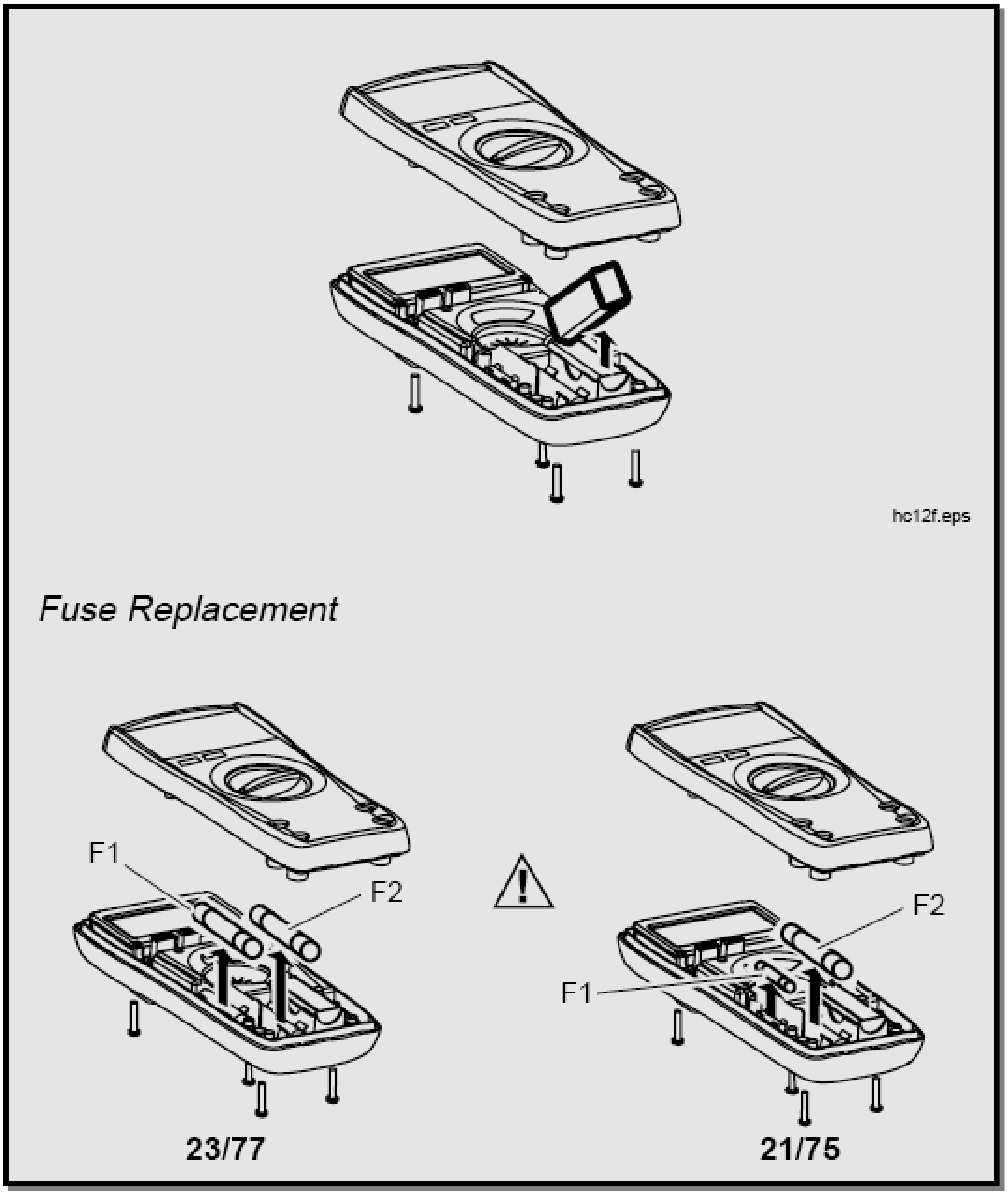


Figure 2-43.—Battery and Fuse Replacement.

2.5.22 Cleaning

To clean the meter, use a damp cloth and mild detergent; do not use abrasives or solvents on the meter.

2.5.23 Parts

Item	Description	Fluke PN	Quan.
BT1	Battery, 9 V, NEDA 1604/IEC 6F22, or NEDA 1604A/IEC 6LR61	696534 614487	1
F1*	**Models 21/75:** Fuse, F630 mA, 250 V, Min Interrupt Rating 1500 A or IEC 127-1	740670	1
F2*	Fuse, F11 A, 1000 VAC/DC, Min Interrupt Rating 17 kA	943118	1
F1*	**Models 23/77:** Fuse, F44/100 A, 1000 VAC/DC, Min Interrupt Rating 10 kA	943121	1
F2*	Fuse, F11 A, 1000 VAC/DC, Min Interrupt Rating 17 kA	943118	1
*** For safety, use exact replacement**			

Table 2-1. —Parts List.

2.5.24 Specifications

Accuracy is specified for a period of one year after calibration, at 18°C to 28°C (64°F to 82°F) with relative humidity to 90%. AC conversions are ac-coupled, average responding, and calibrated to the RMS value of a sine wave input.

Accuracy specifications are given as:
±([% of reading] + [number of least significant digits])

Maximum Voltage Between any Terminal and Earth Ground	Rated voltage
Display	Digital: 3,200 counts, updates 2.5/sec Analog: 31 segments, updates 25/sec
Response Time of Digital Display	V ac < 2 s V dc < 1 s Ω < 1s to 320 kΩ, < 2s to 3.2 MΩ, < 10 s to 32 MΩ
Operating Temperature	0°C to 50°C
Storage Temperature	-40°C to 60°C
Temperature Coefficient	0.1 x (specified accuracy)/°C (<18°C or >28°C)

Electromagnetic Compatibility In RF field of 3 V/m on all functions.	Total accuracy = Specified accuracy + 0.1% of range.
Relative Humidity	
except 32 MΩ range	0% to 90% (0°C to 35°C) 0% to 70% (35°C to 50°C)
32 MΩ range only	0% to 80% (0°C to 35°C) 0% to 70% (35°C to 50°C)
Altitude	Operating: 2000 meters Storage: 12,000 meters
Battery Type	9 V NEDA 1604 or 6F22 or 006P, or NEDA 1604A or 6LR61
Battery Life	2000 hrs typical with alkaline 1600 hrs typical with carbon zinc
Continuity Beeper	4096 Hz
Shock, Vibration	per MIL-T-PRF 28800F Class III, Sinusoidal, Non Operating
Size (H x W x L)	3.7 cm x 8.9 - 7.8 cm x 19 cm (1.5 in x 3.5 - 3.1 in x 7.49 in)
Weight	365 g (12.9 oz)
Safety	Models 21/75 Series III: 600 V CAT III, Models 23/77 Series III: 600 V CAT III and 1000 V CAT II per ANSI/ISA S82.01-1994, EN 61010-1: 1993, CSA C22.2 No 1010.1-92, UL 3111-1.
EMC Regulations	EN 61326-1 1997.
Certifications/Listings	

Table 2-2. —Specifications.

Function		Range	Accuracy
$\overline{\overline{V}}$		3.200 V, 32.00 V, 320.0 V 600 V (21/75), 1000 V (23/77)	±(0.3%+1) ±(0.4%+1)
m$\overline{\overline{V}}$		320.0 mV	±(0.3%+1)
$\tilde{V}$ (45 to 500 Hz, 3.2 V range. Other ranges 45 to 1 kHz)		3.200 V, 32.00 V, 320.0 V 600 V (21/75), 1000 V (23/77)	±(2%+2) ±(2%+2)
Ω	21/75:	320.0 Ω 3200 Ω, 32.00 kΩ, 320.0 kΩ 3.200 MΩ 32.00 MΩ	±(0.5%+2) ±(0.5%+1) ±(0.5%+1) ±(2%+1)
	23/77:	320.0 Ω 3200 Ω, 32.00 kΩ, 320.0 kΩ 3.200 MΩ 32.00 MΩ	±(0.5%+3) ±(0.5%+1) ±(0.5%+1) ±(2%+1)
⊣▶⊢ •)))		2.0 V	±(1% typical)

Function	Range	Accuracy	Burden Voltage (typical)
$\tilde{A}$ (45 Hz to 1 kHz)	32.00 mA, 320.0 mA 10.00 A *	±(2.5%+2) ±(2.5%+2)	6 mV/mA 50 mV/A
$\overline{\overline{A}}$	32.00 mA, 320.0 mA 10.00 A *	±(1.5%+2) ±(1.5%+2)	6 mV/mA 50 mV/A

* 10 A continuous, 20 A for 30 seconds maximum.

Table 2-3. —Functions.

<table>
<tr><th>Function</th><th colspan="3">Input Impedance (Nominal)</th></tr>
<tr><td>V̄, mV̄, Ṽ</td><td colspan="3">>10 MΩ, <50 pF</td></tr>
<tr><td></td><td>Common Mode Rejection Ratio (1 kΩ Unbalanced)</td><td colspan="2">Normal Mode Rejection</td></tr>
<tr><td>V̄, mV̄</td><td>>120 dB at dc,
50 Hz, or 60 Hz</td><td colspan="2">>60 dB at 50 Hz or 60 Hz</td></tr>
<tr><td>Ṽ</td><td>>60 dB dc to 60 Hz</td><td colspan="2"></td></tr>
<tr><td></td><td>Open Circuit Test Voltage</td><td colspan="2">Full Scale Voltage
To 3.2 MΩ   32 MΩ</td></tr>
<tr><td>Ω</td><td><3.1 V dc
<2.8 V dc (typical)</td><td><440 mV dc
<420 mV dc
(typical)</td><td><1.4 V dc
<1.3 V dc
(typical)</td></tr>
<tr><td></td><td>Open Circuit Test Voltage</td><td colspan="2">Full Scale Voltage</td></tr>
<tr><td>▶| ·)))</td><td><3.1 V dc</td><td colspan="2">2.0 V dc</td></tr>
<tr><td></td><td colspan="3">Short Circuit Current (typical)</td></tr>
<tr><td>Ω

▶| ·)))</td><td>21/75:
400 µA

500 µA</td><td colspan="2">23/77:
300 µA

400 µA</td></tr>
<tr><td>▶|</td><td>V_F</td><td colspan="2">Current (typical)</td></tr>
<tr><td></td><td>
0.0 V
0.6 V
1.2 V
2.0 V</td><td>21/75:
0.5 mA
0.4 mA
0.3 mA
0.1 mA</td><td>23/77:
0.4 mA
0.3 mA
0.2 mA
0.1 mA</td></tr>
</table>

Table 2-3 (Cont'd). —Functions.

2.5.25 Branch Circuit Test

Usually, receptacles for portable equipment and fans are on branch circuits separate from lighting branch circuits. Test procedures are the same for any branch circuit. Therefore, a description will be given on the steps necessary to (1) locate the defective circuit and (2) follow through on that circuit and find the trouble.

Assume that, for some reason, several of the lights are not working in a certain section. Because several lights are out, it will be reasonable to assume that the voltage supply has been interrupted on one of the branch circuits.

To verify this assumption, first locate the distribution box feeding the circuit that is inoperative. Then make sure that the inoperative circuit is not being supplied with voltage. Unless the circuits are identified in the distribution box, the voltage at the various circuit terminations will have to be measured. For the following procedures, use the circuits shown in figure 2-31 as an example.

To pin down the trouble, connect the voltage tester to the load side of each pair of fuses in the branch distribution box. No voltage between these terminals indicates a blown fuse or a failure in the supply to the distribution box. To find the defective fuse, make certain S_1 is closed, connect the voltage tester across A-A_1, and next across B-B_1 (fig. 2-31). The full-phase voltage will appear across an open fuse, provided circuit continuity exists across the branch circuit. However, if there is an open circuit at some other point in the branch circuit, this test is not conclusive. If the load side of a pair of fuses does not have the full-phase voltage across its terminals, place the tester leads on the supply side of the fuses. The full-phase voltage should be present. If the full-phase voltage is not present on the supply side of the fuses, the trouble is in the supply circuit from the feeder distribution box.

Assume that you are testing at terminals A-B (fig. 2-31) and that normal voltage is present. Move the test lead from A to A_1. Normal voltage between A_1 and B indicates that fuse A-A_1 is in good condition. To test fuse B-B_1, place the tester leads on A and B, and then move the lead from B to B_1. No voltage between these terminals indicates that fuse B-B_1 is open. Full-phase voltage between A and B_1 indicates that the fuse is good.

This method of locating blown fuses is preferred to the method in which the voltage tester leads are connected across the suspected fuse terminals, because the latter may give a false indication if there is an open circuit at any point between either fuse and the load in the branch circuit.

2.6.0 CIRCUIT BREAKERS

Circuit breakers have three fundamental purposes: to provide circuit protection, to perform normal switching operations, and to isolate a defective circuit while repairs are being made. Circuit breakers are available in manually or electrically operated types that may or may not provide protective functions. Some types may be operated both ways, while others are restricted to one mode.

2.7.0 OVERLOAD RELAYS

Overload relays are provided in motor controllers to protect the motor from excessive currents. Excessive motor current causes normally closed overload relay contacts to open, which break the circuit to the operating coil of the main contactor, and disconnects the motor from the line. Overload relays are of the thermal or magnetic type.

2.7.1 Thermal Overload Relay

The thermal type of overload relay is designed to open a circuit when excessive current causes the heater coils to reach the temperature at which the ratchet mechanism releases. The heater coils are rated so that normal circuit current will not produce enough heat to release the ratchet mechanism.

The thermal type of overload relay has a heat-sensitive element and an overload heater connected in series with the motor circuit (fig. 2-44). When the motor current is excessive, heat from the heater causes the heat-sensitive element to open the overload relay contacts. As it takes time for the heat-sensitive element to heat up, the thermal type of overload relay has an inherent time delay. Thermal overload relays may be of the solder-pot, bimetal, single-metal, or induction type.

BIMETAL TYPE.— The heat-sensitive element is a strip or coil of two different metals fused together along one side. When heated, one metal expands more than the other, causing the strip or coil to bend or deflect and open the overload relay contacts.

SINGLE-METAL TYPE.— The heat-sensitive element is a metal tube around the heater. The tube lengthens when heated and opens the overload relay contacts.

INDUCTION TYPE.— The heat-sensitive element is usually a bimetal strip or coil. The heater consists of a coil in the motor circuit and a copper tube inside the coil. The copper tube acts as a short-circuited secondary of a transformer and is heated by the current induced in it. This type of overload relay is used only in ac controllers, whereas the previously described types of thermal overload relays may be used in ac or dc controllers.

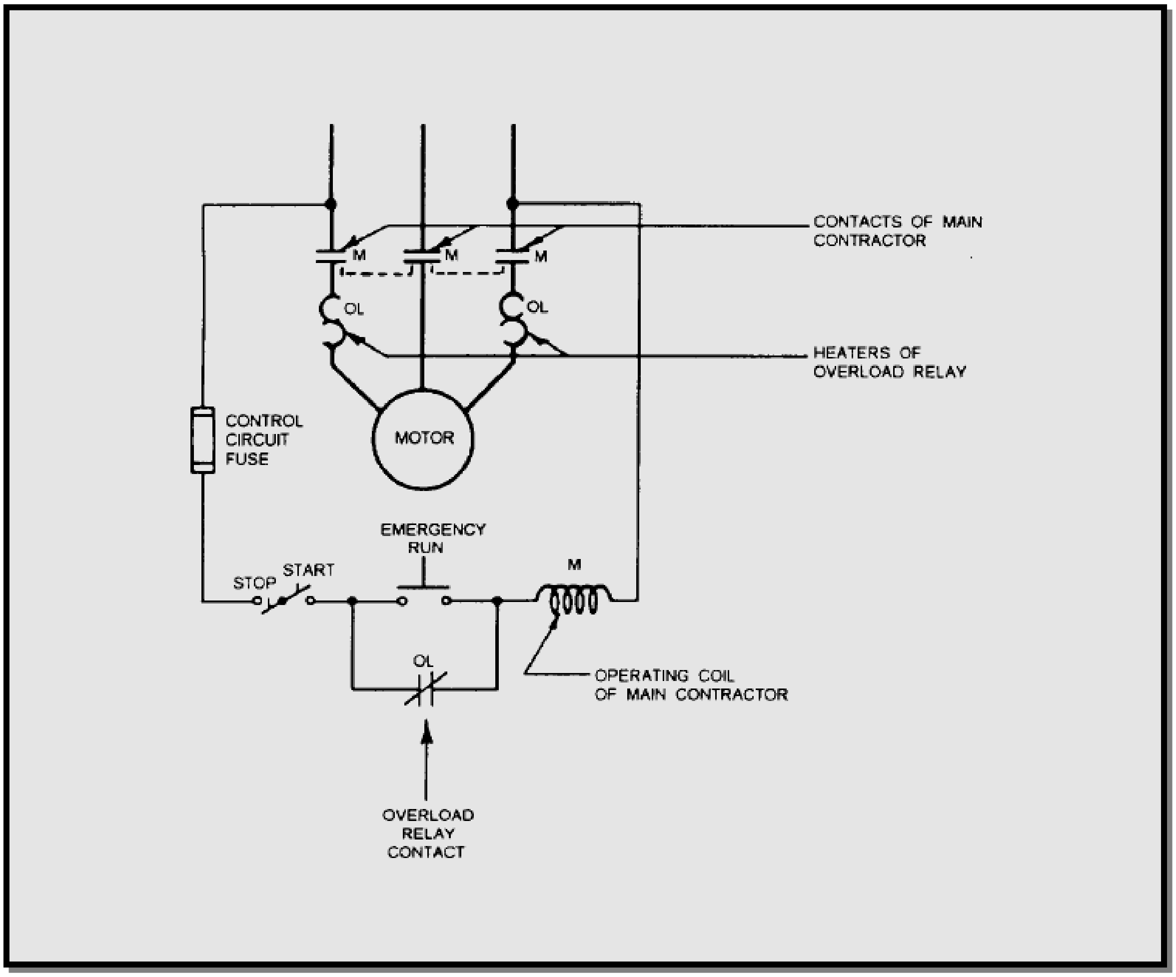


Figure 2-44.-Schematic diagram of motor controller with thermal type of overload relay.

2.7.2 Magnetic Overload Relay

The magnetic type of overload relay has a coil connected in series with the motor circuit and a tripping armature or plunger. When the motor current is excessive, the armature opens the overload relay contacts. Magnetic overload relays may be of the instantaneous or time-delay type.

INSTANTANEOUS TYPE.— This type operates instantaneously when the motor current becomes excessive. The relay must be set at a tripping current higher than the motor starting current to prevent tripping when the motor is started. This type of overload relay is used mostly for motors that are started on reduced voltage and then switched to full line voltage after the motor comes up to speed.

TIME-DELAY TYPE.— This type is essentially the same as the instantaneous type with the addition of a time-delay device. The time-delay device may be an oil dashpot with a piston attached to the tripping armature of the relay. This piston has a hole through which oil passes when the tripping armature is moved due to the excessive motor current. The size of the hole can be adjusted to change the speed at which the piston moves for a given pull on the armature. For a given size hole, the larger the current, the faster the operation. This allows the motor to carry a small overload current for a longer period of time than a large overload current.

2.8.0 ELECTRICAL CABLES

Shipboard electrical and electronic systems require a large variety of electrical cables. Some circuits require only a few conductors having a high current-carrying capacity; others require many conductors having a low current-carrying capacity; still others may require cables with a special type of insulation, the conductors may have to be shielded, or in some cases the conductors may have to be of a metal other than copper.

The proper installation and maintenance of the various electrical systems aboard ship are very important to the IC Electrician. The repair of battle damage, accomplishment of ship alterations, and some electrical repairs may require that changes or additions to the ship's cables be made by IC personnel. Additionally, during shipyard and tender availabilities, you may be required approve the new installations.

To perform these tasks you must first have a working knowledge of the various types, sizes, capacities, and uses of shipboard electrical cable. The IC Electrician must also be capable of selecting, installing, and maintaining cables in such a manner as to ensure their adequacy.

For many years most of the shipboard power and lighting cables for fixed installation had silicone-glass insulation, a polyvinyl chloride jacket, and aluminum armor and were of watertight construction. It was determined that cables with all these features were not necessary for many applications, especially within watertight compartments and noncritical areas above the water-tightness level.

Additionally, cables jacketed with polyvinyl chloride presented the dangers of toxic fumes and dense, impenetrable smoke when undergoing combustion. These hazards were noticed when an electrical fire smoldered through the cable ways aboard a naval ship. Due to the overwhelming amount of smoke and fumes, fire fighters were unable to effectively control the fire and a large amount of damage resulted. A family of low-smoke, low-toxic cable was designed. This cable is constructed with a polyolefin jacket vice polyvinyl chloride jacket. This design conforms to rigid toxic and smoke indexes to effectively reduce the hazards associated with the old design. This cable is covered by Military Specification MIL-C-24643.

A family of lightweight cables was introduced to aid in the elimination of excessive weight from the fleet. Considering the substantial amount of cable present on a ship or submarine, a reduction in cable weight will have a considerable impact on the overall load, thus improving performance and increasing efficiency. This family of lightweight cables is constructed from cross-linked polyalkene and micapolymide insulation and a cross-linked polyolefin jacket. The lightweight cable is covered by Military Specification MIL-C-24640.

2.9.0 CLASSIFICATIONS OF CABLES

Because of the varied service conditions aboard ship, the cable must have the ability to withstand heat, cold, dampness, dryness, bending, crushing, vibration, twisting, and shock. No one type of cable has been designed to meet all of these requirements; therefore, a variety of types are employed in a shipboard cable installation.

Cables are classified as watertight or non-watertight, watertight with circuit integrity construction or non-watertight with circuit integrity construction, and armored or unarmored. They are also further classified for flexing or non-flexing service for power, lighting, control, electronic, and communication and instrumentation applications. Table 2-4 shows the various classifications for cable.

Watertight Cable

The term *watertight cable* indicates standard cable in which all spaces under the impervious sheath are filled with material. This eliminates voids and prevents the flow of water through the cable by hose action if an open end of cable is exposed to water under pressure.

Armored Cable

The term *armored cable* refers to a cable that has an outer shield of weaved braid. The braid is made of aluminum or steel and applied around the impervious sheath of the cable. This weaved braid helps prevent damage to the cable during installation.

Non-flexing Service

Non-flexing service cable designed for use aboard ship is intended for permanent installation and is commonly referred to as such. Cables for use with lighting and power circuits are intended for this non-flexing service. This non-flexing service can be further classified according to its application and is of two types-general use and special use.

GENERAL USE.— Non-flexing service cable is intended for use in nearly all portions of electric distribution systems, including the common telephone circuits and most propulsion circuits. Special cases occur in dc propulsion circuits for surface ships. In those cases where the impressed voltage is less than 1000 volts, an exception is permitted.

MIL-C-24643
Watertight with circuit integrity non-flexing service • Power and Lighting • Control • Electronic, Communication, and Instrumentation
Watertight, non-flexing service • Power and Lighting • Electronic, Communication, and Instrumentation
Non-watertight with circuit integrity, non-flexing service • Electronic, Communication, and Instrumentation
Non-watertight, non-flexing service • Power and Lighting • Control • Electronic, Communication, and Instrumentation
Non-watertight, flexing service • Power and Lighting • Control • Electronic, Communication, and Instrumentation
MIL-C-24640
Watertight with circuit integrity, non-flexing service • Power • Control • Electronic, Communication, and Instrumentation
Watertight, non-flexing service • Electronic, Communication, and Instrumentation
Non-watertight, non-flexing service • Power • Electronic, Communication, and Instrumentation

Table 2-4.-Cab1e Classifications

LSDSGA cable is one type usually found in this general use, non-flexing service. Also in this classification is the type LSMSCA cable. This cable is nothing more than watertight cable for use in interior communications, as well as in FC circuits.

SPECIAL USE.— There are many shipboard electrical circuits where special requirements of voltage, current, frequency, and service must be met in cable installation. There are also other circuits where general use, non-flexing service cable may meet the necessary requirements, yet be economically impracticable. For these reasons, there are many different types of non-flexing service cable for specialized use, such as degaussing, telephone, radio, and casualty power.

Type LSMDU is a multiconductor cable used in degaussing circuits. Type LSTCJA consists of one conductor of constantan (red) and one conductor of iron (gray), and is used for pyrometer base leads.

Flexing Service

Flexing service cable designed for use aboard ship is commonly referred to as being portable because it is principally used as leads to portable electric equipment. It is also of two types—general use and special use.

GENERAL USE.— Flexing service cable is used as leads to portable equipment and permanently installed equipment where cables are subjected to repeated bending, twisting, mechanical abrasion, oil, sunlight, or where maximum resistance to moisture is required.

SPECIAL USE.— There are many different types of flexing service cable designed for special requirements of certain installations, including type LSTTOP and casualty power cables. Type TRF is used for arc-welding circuits.

2.10.0 TYPES AND SIZE DESIGNATIONS OF CABLES

Shipboard electrical cables are identified according to type and size. Type designations consist of letters to indicate construction and/or use. Size designations consist of a number or numbers to indicate the size of the conductor(s) in circular mil area, number of conductors, or number of pairs of conductors, depending upon the type of cable.

In most cases, the number of conductors in a cable, up to and including four conductors, is indicated by the first type letter as follows: S—single conductor; D—double conductor; T—three conductor; and F—four conductor. For cables with more than four conductors, the number of conductors is usually indicated by a number following the type letters. In this latter case, the letter *M* is used to indicate multiple conductor, Examples of common shipboard cable designations are as follows:

LSDSGA-3— LOW smoke, double conductor, shipboard, general use, armored, conductor size approximately 3000 circular roils.

LSDCOP-2— LOW smoke, double conductor, oil resistant, portable, conductor size approximately 2000 circular mils.

LSMSCA-30— LOW smoke, multiple conductor, shipboard, control armored, with 30 conductors.

Most cables and cords contain a continuous, thin, moisture-resistant marker tape directly under the cable or cord binder tape or jacket at less than 1-foot intervals. This tape shows the name and location of the manufacturer; the year of manufacture; the military specification number of the cable; and the progressive serial number. The serial number is not necessarily a footage marker. A serial number is not repeated by a manufacturer in any one year for any one type and size of cable or cord.

2.11.0 RATINGS AND CHARACTERISTICS OF CABLES

Table 2-5 shows the ratings and characteristics of various cables that are included in Military Specification MIL-C-24643. Each cable is identified by the MILSPEC and specification sheet number, followed by the cable type designation, conductor size (AWG or MCM), number of conductors, conductor cross-sectional area (circular mils), overall diameter of the cable, cable weight per foot in approximate pounds, minimum radius of bend (which is approximately 8 times the overall diameter), conductor identification, rated voltage, ampacity (current-carrying capacity in amperes) of each conductor, and the national stock number (NSN).

The overall diameter is the overall measurement of the finished cable and is the determining dimension in selecting the proper deck or bulkhead stuffing tube size or multi-able transit inserts. This diameter is also the determining dimension for stuffing tubes for equipment.

Electrical characteristics are given under columns headed Rated Voltage and Ampacity.

In the column headed CDR ID (conductor identification), the letters stand for the identification and the number stands for the method of applying the identification. There are four codes for identifying the conductors in a cable; they are STD (standard identification code), TEL (telephone identification code), SPL (special identification code), and LTR (letter identification code). Table 2-6 gives the standard identification color codes for identifying conductors in multiple-conductor cables. Table 2-7 gives the telephone identification color codes for telephone cables. Table 2-8 gives the special identification color codes for conductors and groups of conductors, such as pairs and triads. Letter identification codes consist of the letters *A, B, C,* and *D* printed in block type and with black, white, red, and green ink, respectively.

There are six methods of applying identification to the conductors of a cable. They are as follows:

Method 1—calls for printing of the number and color designation on the outer surface of the insulation or jacket of each conductor.

Method 2—calls for the use of opaque white polyester tapes that have been printed with both the number and color designation prior to application.

Method 3—calls for the use of solid colors or solid base colors with tracers as required.

Method 4—calls for the use of colored braids.

Method 5—calls for the use of the printed letter on the outermost insulating tape or the printed letter on a polyester binder tape over the insulating tape.

Method 6—calls for numerals to be printed in ink on the insulation of the conductor.

MIL-SPEC MIL-C-	CABLE TYPE DESIGNATION	CONDUCTOR SIZE: AWG OR MCM	NUMBER OF CONDUCTORS IN CABLE	AREA OF EACH CONDUCTOR (MCM)	CABLE OVERALL DIAMETER MAX. (INCH)	CABLE WEIGHT PER FT APPROX (LBS)	RADIUS OF BEND MIN. (INCH)	CDR ID	RATED VOLTAGE MAX (RMS)	AMPACITY, EACH CONDUCTOR (AMPS, MAX)				NSN 6145-01
										DC OR 60 HZ		400 HZ		
										40 Deg C AMBIENT	50 Deg C AMBIENT	40 Deg C AMBIENT	50 Deg C AMBIENT	
24643/19	LS6SGA- 100	0	6	105.600	1.650	2.919	13.0	LTR-5	1000	136	127	272	250	203-0370
	LS6SGA- 125	00	6	133.100	1.840	3.600	14.5	LTR-5	1000	160	147	299	275	201-9513
	LS6SGA- 150	000	6	167.800	2.010	4.468	16.0	LTR-5	1000	188	173	326	300	201-9514
	LS6SGA- 200	0000	6	211.600	2.250	5.613	18.0	LTR-5	1000	219	202	369	340	201-9515
24643/19	LS6SGU- 100	0	6	105.600	1.600	2.820	13.0	LTR-5	1000	136	127	272	250	201-9511
	LS6SGU- 125	00	6	133.100	1.790	3.490	14.5	LTR-5	1000	160	147	299	275	201-9512
	LS6SGU- 150	000	6	167.800	1.960	4.339	16.0	LTR-5	1000	188	173	326	300	203-2370
	LS6SGU- 200	0000	6	211.600	2.200	5.479	17.5	LTR-5	1000	219	202	369	340	203-0369
24643/26	LS7PS- 6	12	7	6.530	.775	.361	6.0	STD-4	600	35/20*	---	---	---	1811-8376
24643/20	LS7SGA- 3	16	7	2.580	.595	.177	4.5	STD-1	1000	15/11	14/10*	15/11*	14/10*	201-9518
	LS7SGA- 4	14	7	4.110	.645	.231	5.0	STD-1	1000	26/14	24/13	26/14	24/13	201-9519
24643/20	LS7SGU- 3	16	7	2.580	.545	.152	4.5	STD-1	1000	15/11	14/10	15/11	14/10	201-9516
	LS7SGU- 4	14	7	4.110	.595	.198	5.0	STD-1	1000	26/14	24/13	26/14	24/13	201-9517
24643/26	LSDPS- 3	16	2	2.580	.455	.121	3.0	STD-4	600	10	---	10	---	156-9511
	LSDPS- 4	14	2	4.110	.489	.141	3.0	STD-4	600	20	---	20	---	1977-6159
	LSDPS- 6	12	2	6.530	.585	.194	4.5	STD-4	600	28	---	28	---	158-2118
	LSDPS- 9	10	2	10.380	.628	.232	5.0	STD-4	600	41	---	41	---	1542-6699
	LSDPS- 14	9	2	13.090	.730	.323	6.0	STD-4	600	54	---	54	---	154-4372
24643/15	LSDSGA- 3	16	2	2.580	.461	.109	3.5	STD-1	1000	13	12	13	12	202-9501
	LSDSGA- 4	14	2	4.110	.499	.133	4.0	STD-1	1000	22	20	22	20	203-0367
	LSDSGA- 9	10	2	10.380	.625	.230	5.0	STD-1	1000	44	41	44	41	202-9502
	LSDSGA- 14	9	2	13.090	.768	.297	6.0	STD-1	1000	60	55	60	55	202-9503
	LSDSGA- 23	7	2	20.820	.862	.410	7.0	STD-1^	1000	78	72	78	72	202-9504
	LSDSGA- 50	3	2	52.620	.969	.740	8.0	LTR-5	1000	126	116	126	116	204-4855
	LSDSGA- 75	1	2	83.690	1.184	1.086	9.5	LTR-5	1000	168	155	168	155	210-2343
	LSDSGA- 100	0	2	105.600	1.316	1.289	10.5	LTR-5	1000	199	183	199	183	204-4856
	LSDSGA- 200	000	2	211.600	1.719	2.458	14.0	LTR-5	1000	308	284	288	266	204-4857
	LSDSGA- 300	300	2	300.000	2.007	3.326	16.0	LTR-5	1000	413	380	347	319	204-4858
	LSDSGA- 400	400	2	413.600	2.253	4.408	18.0	LTR-5	1000	492	453	337	310	203-0368

* Ind/Avg indicates the maximum current per conductor (Ind), and the maximum current (Avg) per conductor when all conductors in the cable are used.

^ Maybe STD-1 or LTR-5, manufacturers option.

Table 2-5.-Cables for Watertight (With Circuit Integrity), Non-flexing Service, Power and Lighting

Table 2-6.-MIL-DTL-24643B Standard Identification Code

Color, Conductor or Group No.	Background or Base Color	First Tracer Color	Second Tracer Color
1	Black	-----	----
2	White	----	----
3	Red	----	----
4	Green	----	----
5	Orange	----	----
6	Blue	----	----
7	White	Black	----
8	Red	Black	----
9	Green	Black	----
10	Orange	Black	----
11	Blue	Black	----
12	Black	White	----
13	Red	White	----
14	Green	White	----
15	Blue	White	----
16	Black	Red	----
17	White	Red	----
18	Orange	Red	----
19	Blue	Red	----
20	Red	Green	----
21	Orange	Green	----
22	Black	White	Red
23	White	Black	Red
24	Red	Black	White
25	Green	Black	White
26	Orange	Black	White
27	Blue	Black	White
28	Black	Red	Green
29	White	Red	Green
30	Red	Black	Green

Table 2-6 (Cont'd).-MIL-DTL-24643B Standard Identification Code

Color, Conductor or Group No.	Background or Base Color	First Tracer Color	Second Tracer Color
31	Green	Black	Orange
32	Orange	Black	Green
33	Blue	White	Orange
34	Black	White	Orange
35	White	Red	Orange
36	Orange	White	Blue
37	White	Red	Blue
38	Brown	----	----
39	Brown	Black	----
40	Brown	White	----
41	Brown	Red	----
42	Brown	Green	----
43	Brown	Orange	----
44	Brown	Blue	----
45	White	Black	Blue
46	Red	White	Blue
47	Green	Orange	Red
48	Orange	Red	Blue
49	Blue	Red	Orange
50	Black	Orange	Red
51	White	Black	Orange
52	Red	Orange	Black
53	Green	Red	Blue
54	Orange	Black	Blue
55	Blue	Black	Orange
56	Black	Orange	Green
57	White	Orange	Green
58	Red	Orange	Green
59	Green	Black	Blue
60	Orange	Orange	Blue

Table 2-6 (Cont'd).-MIL-DTL-24643B Standard Identification Code

Color, Conductor or Group No.	Background or Base Color	First Tracer Color	Second Tracer Color
61	Blue	Green	Orange
62	Black	Red	Blue
63	White	Orange	Blue
64	Red	Black	Blue
65	Green	Orange	Blue
66	Orange	White	Red
67	Blue	White	Red
68	Black	Green	Blue
69	White	Green	Blue
70	Red	Green	Blue
71	Green	White	Red
72	Orange	Red	Black
73	Blue	Red	Black
74	Black	Orange	Blue
75	Red	Orange	Blue
76	Green	Red	Black
77	Orange	White	Green
78	Blue	White	Green
79	Red	White	Orange
80	Green	White	Orange
81	Blue	Black	Green
82	Orange	White	----
83	Green	Red	----
84	Black	Green	----
85	White	Green	----
86	Blue	Green	----
87	Black	Orange	----
88	White	Orange	----
89	Red	Orange	----
90	Green	Orange	----

Table 2-6 (Cont'd).-MIL-DTL-24643B Standard Identification Code

Color, Conductor or Group No.	Background or Base Color	First Tracer Color	Second Tracer Color
91	Blue	Orange	----
92	Black	Blue	----
93	White	Blue	----
94	Red	Blue	----
95	Green	Blue	----
96	Orange	Blue	----
97	Yellow	----	----
98	Yellow	Black	----
99	Yellow	White	----
100	Yellow	Red	----
101	Yellow	Green	----
102	Yellow	Orange	----
103	Yellow	Blue	----
104	Black	Yellow	----
105	White	Yellow	----
106	Red	Yellow	----
107	Green	Yellow	----
108	Orange	Yellow	----
109	Blue	Yellow	----
110	Black	Yellow	Red
111	White	Yellow	Red
112	Green	Yellow	Red
113	Orange	Yellow	Red
114	Blue	Yellow	Red
115	Black	Yellow	White
116	Red	Yellow	White
117	Green	Yellow	White
118	Orange	Yellow	White
119	Blue	Yellow	White
120	Black	Yellow	Green
121	White	Yellow	Green
122	Red	Yellow	Green
123	Orange	Yellow	Green
124	Blue	Yellow	Green
125	Black	Yellow	Blue
126	White	Yellow	Blue
127	Red	Yellow	Blue

TELEPHONE IDENTIFICATION CODE (TEL)

Color or Conductor No.	Color	Color or Conductor No.	Color
1	Black	7	Brown
2	White	8	Gray
3	Red	9	Yellow
4	Green	10	Purple
5	Orange	11	Tan
6	Blue	12	Pink

Table 2-7.-Telephone Identification Code (TEL)

The pairing of conductors for forming pairs shall be as follows:

No. 1 paired with Nos. 2 thru 12 for next 11 pairs
No. 2 paired with Nos. 3 thru 12 for next 10 pairs
No. 3 paired with Nos. 4 thru 12 for next 9 pairs
No. 4 paired with Nos. 5 thru 12 for next 8 pairs
No. 5 paired with Nos. 6 thru 12 for next 7 pairs
No. 6 paired with Nos. 7 thru 12 for next 6 pairs
No. 7 paired with Nos. 8 thru 12 for next 5 pairs
No. 8 paired with Nos. 9 thru 12 for next 4 pairs
No. 9 paired with Nos. 10 thru 12 for next 3 pairs
No. 10 paired with Nos. 11 thru 12 for next 2 pairs
No. 11 paired with No.12

SPECIAL IDENTIFICATION CODE (SPL)

Color or Conductor No.	Color	Color or Conductor No.	Color
1	Black	7	Brown
2	White	8	Gray
3	Red	9	Yellow
4	Green	10	Purple
5	Orange	11	Tan
6	Blue	12	Pink

Table 2-8.-Special Identification Code (SPL)

Twisted pair identification code. This code consists of numbers in sequence running from 1 through the number corresponding to the total quantity of twisted pairs in the cable. Both conductors in each pair shall be numbered the same, denoting the sequence number of the pair. Distinction between the two conductors is provided by different colored insulation. Conductors of a cable with a single pair need not be numbered.

Twisted triad identification code. This code consists of numbers in sequence running from 1 through the number corresponding to the total quantity of twisted triads in the cable. All three conductors shall be numbered the same, denoting the sequence number of the triad: Distinction between the three conductors is provided by different colored insulation. Conductors of a cable with a single triad need not be numbered.

2.12.0 CABLE COMPARISON HANDBOOK

A cable comparison handbook was developed by NAVSEA and contains information on the most current cables authorized for shipboard use. The handbook provides information to supply and installation activities on the use of electrical shipboard cable, particularly in the selection of suitable alternate or substitute cables for use in lieu of specified types and sizes that might not be immediately available, and for selecting a currently available item suitable for replacement of obsolete items. Cables will be listed in the handbook by general classifications as to application and design.

COMMON SHIPBOARD CABLE APPLICATIONS
J-C-90: Flexible cord and fixture wire.
J-C-96: Neoprene jacketed telephone wire.
J-C-580: Flexible cord and fixture wire.
J-C-0741: Rubber and/or neoprene welding cable.
MIL-C-17: Coaxial cable – polyethylene and Teflon dielectric.
MIL-C-915, MIL-C-2194: Shipboard cable.
MIL-C-1486: 10 conductor WM-46/U only.
MIL-C-3078: Cable, electric, insulated low tension single conductor.
MIL-C-3432: 300 volt and 600 volt rubber insulated power and control cable.
MIL-C-3458: Cables, telephone.
MIL-C-3702: Cable, power electrical, ignition, high tension.
MIL-C-3849: Tinsel cord. Light duty low voltage flexible cord for switchboards, microphones, telephones, etc.
MIL-C-3883: Cord electrical (audio frequency).
MIL-C-3884: Conductor electrical (short lay).
MIL-C-4839: KEL-F insulated cable, WF-15/U.
MIL-C-4866: RG-62 B/U cable.
MIL-C-4921A (ASG): Single conductor 8 AWG. 5,000 volt cable with butyl compound insulation and polychloroprene. For airport lighting.
MIL-C-5136: Cable, power, electric, polychloroprene sheathed, buna compound insulated.
MIL-C-5767: Low temperature rubber portable cords.
MIL-C-6166: Cord, headset-microphone CX1301/AR.
MIL-C-7078: 600 volt aircraft cable.
MIL-C-8721 (ASG): Cable, ignition high tension, aircraft quality.
MIL-C-8721: Miniature coaxial cables with Teflon TFE cores.
MIL-C-8817 (ASG): Cable ignition, high tension, aircraft quality.
MIL-C-9360: RG 134/U cable
MIL-C-10065: Cables, special purpose electrical (multi-pair) audio frequency.
MIL-C-10369: Cable, telephone field, for rapid payout.
MIL-C-10392: Cables, special purpose, electric (miniature).
MIL-C-10581: Cables telephone, cable assemblies, telephone, coil assembly, telephone loading

Table 2-9.-Common Shipboard Cable Applications

COMMON SHIPBOARD CABLE APPLICATIONS
MIL-C-11060: Cables, twisted pair, internal hook-up, unshielded and shielded.
MIL-C-11097: Cable, telephone (Wire W-50-A).
MIL-C-11311: Telephone cable types WD-31/U and WT-24/U.
MIL-C-11440: Cable, power electrical.
MIL-C-12064: Low temperature power cable and cords for Arctic service.
MIL-C-12423: Cable, telephone WD-33 U.
MIL-C-12881: Cables, telephone, switchboard (cable and cable assemblies).
MIL-C-12992: Cable assembly, power, electrical (Cord CX-227 TVQ-1).
MIL-C-13066: Cable, telephone (submarine No. 19 AWG. and No. 22 AWG.).
MIL-C-13077: Cable, special purpose, electrical.
MIL-C-13486: Cables, special purpose electrical: low tension, heavy duty, single CDR & multiconductor shielded arid unshielded
MIL-C-13777: Multi-conductor missile ground support cable.
MIL-C-13892: Cable, telephone (flexible).
MIL-C-14189: Cable, power electrical, 3000 volt, for field use.
MIL-C-15325: Cable, tow, electric (three conductor).
MIL-C-15479: Cables, power, electrical, submarine, Navy Standard Harbor Defense.
MIL-C-18959: Cable power, electrical, portable neoprene jacketed 600 volt.
MIL-C-18961: Cable, special purpose, electrical and wire, electrical, shot
MIL-C-18962: Cable, power, electrical, direct burial, neoprene jacketed 600 volt.
MIL-C-19381 (Ships): Cables, special purpose, electrical nuclear plant.
MIL-C-19547: Cables, electrical, special purpose, shore use.
MIL-C-19638: Cables, power electric, submarine, Navy Harbor Defense.
MIL-C-19654: Cable, telephone, submarine.
MIL-C-19787: Cable, electric, torpedo, 65 conductor (torpedo control, electric setting).
MIL-C-19883: Cables, special purpose, electric, for remote control radar set AN/FPN-28.
MIL-C-21069: Cable, electrical, shield, 600 volt (non-flexing service).
MIL-C-22667: Cable, special purpose, buoyant, electrical (submarine use).
MIL-C-23020: Coaxial cable for use inside submarines (water blocked).
MIL-C-23206: Cable, special purpose, electrical. Silicone rubber, water blocked.
MIL-C-23437: Cable, electrical, shielded pairs.
MIL-C-24145 (Ships): Cable, electrical special purpose for shipboard use (water blocked and non-water blocked). Formerly BuShip 660 L.
MIL-C-24640: Cable, electrical, lightweight for shipboard use.
MIL-C-24643: Cable and cord, electrical, low-smoke for shipboard use.
MIL-C-25115: RG-62 C/U.

Table 2-9 (Cont'd).-Common Shipboard Cable Applications

COMMON SHIPBOARD CABLE APPLICATIONS
MIL-C-25509: RG-115 A U
MIL-C-26468 (USAF): Cables, guided missile, ground installation, general requirements for.
MIL-C-27072: Multi-conductor ground support cable.
MIL-C-27212: Cable, power, electrical, airport lighting control.
MIL-C-27500: Shielded and unshielded aircraft and missile cables.
MIL-C-36359 (USAF): Power cable of two voltage range for airport lighting 8 AWG. (3,000-5,OOOV) CCLP insulated.
MIL-C-55021: Cables, twisted pairs and triples, internal hook-up, shielded and unshielded.
MIL-C-55036: Cable, telephone, WM130##/6.
MIL-E-9085 (USAF): Electrical cord, WM-85/u.
MIL-E-9088 (USAF): Electrical cord, WF-15/u.
MIL-R-833 (USAF): RF cable, RG12/u.
MIL-STD-122: Color code for chassis wiring for electronic equipment.
MIL-STD-681: Identification coding and application of hook-up wire.
MIL-W-76: General purpose hook-up wire. Vinyl insulated types LW, MW and HW.
MIL-W-438: Wire ignition electric power.
MIL-C-442: Thermoplastic or rubber jacketed two conductor parallel rip cord.
MIL-W-583: Wire, magnet, electrical.
MIL-W-3093: Wire, insulated, W-121, W-122, W-123, WD15/u, WD-16, WF-9/u, WT-3/u (distributing, frame wires).
MIL-W-3104: Wire, insulated No. 20 AWG., extra flexible).
MIL-W-3975: Wire, electrical (tinsel).
MIL-W-3861: Wire, electrical (bare copper).
MIL-W-5086: 600 volt aircraft wire (copper conductors).
MIL-W-5088: Installation of wiring and wiring devices in aircraft.
MIL-W-5274: Spec for aircraft wire, Type I 600V, Type II 600V, Type 111 300 rating
MIL-W-5845: Wire, electrical, iron and constantan, thermocouple.
MIL-W-5846: Wire, electrical, chromel and alumel, thermocouple.
MIL-W-5908: Wire, electrical, copper and constantan, thermocouple.
MIL-W-6370: Wire, electrical, insulated antenna.
MIL-W-7072: 600 volt aircraft wiring (aluminum conductors).
MIL-W-7500: Wire, electrical, WS-31-U.
MIL-W-8160: Installation of wire in guided missiles.
MIL-W-877: 600 volt silicone rubber insulated aircraft wire.
MIL-W-12349: KEL-F insulated hook-up wire.
MIL-W-12410: General purpose hook-up wire similar to MIL-W-76.

Table 2-9 (Cont'd).-Common Shipboard Cable Applications

COMMON SHIPBOARD CABLE APPLICATIONS
MIL-W-12995: Wire, electrical (W-29 and W-120).
MIL-W-13075: Wire, electrical
MIL-W-13169: Wire, electrical (for instrument test leads).
MIL-W-13241: Wire, electrical.
MIL-W-16400: General specification for electronic equipment, Naval ship and shore.
MIL-W-16878: Electronic hook-up wire. Includes vinyl (Types B, C, and D), Teflon (Types ET, E, EE, KT, K and KK) and polyethylene (Type J).
MIL-W-17211 (Ships): Wire, electrical, radio antenna 7/12, 7/14, 7/16, 7/18, 7/20, 7/22.
MIL-W-19150: Wire, insulated, hard drawn copper.
MIL-W-19583 (Navy): Wire, electrical, magnet, high temperature, film insulated.
MIL-W-21306: Wire, electrical twisted pair, color coded switchboard.
MIL-W-22759: Teflon and Tefzel insulated airframe wire.
MIL-W-25038: Wire, electrical, high temperature and fire-resistant aircraft.
MIL-W-27300: Teflon insulated 600 volt aircraft wire.
MIL-W-81044: Irradiated wire for aircraft and hook-up.
MIL-W-81381: Wire, electric polyamide insulated copper and copper alloy (Kapton H-film).
MIL-W-81822: Solid conductor, wire wrap insulated and uninsulated.
NAS-702: General purpose PVC insulated hook-up wire.
NAS-703: High temperature general purpose Teflon TFE insulated wire. Similar to Types E and EE of MIL-W-16878.

Table 2-9 (Cont'd).-Common Shipboard Cable Applications

2.13.0 CABLE MARKING

Metal tags embossed with the cable designations are used to identify all permanently installed shipboard electrical cables. The tags (fig. 2-45), when properly applied, afford easy identification of cables for purposes of maintenance and repair of IC circuits.

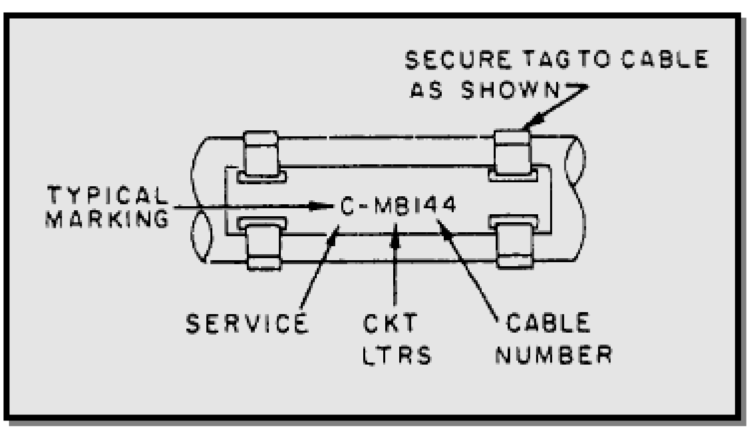


Figure 2-45.-Cable tags.

These cable designations include (1) the service letter, (2) the circuit letter(s), and (3) the cable number. The SERVICE is denoted by the letter C, which is the designation for all cables and circuits that comprise the IC system in naval ships. Each circuit is distinguished by a single letter or double letters. These letters identify the cable as a part of one of the numerous IC circuits. If two or more circuits of the same system are contained in a single cable, the number preceding the circuit letter or letters is omitted. The cable number is the number of the cable of the particular circuit.

A typical IC cable designation is C-MB144. The letter *C* denotes the service (the IC system). The letters *MB* denote the circuit, engine-order system, which may actually include wires of circuits 1MB, 2MB, 3MB, and so on. The number 144 denotes cable number 144 of circuit MB.

Permanently installed ships' cables are tagged as close as practicable to each point of connection, on both sides of decks, bulkheads, and other barriers. Cables located within a single compartment in such a manner that they can be readily traced are not tagged.

2.14.0 TERMINAL MARKING

In single-letter circuits and dc supply circuits, the positive terminal is designated by a single letter, *M*. Similarly, an arbitrary polarity of single-phase ac circuits is designated by a single letter, *M* (assumed instantaneous positive). The other side (representing the opposite polarity of both dc and ac circuits is designated by double letters, *MM*.

Double-letter circuits have supply lead markings assigned as for single-letter circuits, except that the second letter of the negative is doubled; for example, positive MB, negative MBB.

All IC terminals are identified by insulated sleeving that is stamped with the lead number and the cable number the lead belongs to.

The wire terminals 3EP and 3EPP (fig. 2-46), respectively, are the positive and negative supply terminals from cable C-E-52, which emanates from the IC switchboard and leaves from cable C-E-53.

The wire terminals 3EP3, 3EP5, 3EP6, and 3EP8 from cable C-E-52 are the positive terminals of push-button stations 3, 5, 6, and 8, respectively. The functions of these wires are found on the elementary and isometric drawings of the 3EP (protected E call) circuit for your ship.

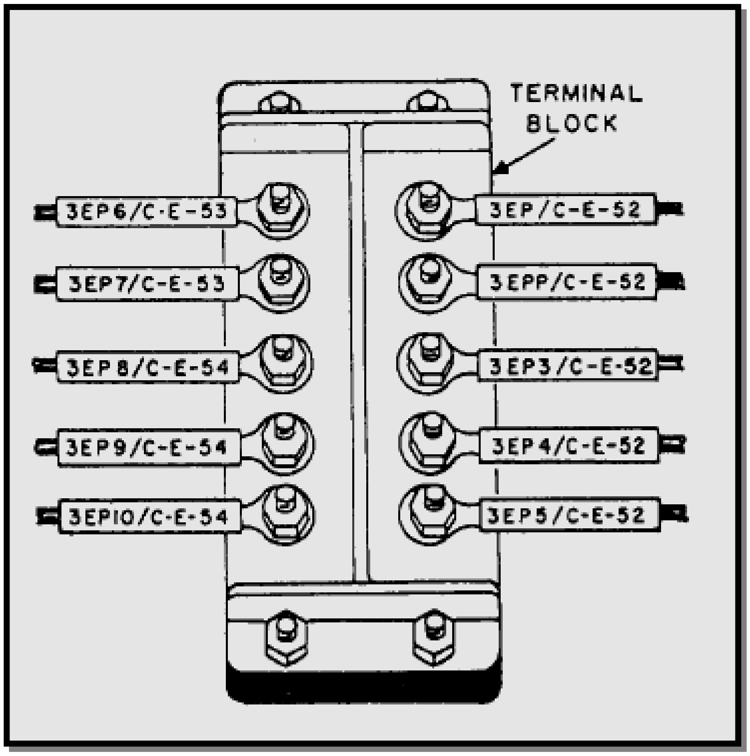


Figure 2-46.—Wire terminal markings.

Numbers following the circuit letter indicate a serial number assigned for the station, followed by the section wire number designating the function of the circuit. On systems containing synchros, the numerals 1, 2, and 3 are used for the connections to secondary windings. Where more than one synchro is employed in a single instrument, the numerals 4, 5, and 6 apply to the second synchro, and 7, 8, and 9 to the third synchro. For example, l-MB 14 should be interpreted as follows:

1—starboard circuit

MB—engine-order system

1—station number, such as pilot house

4—connection to secondary windings of the No. 2 synchro receiver in the instrument

If corresponding portions of a circuit are energized from the forward and aft IC switchboards, the suffix letters *F* and *A* are added to the ends of wire markings to indicate the switchboard from which the wire originated.

All terminals in a circuit that may be connected without a break (in the electrical sense) should be assigned the same wire marking. A fuse, switch, or instrument is considered a break in the circuit and requires a change in the wire marking.

Signal contacts should be connected to the positive (single-letter connection) in the instruments. The section-wire markings for bell or visual signal circuits should be assigned the next higher number after assignment of numbers to secondary windings of all synchro receivers in the instruments. For example, in an instrument containing two synchro receivers the signal circuits should be assigned section wires No. 7, 8, and so on.

2.15.0 MAINTENANCE OF CABLES

The purpose of cable maintenance is to keep the cable insulation resistance high. Cables should be kept clean and dry, and protected from mechanical damage, oil, and salt water.

The purpose of insulation on electrical cables and equipment is to (1) isolate current-carrying conductors from metallic and structural parts and (2) insulate points of unequal potential on conductors from each other. The resistance of such insulation should be sufficiently high to result in negligible current flow through or over its surface.

2.15.1 Factors Affecting Insulation Resistance

Factors that affect cable insulation resistance measurements are length, type, temperature, and the equipment connected in the circuit. Each of these factors must be evaluated to reliably determine the condition of the cable from the measurements obtained.

LENGTH OF CABLE.— The insulation resistance of a length of cable is the resultant of a number of small individual leakage paths or resistances between the conductor and the cable sheath. These leakage paths are distributed along the cable. Hence, the longer the cable, the greater the number of leakage paths and the lower the insulation resistance. For example, if one leakage path exists in each foot of cable, them will be 10 such paths for current to flow between the conductor and the sheath in 10 feet of cable, and the total amount of current flowing in all of them would be 10 times as great as that which would flow if the cable were only 1 foot long. Therefore, to establish a common unit of comparison, cable-insulation resistance should be expressed in megohms (or ohms) per foot of length. This is determined by multiplying the measured insulation resistance of the cable by its total length in feet.

When measured insulation resistance is converted to insulation resistance per foot, the total length of cable to be used is equal to the length of the cable sheath for single-conductor cable and for multiple-conductor cable in which each conductor is used in one leg of a circuit. For example, in an LSTSGA cable with a cable sheath of 100 feet in which the three conductors are phases A, B, and C of a 3-phase power circuit, the total length of the cable is 100 feet, not 300 feet. The reason for this is that each conductor is measured separately. If this cable is connected, either in series or parallel, to a similar cable that has a sheath length of 400 feet, the total length is 500 feet. As another example, 200 feet of type LSMSCA cable (7-conductor cable) connected to 200 feet of LSMSCA-24 cable (24-conductor cable) represents a total cable length of 400 feet.

TYPE OF CABLE.— Insulation resistance will vary considerably with the nature of the insulating materials employed and the construction of the cable. Therefore, it is possible to determine the condition of a cable by its insulation resistance measurements only when they are considered in relation to the typical characteristics of the particular type of cable. A Resistance Test Record Card, NAVSEA 531-1 (fig. 2-47), should be used to determine if the measured insulation resistance values are above the minimum acceptable values.

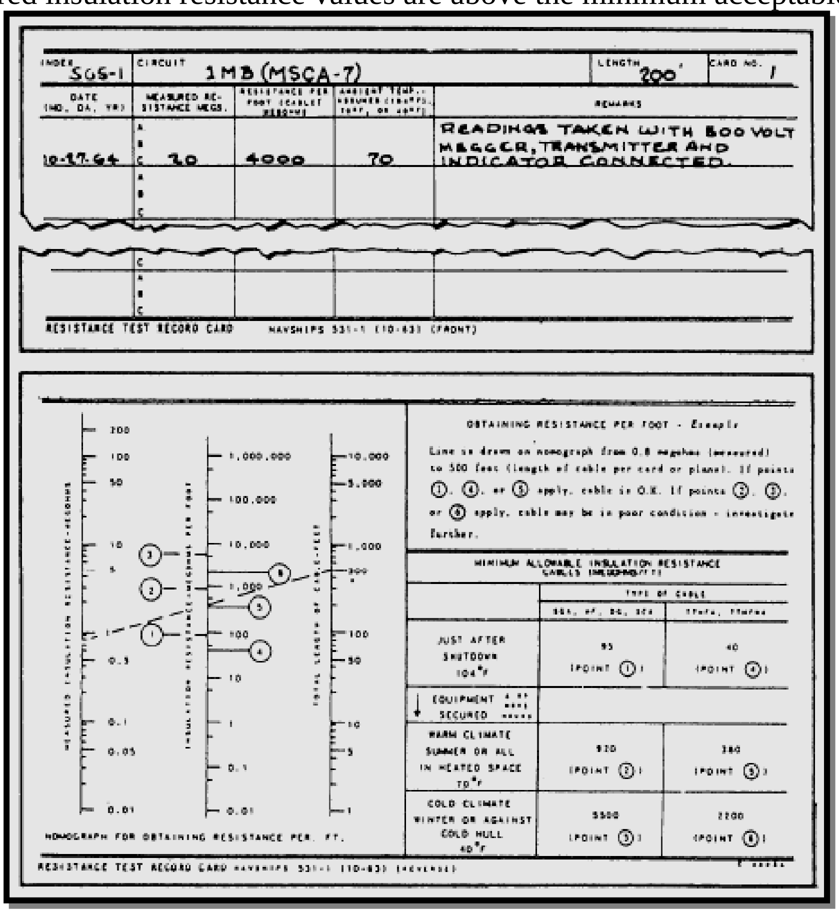


Figure 2-47.-Resistance Test Record Card, NAVSEA 531-1.

TEMPERATURE OF CABLE.— It is important to maintain the operating temperature of electrical equipment within their designed values to avoid premature failure of insulation. Temperatures only slightly in excess of designed values may produce gradual deterioration, which, though not immediately apparent, shortens the life of the insulation. Therefore, the temperature of the cable must be considered with the insulation resistance measurements. Consult *NSTM,* chapter 300, for the proper procedures for measuring the temperature of a cable.

EQUIPMENT CONNECTED.— When insulation resistance measurements are made with equipment connected, always record the exact equipment included and the type of tester used so accurate comparisons can be made with similar past or future measurements.

2.15.1.1 Testing Cables

Insulation resistance tests (ground tests) must be made periodically on IC cables to determine the condition of the cables. In addition, tests should be made when cables have been damaged, when cables have been disconnected for circuit or equipment changes, when there is evidence that a cable has been subjected to oil or salt water, and after shipboard overhauls.

Because of the variables in IC cables, such as cable length, type, or the temperature of the cable sheath, no single minimum insulation resistance reading for IC cabling can be given. For most IC cabling a reading of 0.2 megohm for each conductor is considered minimum. For the more extensive sound-powered telephone circuits, insulation resistance readings of 50,000 ohms is the acceptable minimum. For short cable runs, minimum insulation resistance should be well above 50,000 ohms.

IC cables should be tested with an insulation resistance measuring instrument (Megger). If a Megger is not available, consult NSTM, chapter 300, for alternate methods of testing the insulation resistance.

To ground test a multiconductor IC cable with a Megger, proceed as follows:

1. Check to see that the cable armor is grounded by measuring between the cable armor and the metal structure of the ship; normally, grounding has been accomplished by cable straps. If a zero reading is not obtained, ground the cable armor.

2. Select one conductor to be tested, and connect all other conductors in the cable together. Ground them with temporary wires or jumpers.

3. Measure the resistance of the conductor being tested to ground. Apply test voltage until a constant reading is obtained. Crank hand-driven generator-type Meggers for at least 30 seconds to ensure a steady reading.

4. Repeat steps 2 and 3 as necessary to test each conductor to ground.

A reading equal to or above the accepted minimum for the cable concerned indicates that the conductor under test is satisfactory. A reading below the accepted minimum indicates that the insulation resistance of the conductor under test to ground or from one or more of the grounded conductors or both is low. The grounded conductors must then be disconnected from ground, and each conductor tested individually to isolate the low-reading conductor(s).

An alternate method of ground testing multiconductor cables is to connect all conductors together and measure the insulation resistance from all conductors to ground simultaneously. If this reading is equal to or above the accepted minimum, no other reading need be taken. If the reading is below the accepted minimum, the conductors must be separated and tested individually to isolate the low-reading conductor(s).

When checking insulation resistance on circuits where semiconductor control devices are involved, the 500-volt dc Megger cannot be used. An electron tube megohmmeter is used on circuits and components where insulation resistance must be checked at a much lower potential. The megohmmeter operates on internal batteries. When circuits or components under test contain a large electrical capacity, the megohmmeter READ button must be depressed for a sufficient time to allow its capacitor to charge before a steady reading is obtained. The test voltage applied by the megohmmeter to an unknown resistance is approximately 50 volts when resistances of approximately 10 megohms are measured and slightly greater than this when higher resistances are measured.

2.15.2 Cable Repair

A cable repair is the restoration of the cable armor or the outermost sheath or both. Cable repair may be made by ship’s force. However, cable repair should be according to DOD-STD-2003-4 (Navy), unless standard methods cannot be applied.

2.15.3 Cable Splicing

A cable splice is the restoration on any part of a cable that cannot be restored by a cable repair. Cable splices should be according to DOD-STD-2003-4 (Navy), unless standard methods cannot be applied. Cable splices should not be made by ship's force except in an emergency. When such splices are made, they should be replaced at the earliest opportunity by a continuous length of cable or by an approved splice installed by a repair activity.

2.16.0 CABLE INSTALLATION

The job of installing cable may be performed by IC personnel whenever necessary to repair damage or to accomplish authorized ship alterations (SHIPALTs). Before work is begun on a new cable installation, cableway plans should be available. If repairs to a damaged section of installed cable are to be effected, information on the original installation can be obtained from the plans of the ship's electrical system, which are normally on file in the engineering department office (legroom) aboard ship. If a SHIPALT is to be accomplished; applicable plans not already on board can be obtained from the naval shipyard listed on the authorization for the SHIPALT at the planning yard for the ship.

2.16.1 Selecting Cable

When selecting cable, use all reference data available. Electrical cables installed aboard Navy vessels must meet certain requirements determined by the Naval Sea Systems Command. These requirements, published in the General Specifications for Ships of the U.S. Navy, NAVSEA S9AA0-AA-SPN-010/ GEN.SPEC, are too numerous to cover in detail in this training manual; hence, only the more basic ones are included.

2.16.2 Installing Cable

Before installing new cable, survey the area to see if there are spare cables in existing wireways and spare stuffing tubes that can be used in the new installation. The cable run must be located so damage from battle will be minimized, physical and electrical interference with other equipment and cables will be avoided, and maximum dissipation of internally generated heat will occur. Do not run cables on the exterior of the deckhouse or similar structures above the main deck, except where necessary, because of the location of the equipment served or because of structural interferences or avoidance of hazardous conditions or locations. Where practicable, route vital cables along the inboard side of beams or other structural members to afford maximum protection against damage by flying splinters or machine-gun strafing.

Where practicable, avoid installing cable in locations subject to excessive heat. Never install cable adjacent to machinery, piping, or other hot surfaces having an exposed surface temperature greater than 150°F. In general, cables should not be installed where they may be subjected to excessive moisture.

Because attenuation (power loss) in a line increases with its length, cables should be kept as short as practicable.

Flexible cables are flexible only in the sense that they will assume a relatively long bend radius. They are not intended to be stretched, compressed, or twisted. Bends are made as large as practicable.

The numbers of connectors are generally kept to a minimum to reduce line losses and maintenance problems.

Fabricated straps are used for holding the cables. They are snug, but not too tight. Back straps (which keep the cable away from a surface) are used for cable runs along masts or in compartments that are subject to sweating. In more recent installations, semicontour straps and cable bands are used for certain applications.

The exact methods of installing cables can be found in the Electronics Installation and Maintenance Book, NAVSEA SE000-00-EIM- 110.

2.16.3 Cable Supports

Types of cable supports are the single cable strap, cable rack, and modular cable supports.

SINGLE CABLE STRAP.— The single cable strap is the simplest form of cable support. The cable strap is used to secure cables to bulkheads, decks, cable hangers, fixtures, and so on. The one-hole cable strap (fig. 2-48, view A) may be used for cables not exceeding five-eighths of an inch in diameter. The two-hole strap (fig. 2-48, view B) may be used for cables over five-eighths of an inch in diameter. The spacing of simple cable supports must not exceed 32 inches center to center.

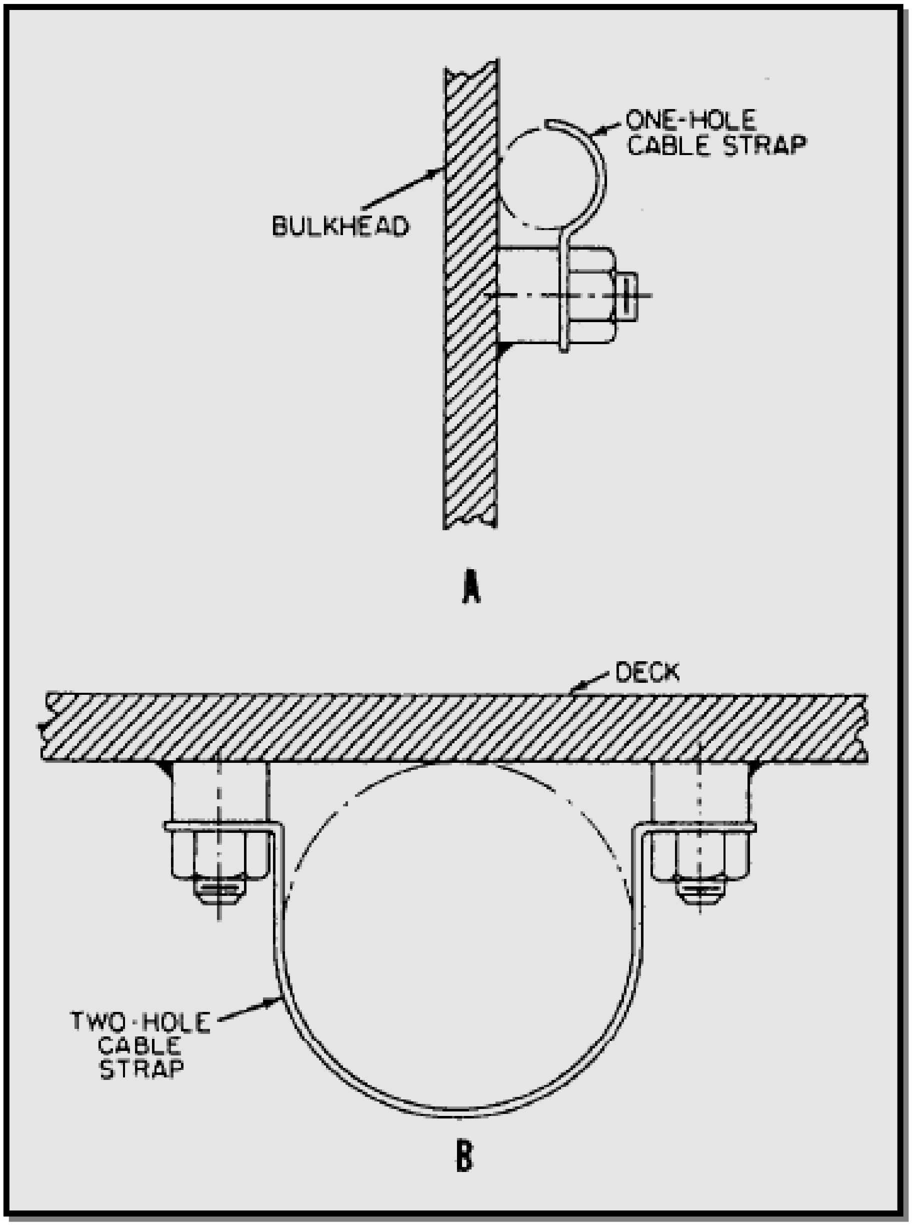


Figure 2-48.-Single cable strap applications.

CABLE RACK.— A more complex cable support is the cable rack, which consists of the cable hanger, cable strap, and hanger support (fig. 2-49).

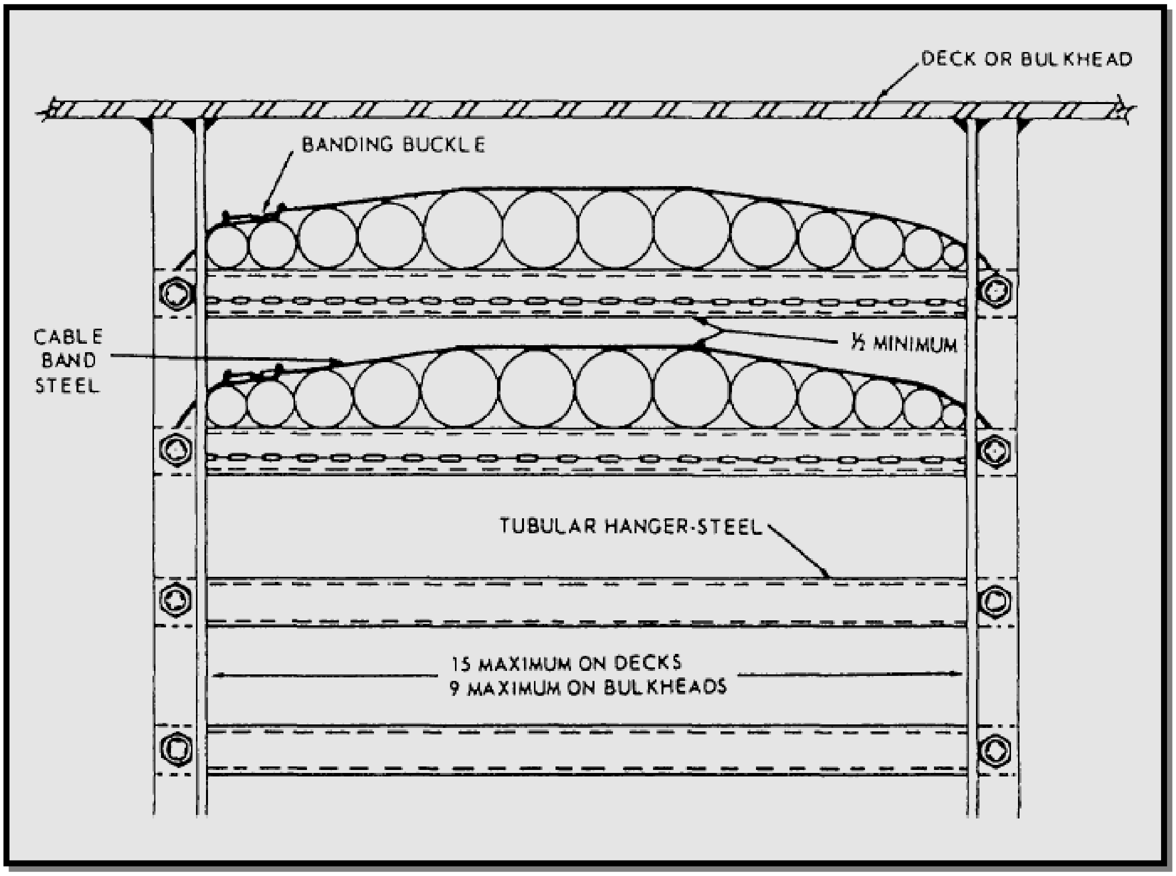


Figure 2-49.-Cables installed in a cable rack.

Banding material is five-eighths of an inch wide and may be zinc-plated steel, corrosion-resistant steel, or aluminum, depending on the requirements of the installation. For weather-deck installations, use corrosion-resistant steel band with copper-armored cables; zinc-coated steel with steel armor; and aluminum with aluminum armor.

When applying banding material, apply one turn of banding for a single cable less than 1 inch in diameter. Apply two turns of banding for single cables of 1 inch or more in diameter and for a row of cables. Apply three turns of banding for partially loaded hangers where hanger width exceeds the width of a single cable or a single row of cable by more than one-half inch.

Cables must be supported so the sag between supports, when practicable, will not exceed 1 inch. Five rows of cables may be supported from an overhead in one cable rack; two rows of cables may be supported from a bulkhead in one cable rack. As many as 16 rows of cables may be supported in main cableways, in machinery spaces, and boiler rooms. Not more than one row of cable should be installed on a single hanger.

MODULAR CABLE SUPPORTS.— Modular cable supports (fig. 2-50) are installed on a number of naval ships. The modular method saves over 50 percent in cable-pulling time and labor. Groups of cables are now passed through wide opened frames instead of inserted individually in stuffing tubes. The frames are then welded into the metal bulkheads and decks for cable runs.

The modular method of supporting electrical cables from one compartment to another is designed to be fireproof, watertight, and airtight.

Modular insert semicircular grooved twin half-blocks are matched around each cable to form a single block. These grooved insert blocks, which hold the cables (along with the spare insert solid blocks), fill up a cable support frame.

During modular armored cable installation, a sealer is applied in the grooves of each block to seal the space between the armor and cable sheath. The sealer penetrates the braid and prevents air passage under the braid. A lubricant is used when the blocks are installed to allow the blocks to slide easily over each other when they are packed and compressed over the cable. Stay plates are normally inserted between every completed row to keep the blocks positioned and to help distribute compression evenly through-out the frame. When a frame has been built up, a compression plate is inserted and tightened until there is sufficient room to insert the end packing.

To complete the sealing of the blocks and cables, the two bolts in the end packing are tightened evenly until there is a slight roll of the insert material around the end packing metal washers. This indicates the insert blocks and cables are sufficiently compressed to form a complete seal. The compression bolt is then backed off about one-eighth of a turn.

When removing cable from modular supports, first tighten down the compression bolt. This pushes the compression plate further into the frame to free the split and packing. Then remove this end packing by loosening the two bolts that separate the metal washers and the end packing pieces. Back off the compression bolt, loosening the compression plate. Then remove this plate, permitting full access to the insert blocks and cables.

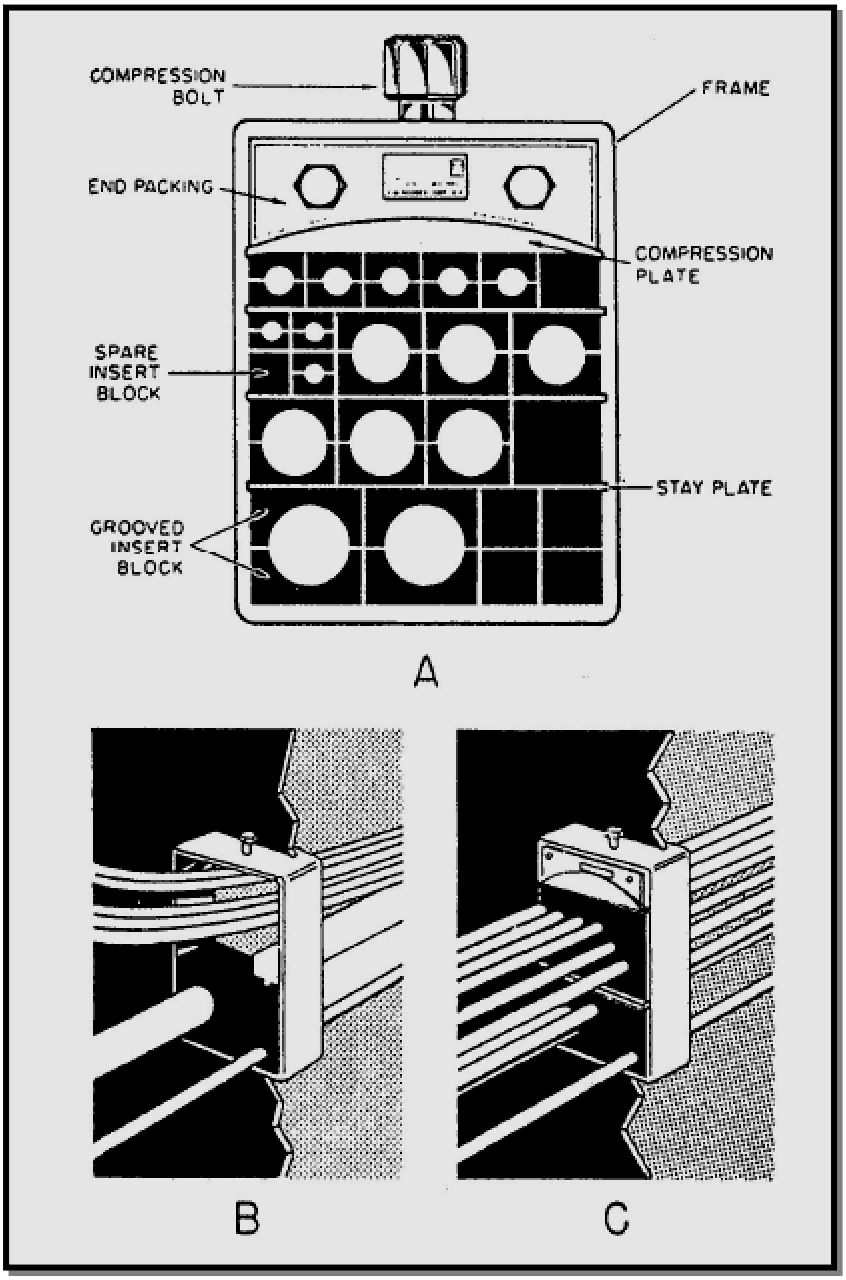


Figure 2-50.—Modular cable supports.

2.16.4 Stuffing Tubes

Stuffing tubes (fig. 2-51, views A, B, and C) are used to provide for the entry of electric cable into splash-proof, spray tight, submersible, and explosion proof equipment enclosures. Cable clamps, commonly called box connectors (shown in fig. 2-52), may be used for cable entry into all other types of equipment enclosures. However, top entry into these enclosures should be made drip-proof through stuffing tubes or cable clamps sealed with plastic sealer.

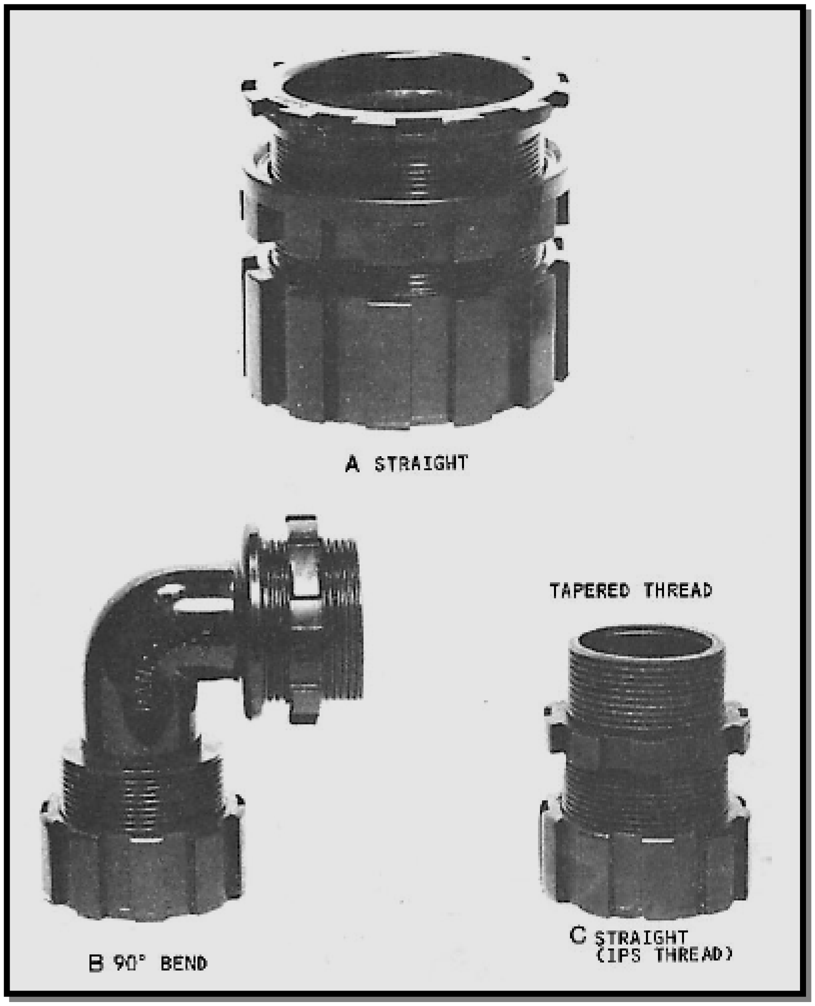


Figure 2-51.—Ny1on stuffing tubes.

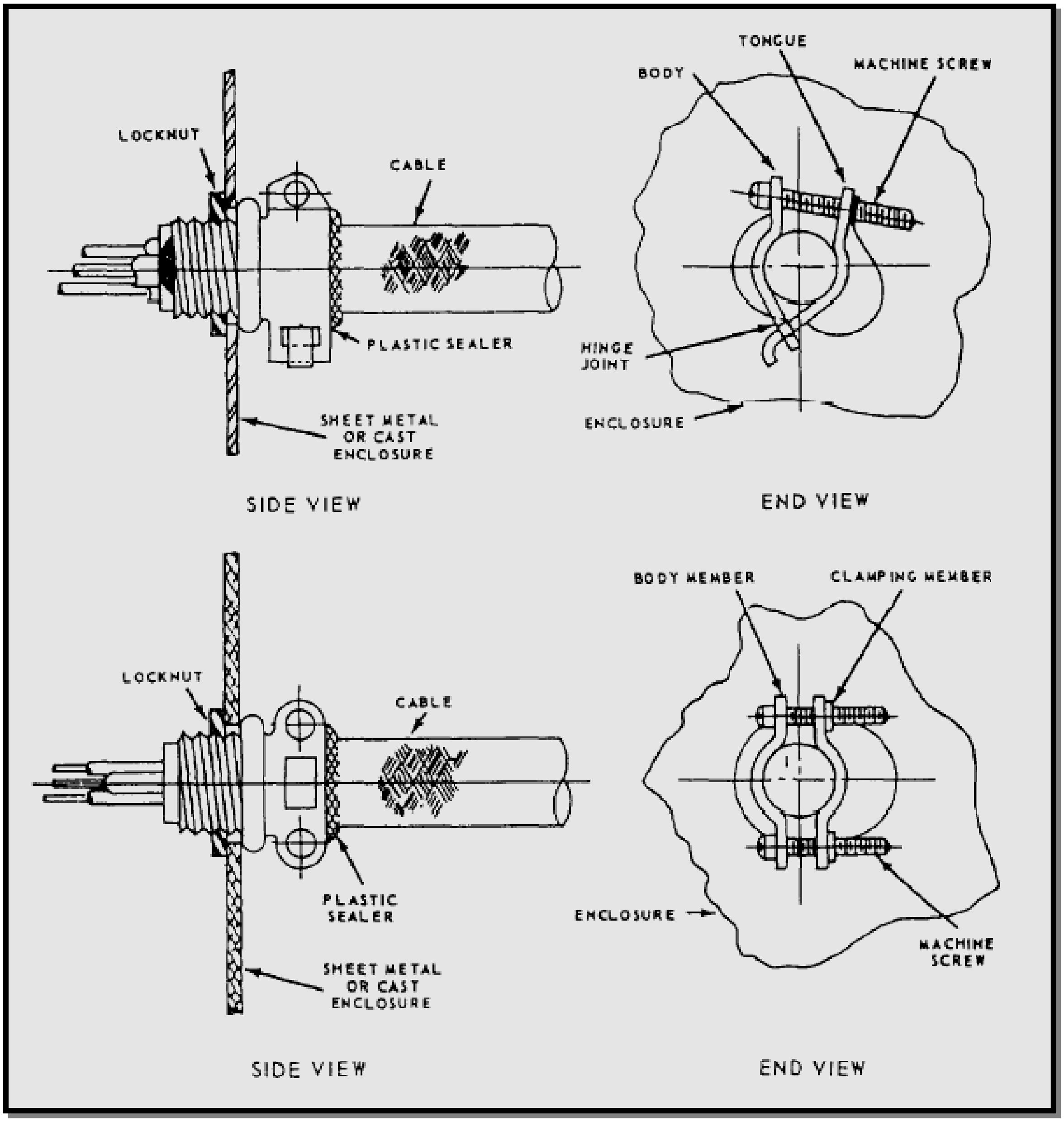


Figure 2-52.-Cable clamps.

Below the main deck, stuffing tubes are used for cable penetrations of watertight decks, watertight bulkheads, and watertight portions of bulkheads that are watertight only to a certain height. Above the main deck, stuffing tubes are used for cable penetrations of (1) watertight or airtight boundaries; (2) bulkheads designed to withstand a waterhead; (3) that portion of bulkheads below the height of the sill or coaming of compartment accesses; (4) flametight or gastight or watertight bulkheads, decks, or turrets or gun mounts; and (5) structures subject to sprinkling.

Stuffing tubes are made of nylon, steel, brass, or aluminum alloys. Nylon tubes have very nearly replaced metal tubes for cable entry to equipment enclosures.

The nylon stuffing tube is lightweight, positive-sealing, and noncorrosive. It requires only minimum maintenance for the preservation of watertight integrity. The watertight seal between the entrance to the enclosure and nylon body of the stuffing tube is made with a neoprene O-ring, which is compressed by a nylon locknut. A grommet-type neoprene packing is compressed by a nylon cap to accomplish a watertight seal between the body of the tube and the cable. Two slip washers act as compression washers on the grommet as the nylon cap of the stuffing tube is tightened. Grommets of the same external size, but with different sized holes for the cable, are available.

This allows a single-size stuffing tube to be used for a variety of cable sizes, and makes it possible for 9 sizes of nylon tubes to replace 23 sizes of aluminum, steel, and brass tubes.

The nylon stuffing tube is available in two parts. The body, O-ring, locknut, and cap comprise the tube; and the rubber grommet, two slip washers, and one bottom washer comprise the packing kit.

A nylon stuffing tube that provides cable entry into an equipment enclosure is applicable to both watertight and non-watertight enclosures (fig. 2-53, view A). Note that the tube body is inserted from inside the enclosure. The end of the cable armor, which will pass through the slip washers, is wrapped with friction tape to a maximum diameter. To ensure a watertight seal, one coat of neoprene cement is applied to the inner surface of the rubber grommet and to the cable sheath where it will contact the grommet. After the cement is applied, the grommet is immediately slipped onto the cable. The paint must be cleaned from the surface of the cable sheath before applying the cement.

Sealing plugs are available for sealing nylon stuffing tubes from which the cables have been removed. The solid plug is inserted in place of the grommet, but the slip washers are left in the tube (fig. 2-53, view B).

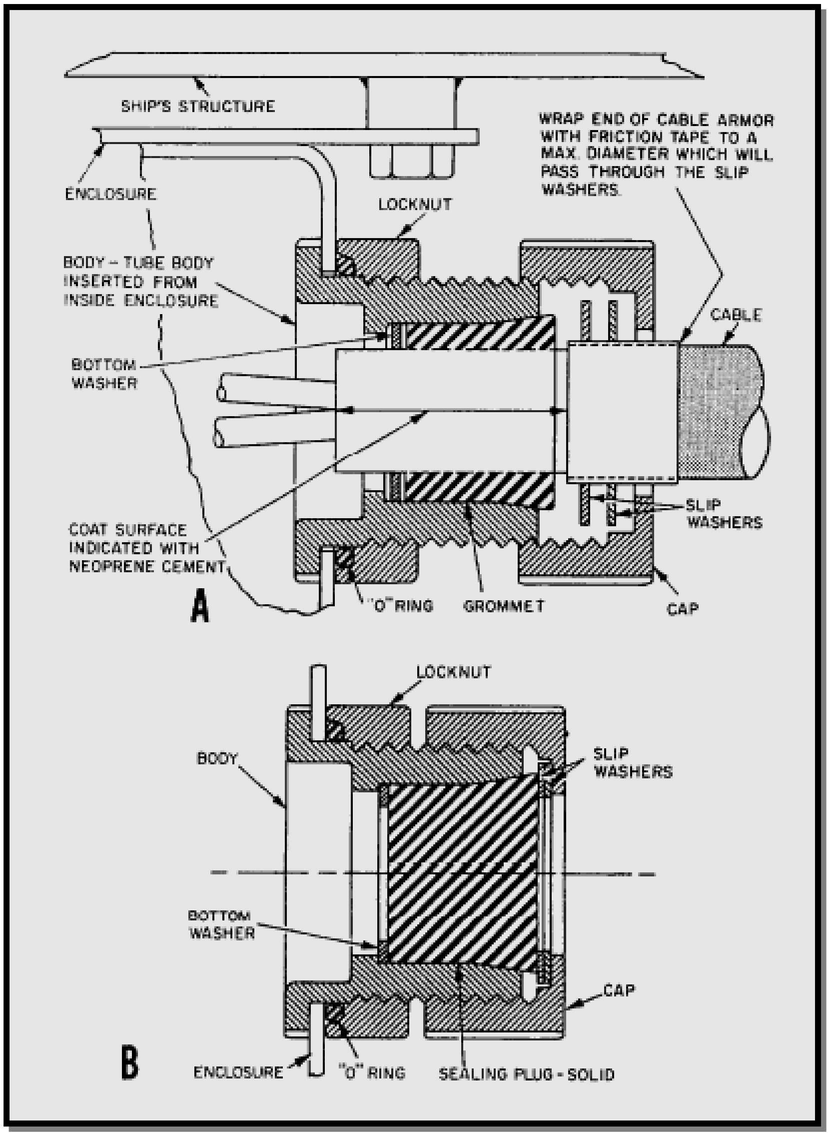


Figure 2-53.—Representative nylon stuffing tube installations.

A grounded installation that provides for cable entry into an enclosure equipped with a nylon stuffing tube is shown in figure 2-54. This type of installation is required only when radio interference e tests indicate that additional grounding is necessary within electronic spaces. In this case, the cable armor is flared and trimmed to the outside diameter of the slip washers. One end of the ground strap is inserted through the cap; and one washer is flared and trimmed to the outside diameter of the washers. Contact between the armor and the strap is maintained by pressure of the cap on the slip washers and the rubber grommet.

Watertight integrity is vital aboard ship in peacetime or in combat. Just one improper cable installation could endanger the entire ship. For example, if a cable is replaced by a newer cable of a smaller size and the fittings passing through a watertight bulkhead are not changed to the proper size, the result could be two flooded spaces in the event of a collision or enemy hit.

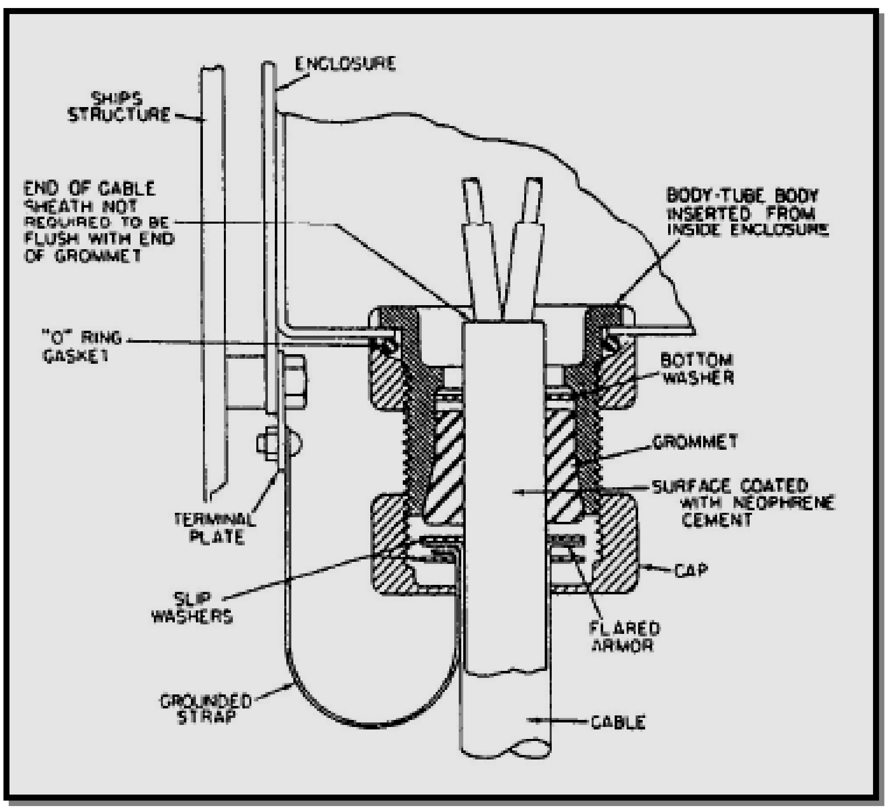


Figure 2-54.—Nylon stuffing tube grounded installation.

2.16.5 Kickpipes and Deck Risers

Where one or two cables pass through a deck in a single group, kickpipes are provided to protect the cables against mechanical damage. Steel pipes are used with steel decks, and aluminum pipes with aluminum and wooden decks. When stuffing tubes and kickpipes are installed, care must be taken not to install two different metals together; an electrolytic action may be set up. Inside edges on the ends of the pipe and the inside wall of the pipe must be free of burrs to prevent chafing of the cable. Kickpipes, including the stuffing tube, should have a minimum height of 9 inches and a maximum of 18 inches. If the height exceeds 12 inches, a brace is necessary to ensure rigid support. If the installation of kickpipes is required in non-watertight decks, a conduit bushing may be used in place of the stuffing tube.

When three or more cables pass through a deck in a single group, riser boxes must be used to provide protection against mechanical damage. Stuffing tubes are mounted in the top of riser boxes required for topside weather-deck applications. For cable passage through watertight decks inside a vessel, the riser box may cover the stuffing tubes if it is fitted with an access plate of expanded metal or perforated sheet metal. Stuffing tubes are not required with riser boxes for cable passage through non-watertight decks.

2.16.6 Connecting Cable

When connecting a newly installed cable to a junction box or unit of IC equipment, the length of the cable must be carefully estimated to ensure a neat installation (fig. 2-55). To do this, form the cable run from the last cable support to the equipment by hand. Allow sufficient slack and radius of bend to permit repairs without renewal of the cable. Carefully estimate where the armor on the cable will have to be cut to fit the stuffing tube (or connector), and mark the location with a piece of friction tape. In addition to serving as a marker, the tape will prevent unraveling and hold the armor in place during cutting operations.

Determine the length of the cable inside the equipment, using the friction tape as a starting point. Whether the conductors go directly to a connection or form a laced cable with break-offs, carefully estimate the length of the longest conductor. Then add approximately 2 1/2 times its length, and mark this position with friction tape. The extra cable length will allow for mistakes in attaching terminal lugs and possible rerouting of the conductors inside the equipment. You now know the length of the cable and can cut it.

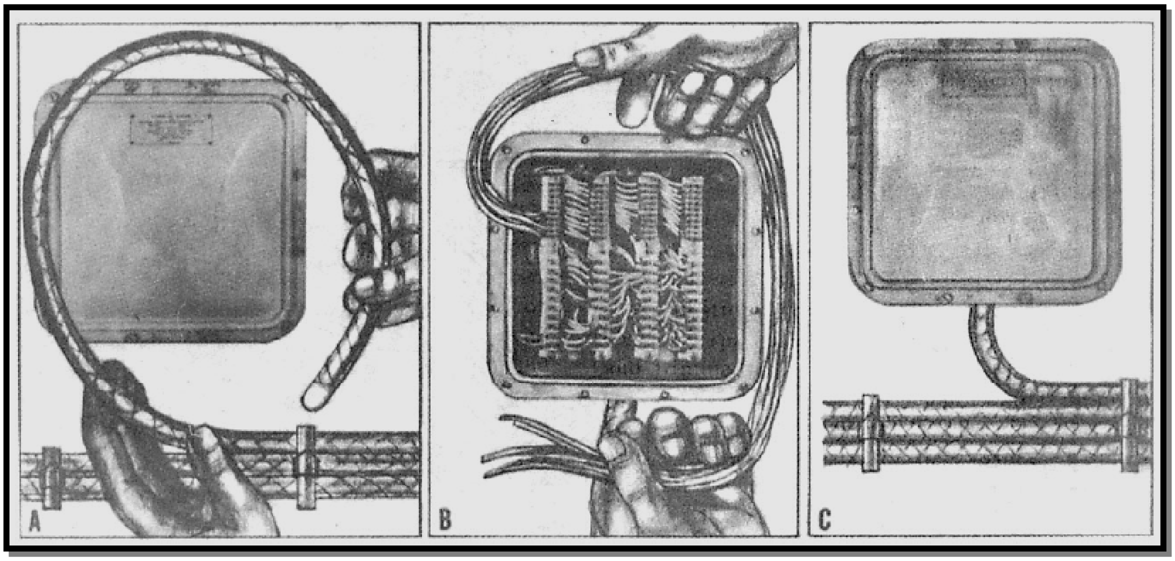


Figure 2-55.—Connecting cable to a junction box.

STRIPPING CABLE.— The cable armor maybe removed by using a cable stripper of the type shown in figure 2-56. Care must be taken not to cut or puncture the cable sheath where the sheath will contact the rubber grommet of the nylon stuffing tube.

Next, remove the impervious sheath, starting a distance of at least 1 1/4 inch (or as necessary to fit the requirements of the nylon stuffing tube) from where the armor terminates. Use the cable stripper for this job. Do not take a deep cut because the conductor insulation can be easily damaged. Flexing the cable will help separate the sheath after the cut has been made. Clean the paint from the surface of the remaining impervious sheath exposed by the removal of the armor. This paint is conducting. It is applied during manufacture of the cable and passes through the armor onto the sheath. Once the sheath has been removed, the cable filler can be trimmed with a pair of diagonal cutters.

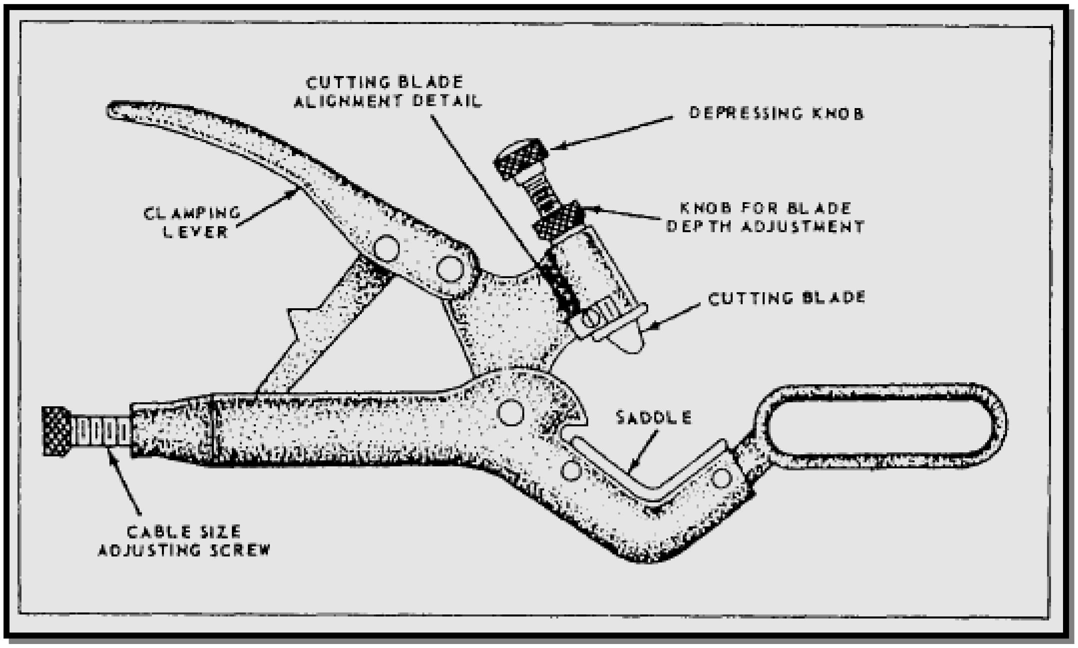


Figure 2-56.-Cable stripper.

CABLE ENDS.— When a cable is terminated in an enclosed equipment through a metal stuffing tube, the cable jacket must be tapered and any cavities filled with plastic sealer to prevent possible water transit in the event of flooding. The tapered section is then wrapped with synthetic resin tape, and the end of the tape served with treated glass cord.

When a cable is terminated in enclosed equipment through a nylon stuffing tube, the cable jacket is cut square and allowed to protrude through the grommet (fig. 2-53, view A).

When a connector is used for cable termination, the armor is cut back and taped, and the square cut jacket allowed to protrude through the connector about one-eighth inch.

The ends of cables terminating in open equipment are tapered, taped, served with cord, and varnished (fig. 2-57).

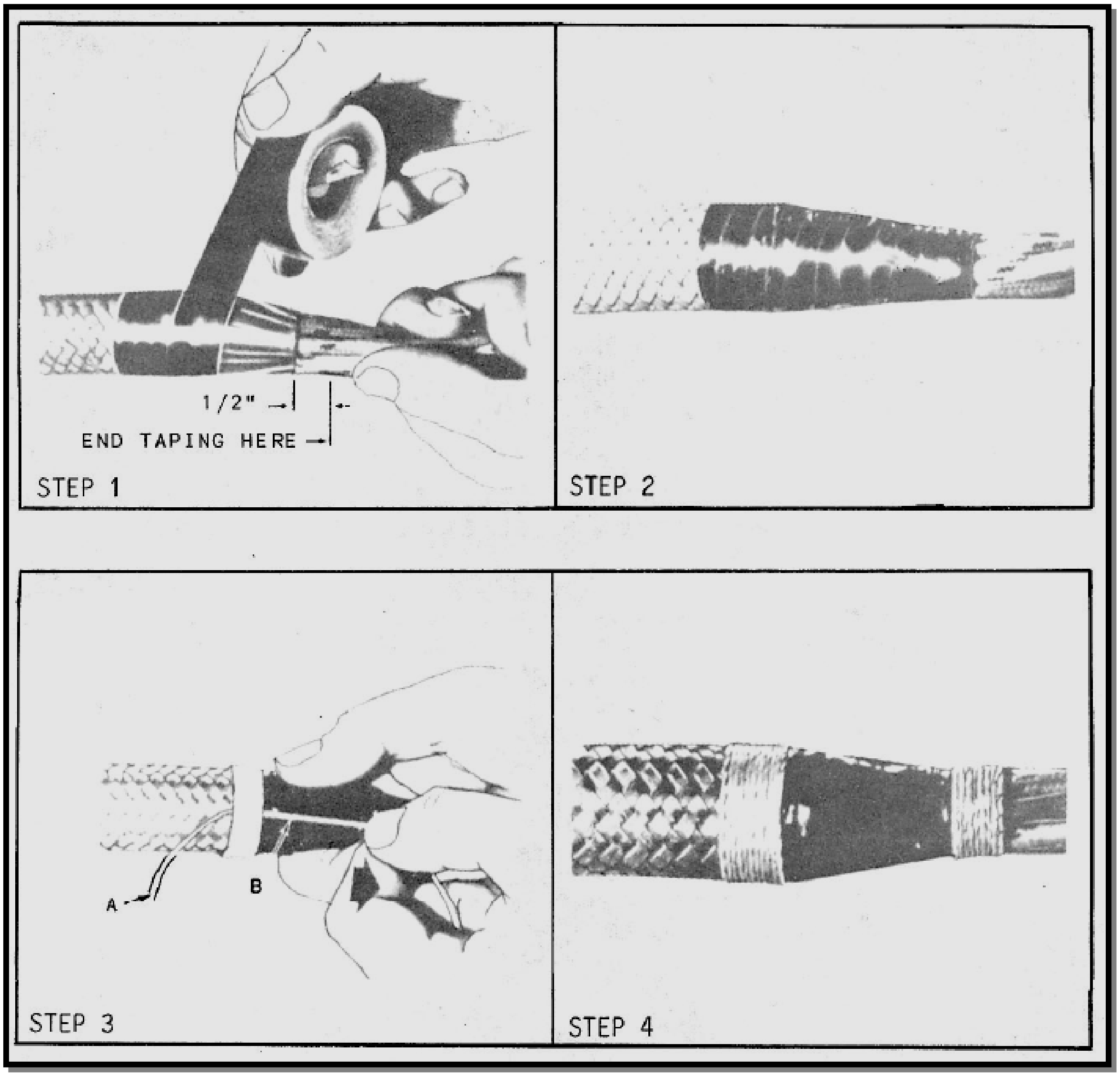


Figure 2-57.—Preparing cable ends.

CONDUCTOR ENDS.— Hand wire strippers (fig. 2-58) are used to strip insulation from the conductors. Figure 2-59 shows the proper procedure for stripping conductor ends using the hand wire strippers. Care must be taken to avoid nicking the conductor while removing the insulation. Do not use side, or diagonal, cutters for stripping insulation from conductors.

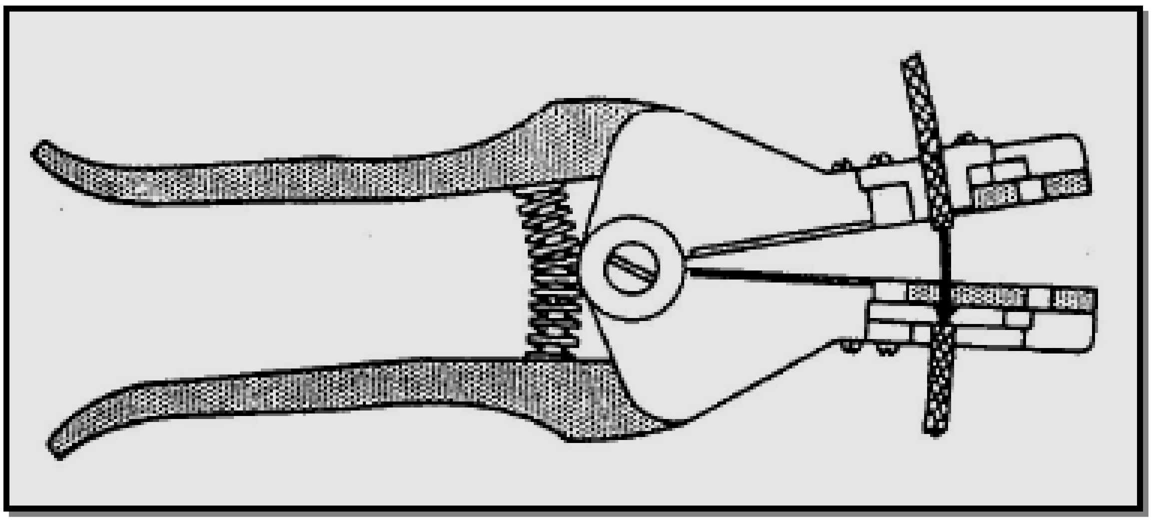


Figure 2-58.—Hand wire stripper.

Thoroughly clean conductor surfaces before applying terminals. After baring the conductor end for a length equal to the length of the terminal barrel, clean the individual strands thoroughly and twist them tightly together. Solder them to form a neat, solid terminal for fitting either approved clamp-type lugs or solder-type terminals. If the solder-type terminal is used, tin the terminal barrel and clamp it tightly over the prepared conductor (before soldering) to provide a solid mechanical joint. Conductor ends need not be soldered for use with solderless-type terminals applied with a crimping tool. Do not use a side, or diagonal, cutter for crimping solderless-type terminals. Refer to NEETS, module 4, for the proper procedures for soldering and crimping.

Solderless-type terminals may be used for all lighting, power, interior communications, and fire control applications. However, equipment provided with solder-type terminals by the manufacturer and wiring boxes or equipment in which electrical clearances would be reduced below minimum standards require solder-type terminals.

For connection under a screwhead where a standard terminal is not practicable, you can use an alternate method. Bare the conductor for the required distance and thoroughly clean the strands. Then twist the strands tightly together, bend them around a mandrel to form a suitable size loop (or hook where the screw is not removable), and dip the prepared end into solder. Remove the end, shake off the excess solder, and allow it to cool before connecting it.

After the wiring installation has been completed, measure the insulation resistance of the wiring circuit with a Megger or similar (0 to 100 megohm, 500 volts dc) insulation resistance measuring instrument. Do not energize a newly installed, repaired, or modified wiring circuit without first ascertaining (by insulation tests) that the circuit is free of short circuits and grounds.

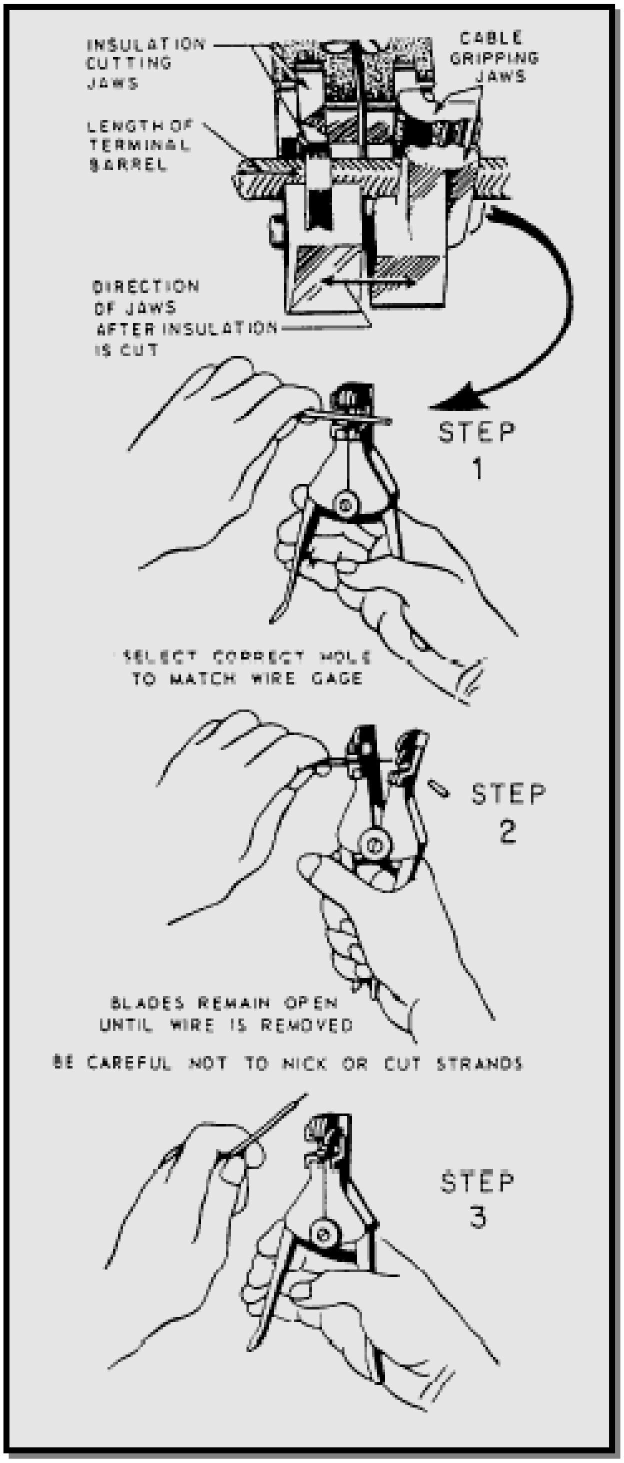


Figure 2-59.—Stripping wire with a hand stripper.

2.16.7 Lacing Conductors

Conductors within equipment must be kept in place to present a neat appearance and to facilitate tracing of the conductors when alterations or repairs are required. When conductors are properly laced, they support each other and form a neat, single cable.

Use a narrow flat tape wherever possible for lacing and tying. This tape is not an adhesive type of tape. Round cord may also be used, but its use is not preferred because cord has a tendency to cut into wire insulation. Use cotton, linen, nylon, or glass fiber cord or tape, according to the temperature requirements.

Cotton or linen cord or tape must be pre-waxed to make it moisture and fungus resistant. Nylon cord or tape may be waxed or un-waxed; glass fiber cord or tape is usually un-waxed.

The amount of flat tape or cord required to single lace a group of conductors is about 2 1/2 times the length of the longest conductor in the group. Twice this amount is required if the conductors are to be double laced.

Before lacing, lay the conductors out straight and parallel to each other. Do not twist them together. Twisting makes conductor lacing and tracing difficult.

A shuttle on which the cord can be wound will keep the cord from fouling during the lacing operations. A shuttle similar to the one shown in figure 2-60 may easily be fashioned from aluminum, brass, fiber, or plastic scrap. Smooth the rough edges of the material used for the shuttle to prevent operator and damage to the cord.

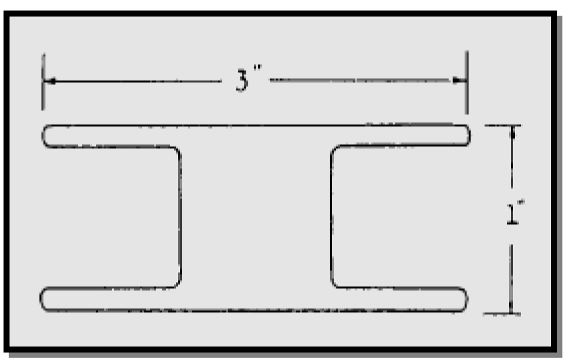


Figure 2-60.—Lacing shuttle.

To fill the shuttle for single lace, measure the cord, cut it, and wind it on the shuttle. For double lace, proceed as before, except double the length of the cord before winding it on the shuttle, and start the ends on the shuttle to leave a loop for starting the lace.

Some installations, however, require the use of twisted wires. One example is the use of twisted pairs for the ac filament leads of certain electron tube amplifiers. This minimizes the effect of radiation of their magnetic field and helps to prevent annoying hums in the amplifier output. You should duplicate the original layout when replacing such twisted leads and when relating and wiring harness.

SINGLE LACE.— Single lace may be started with a square knot and at least two marling hitches drawn tight. Details of the square knot and the marling hitch are shown in figure 2-61. Do not confuse the marling hitch with a half hitch. In the marling hitch, the end is passed over and under the strand (step 1). After forming the marling hitches, draw them tight against the square knot (step 2). The lace consists of a series of marling hitches evenly spaced at 1/2- to 1-inch intervals along the length of the group of conductors (step 3).

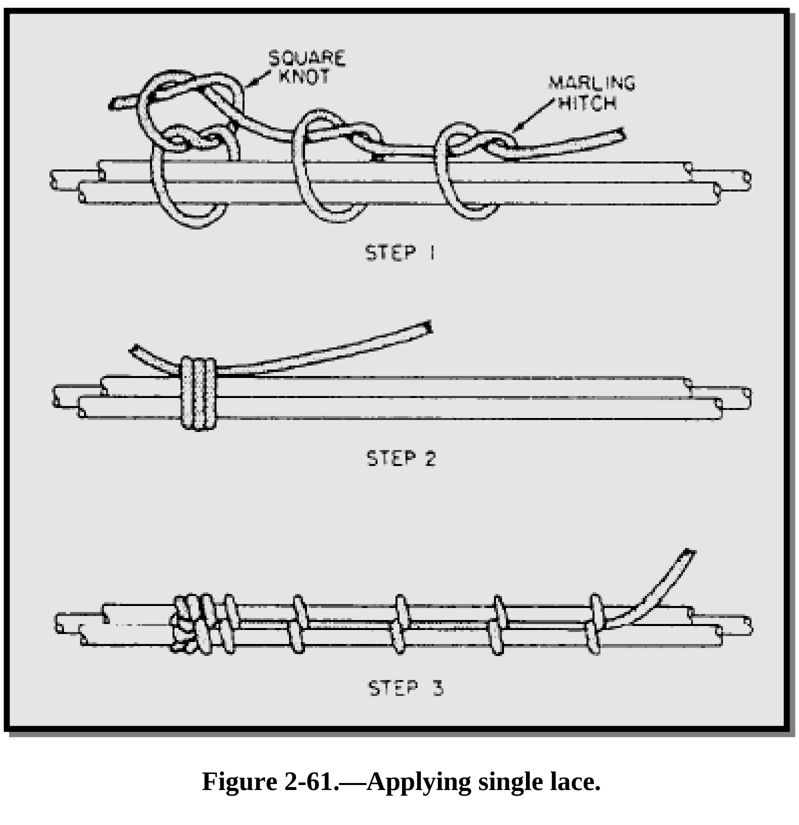


Figure 2-61.—Applying single lace.

When dividing conductors to form two or more branches, follow the procedure illustrated in figure 2-62. Bind the conductors with at least six turns between two marling hitches, and continue the lacing along one of the branches (fig. 2-62, view A). Start a new lacing along the other branch. To keep the bends in place, form them in the conductors before lacing. Always add an extra marling hitch just before a breakout (fig. 2-62, view B).

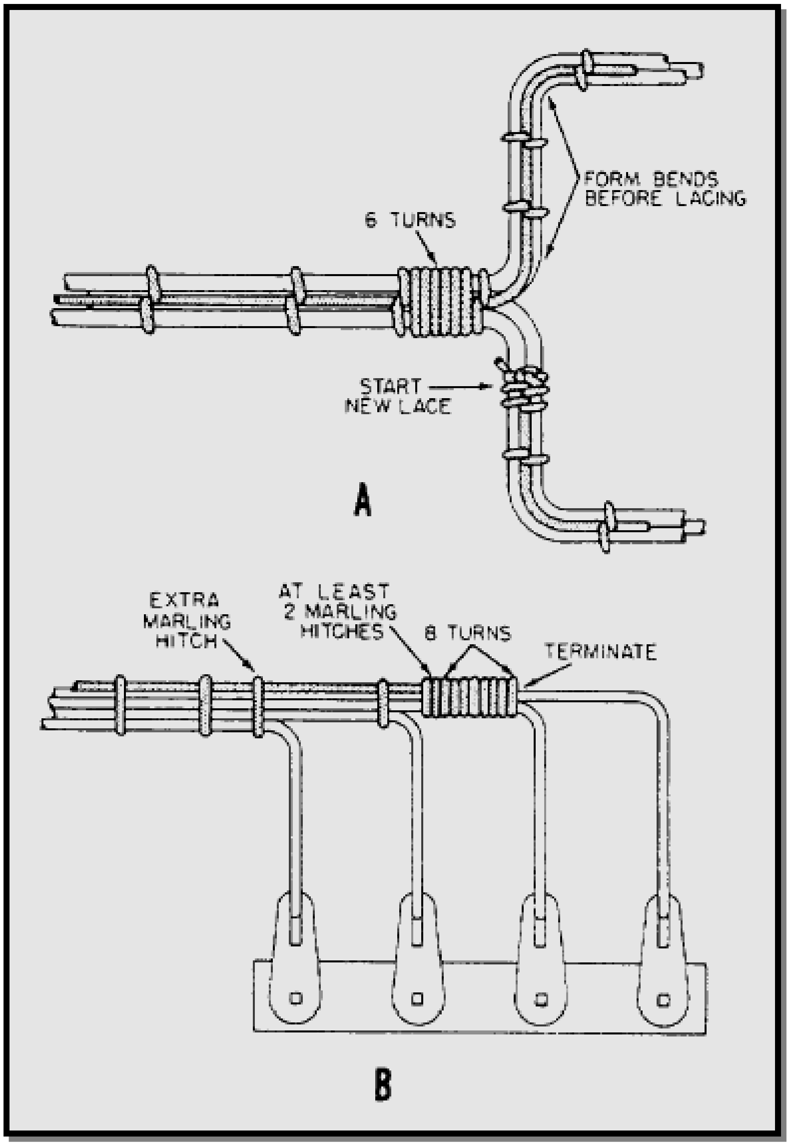


Figure 2-62.—Lacing branches and breakouts.

DOUBLE LACE.— Double lace is applied in a manner similar to single lace. However, it is started with the telephone hitch and is double throughout the length of the lacing (fig. 2-63). You can terminate double, as well as single, lace by forming a loop from a separate length of cord and using it to pull the end of the lacing back underneath a serving of approximately eight turns (fig. 2-64).

An alternate method of ending the lacing is illustrated in figure 2-65. This method can also be used for either single- or double-cord lacing.

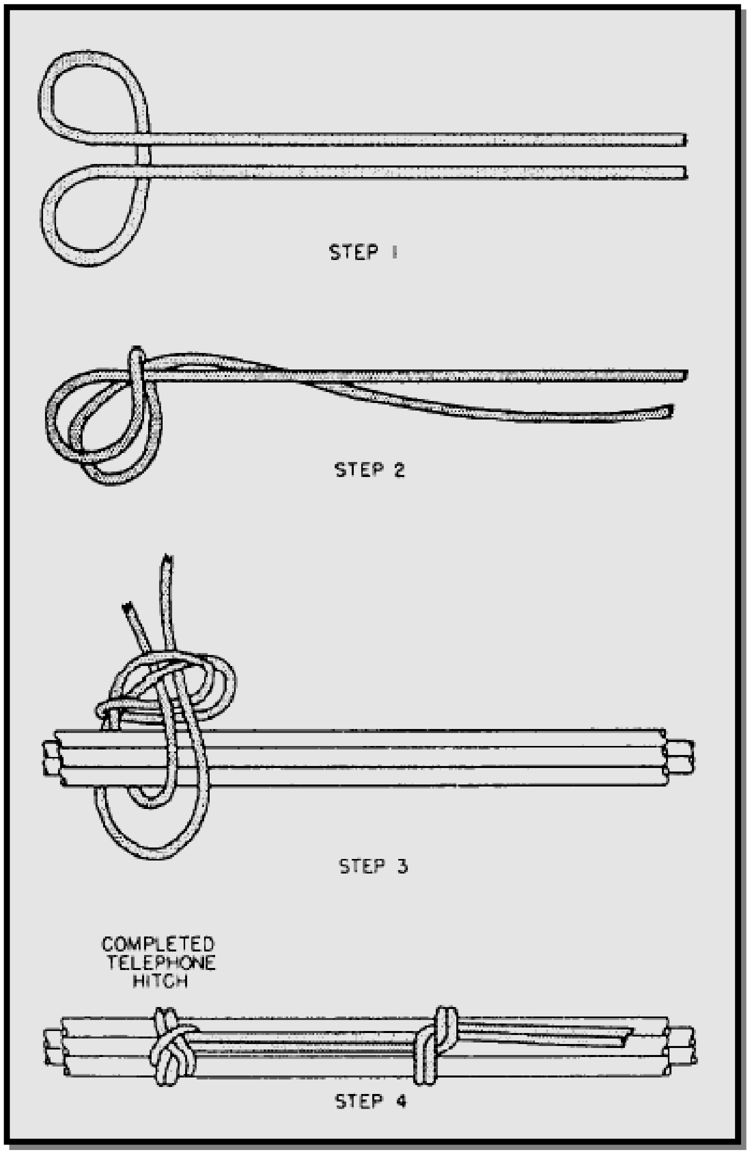


Figure 2-63.-Starting double lace with the telephone hitch.

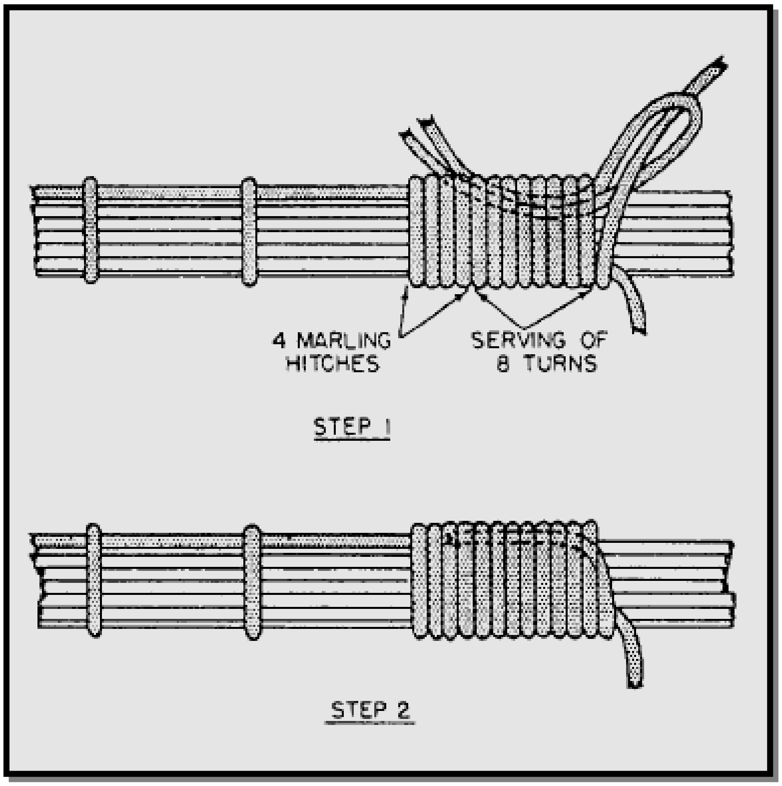


Figure 2-64.-The loop method of terminating the lace.

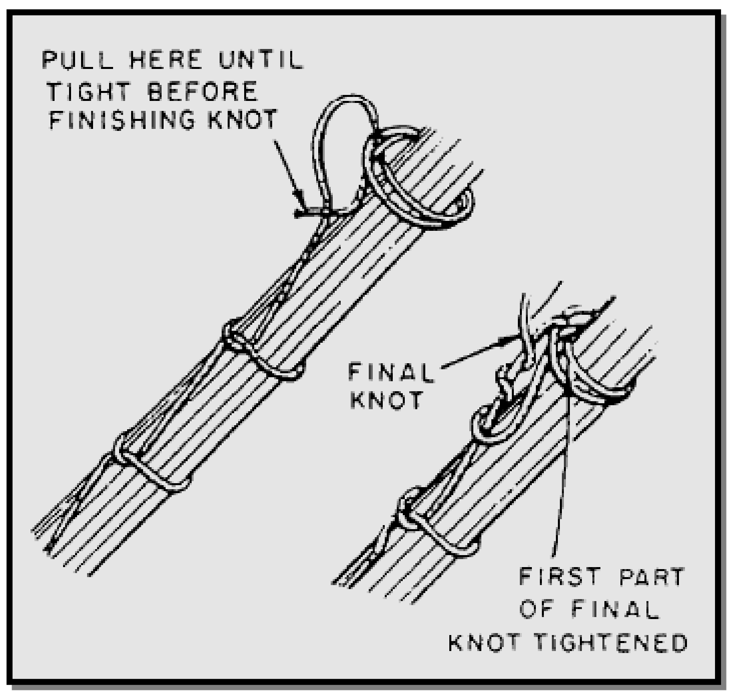


Figure 2-65.—Alternate method of terminating the lace.

LACING MULTICONDUCTORS.— Lace the spare conductors of a muticonductor cable separately, and secure them to active conductors of the cable with a few telephone hitches. When two or more cables enter an enclosure, each cable group should be laced separately. When groups parallel each other, they should be bound together at intervals with telephone hitches.

Conductor ends (3000 cm or larger) should be served with cord to prevent fraying of the insulation (fig. 2-66).

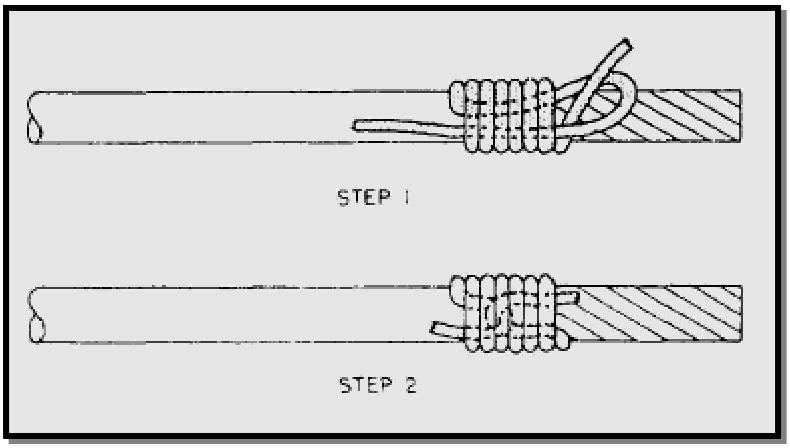


Figure 2-66.-Serving conductor ends.

SPOT TYING.— When cable supports are used in equipment, as illustrated in figure 2-67, spot ties are used to secure the conductor groups if the supports are more than 12 inches apart. The spot ties are made by wrapping the cord around the group (fig. 2-68). To finish the tie, a clove hitch followed by a square knot with an extra loop is used. The free ends of the cord are then trimmed to a minimum of three-eighths of an inch.

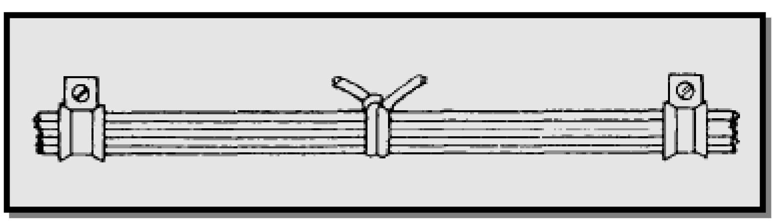


Figure 2-67.-Use of spot ties.

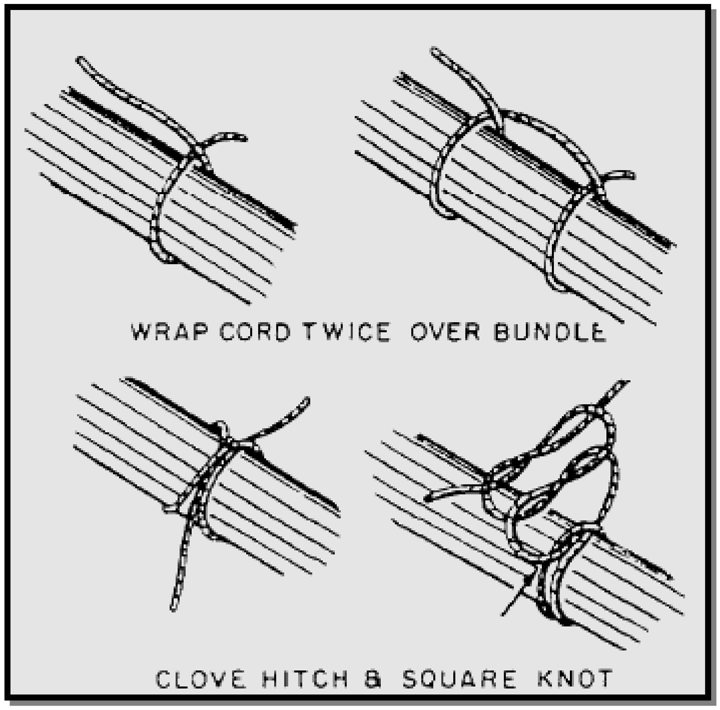


Figure 2-68.-Making spot ties.

SELF-CLINCHING CABLE STRAPS.— Self-clinching cable straps are adjustable, lightweight, flat nylon straps. They have molded ribs or serrations on the inside surface to grip the wire. They may be used instead of individual cord ties for securing wire groups or bundles quickly. The straps are of two types: a plain cable strap and one that has a flat surface for identification of cables.

Installing self-clinching cable straps is done with a military standard hand tool (fig. 2-69). An illustration of the working parts of the tool is shown in figure 2-70. To use the tool, follow the manufacturer's instructions. Do not use nylon cable straps over wire bundles containing radio-frequency (RF) coaxial cable. Do not use nylon straps in areas where failure of the strap would allow the strap to fall into movable parts or in high-temperature areas (above 250°F).

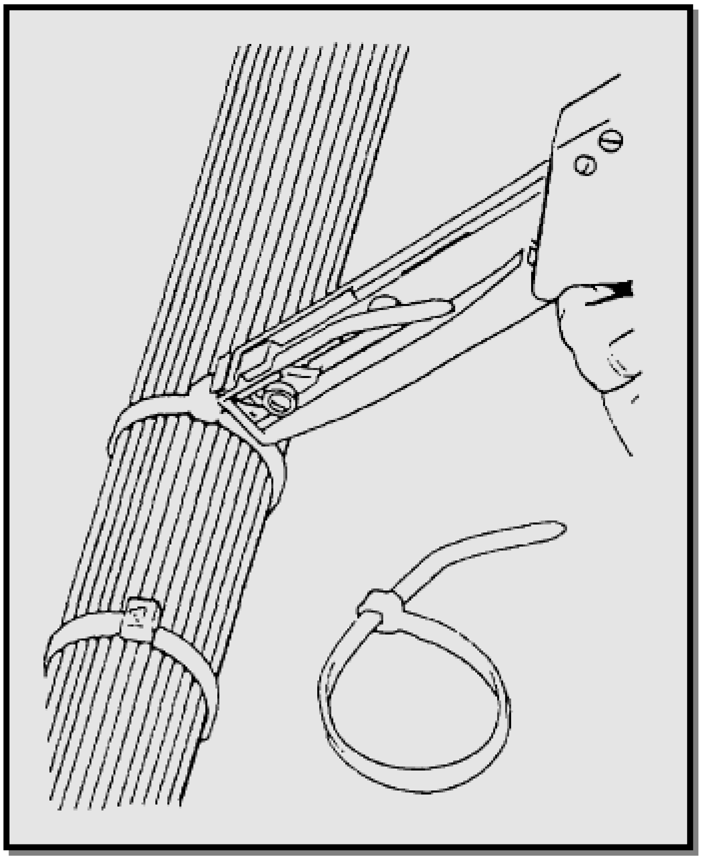


Figure 2-69.—Installing self-clinching cable straps.

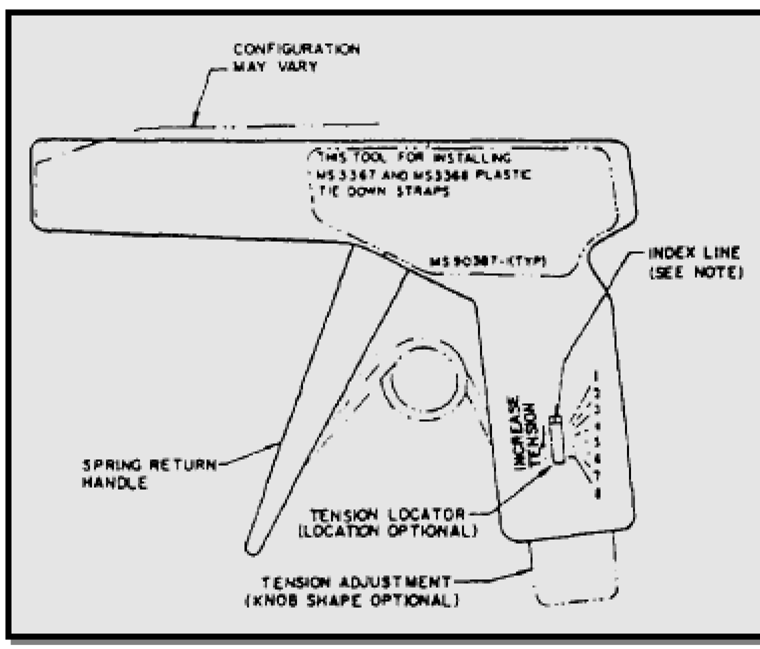


Figure 2-70.-Military standard tool for self-clinching cable straps.

HIGH-TEMPERATURE, PRESSURESENSITIVE TAPE LACING.— High-temperature, pressure-sensitive tape should be used to tie wire bundles in areas where the temperatures may go above 250°F. Install the tape as follows (see fig. 2-71):

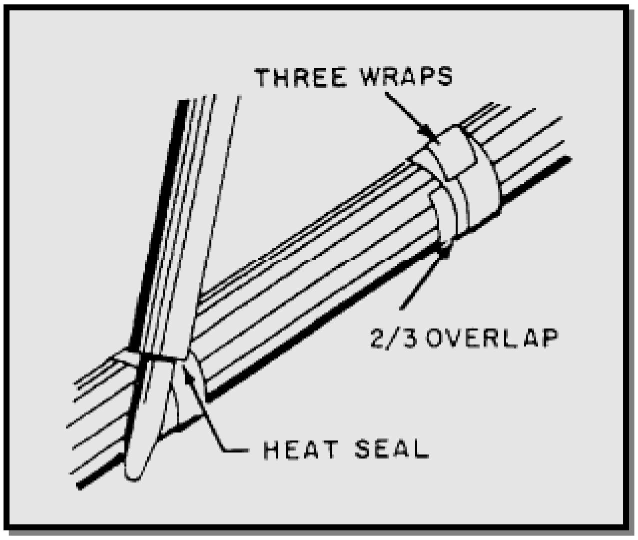


Figure 2-71.-Securing wire bundles in high temperature areas.

1. Wrap tape around the wire bundle three times, with a two-thirds overlap for each turn.

2. Heat-seal the loose tape end with the side of a soldering iron tip.

2.16.8 Radio-Frequency Coaxial Cables

RF cables may look like power cables, but they require special handling and careful installation. These cables are vital to the proper operation of all electronic equipment. They must be installed and maintained with the greatest care.

Flexible RF transmission lines (coax) are two-conductor cables. One conductor is concentrically contained within the other, as shown in figure 2-72. Both conductors are essential for efficient operation of the transmission line. The proper connectors and terminations are also necessary for efficient operation of the line.

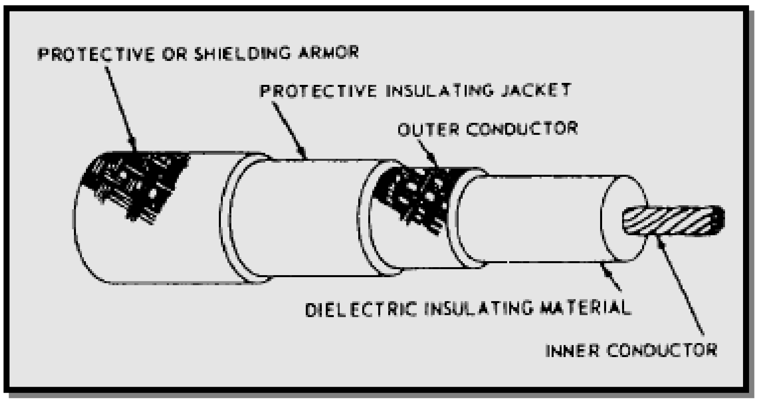


Figure 2-72.-Construction of flexible RF transmission line.

The inner conductor may be either solid or stranded. It may be made of un-plated copper, tinned copper, or silver-plated copper. Special alloys may be used for special cables.

The dielectric insulating material is usually polyethylene or Teflon. Polyethylene is a gray, translucent material. Although it is tough under general usage, it will flow when subjected to heavy pressure for a period of time. Teflon is a white opaque plastic material. This material will withstand high temperatures and will remain flexible at relatively low temperatures. It has a peculiar quality in that nothing will stick to it, and it is unaffected by the usual solvents.

Braided copper is usually used for the outer conductor; it maybe tinned, silver-plated, or bare. The outer conductor is chosen to give the best electrical qualities consistent with maximum flexibility.

The protective insulating jacket is usually a synthetic plastic material (vinyl resin). Neoprene rubber is generally used on pulse cable; silicone rubber jackets are used for high-temperature applications.

Armor is needed for protection. It may be braided aluminum, or sometimes galvanized that used on power cables.

2.17.0 FIBER OPTICS

Optics is the scientific study of light, its composition, how it travels, its effect on objects, and how it enables us to see. Fiber optics is the technique of transmitting light or images through a particular configuration of glass or plastic fibers.

The most common use of fiber optics today is as a transmission link connecting two electronic devices or circuits.
The fiber optic link changes electrical signals into optical signals, sends or transmits light signals through the fiber and then changes the optical signals back into electrical signals.

2.17.1 FIBER OPTIC CHARACTERISTICS

A Typical optical fiber consists of three parts: core, cladding and buffer. See 2-73, Fiber Characteristics.

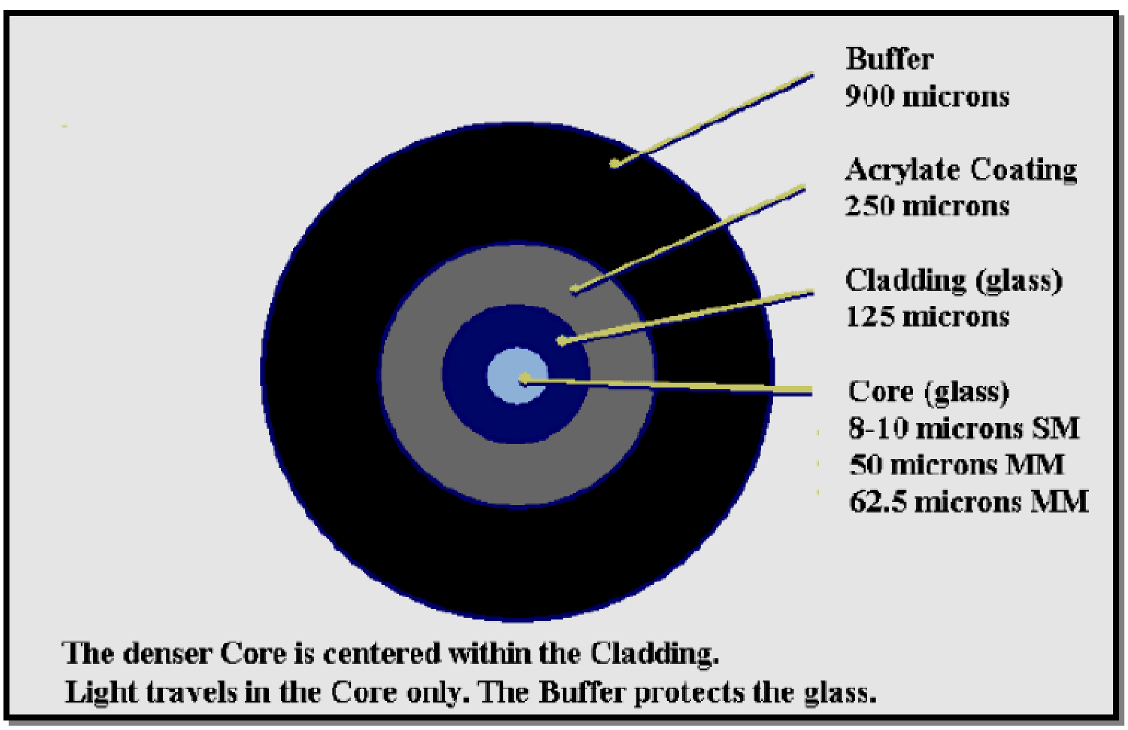


Figure 2-73. Fiber Characteristics

2.17.1.1 Fiber Core

The core is the optical transmission path. The light has to remain in the core and travel through the fiber to the receiving end. It is important to realize that the core is made from a solid section of ultrapure, ultratransparent silicon dioxide or fused quartz (glass). If seawater were as clear as a fiber, you could see to the bottom of the deepest ocean trench, the 32,177-foot-deep Mariana Trench in the Pacific.

The core will always be denser than the cladding in order to minimize the loss of light. The core diameter may range from around 2 microns for the smallest single-mode glass fibers, to 100 microns for large multi-mode glass fibers. Most fibers used in military applications are made from superior glass materials.

2.17.1.2 Fiber Cladding

The cladding surrounds the core and provides the reflective surface that allows light to propagate along the core to the distant end. The cladding is also a solid section of transparent glass or plastic, however, a significant decrease in density at the core-to-cladding interfaces helps keep light loss to a minimum. The cladding diameter of most glass fibers is 125 microns, but can be as large as 140 microns.

The fiber manufacturer would express the core-to-cladding size relationship for a fiber with a 62.5 micron core and a 125 micron cladding as 62.5/125.

The relationship between the core and the cladding is an important one. First, the surface where the core meets the cladding must be very smooth in order to achieve regular reflection. Otherwise, the light would scatter when it strikes the surface. Secondly, in order to minimize signal loss the core material must be denser than the cladding material.

2.17.1.3 Fiber Coating

The core and cladding are encased in a coating, which are usually one or more layers of polymer or acrylate material. In cables used for inside installations, the fiber is coated with a tight buffer, which may include two layers of acrylate material. Fibers with tight buffer coatings are generally used for patch cords and similar applications indoors. Tight buffer diameters are typically 900 microns.

Optical fibers used in the outside plant are usually coated with a thin layer of acrylate, which is usually 250 microns in diameter. The acrylate coating provides limited protection and color coding. Several coated fibers are then placed into breakout, distribution, or loose tube cable, depending on the application. Loose tube configurations allow the fibers to be slightly longer than the confining tubes to prevent strain damage during installation.

2.17.2 MODES

A mode is simply a path that a light ray can follow in traveling down a fiber. The number of modes supported by a fiber ranges from 1 (**Singlemode**) to over 100,000 (>1 = **Multimode**). This is dependent on the size and properties of the fiber (Core and Cladding).

2.17.2.1 Multimode

STEP INDEX FIBER. Multimode step is the simplest type. It has a core diameter from 100 microns to 970 microns and it includes glass, PCS and plastic construction. The step index fiber is the widest ranging, although not the most efficient in having high bandwidth and low losses. Since the light reflects at different angles for different paths, the path lengths of different modes are different. Thus, different rays take a shorter or longer time to travel the length of the fiber. The ray that goes straight down the center of the fiber core without reflecting arrives at the other end faster than those rays that take a different or longer route. Therefore, light entering the fiber at the same time will exit the other end at different times. This spreading of light over time is called modal dispersion.

Modal dispersion is that type of dispersion that results from the varying path lengths of different modes in a fiber. Imagine three race cars all traveling at the same speed. The first car follows a straight path. The second has to zigzag back and forth and the third car travels an intermediate path. If all three cars start at the same time and travel to a finish line one mile away, they obviously will arrive at different times. The same holds true for a pulse of light injected into a fiber. Different rays will follow different paths and so arrive at different times.

GRADED INDEX FIBER. One way to reduce modal dispersion is to use graded index fibers. Graded index fiber has numerous concentric layers of glass resembling the rings of a tree. Each ring outward from the central axis of the core having a lower IOR than the previous one. Light travels faster in a lower index of refraction. So, the further the light travels from the center of the axis, the greater its speed.

Each layer of the core reflects light. Instead of being sharply reflected as in the step index fiber, the light is now bent or continually refracted in an almost sinusoidal pattern. Those rays that follow the longest path by traveling near the outside of the core have a faster average velocity. The light traveling near the center of the core has the slowest average velocity. As a result, all rays tend to reach the end of the fiber at the same time. Graded index fibers have core sizes of 50, 62.5, or 85 microns and a cladding diameter of 125 microns. Standard on Naval ships is the 62.5 and 125 microns.

2.17.2.2 Singlemode

SINGLE MODE FIBER. Another way to reduce modal dispersion is to reduce the core's diameter until only one ray will propagate down the fiber. The single-mode fiber has an exceedingly small core diameter of only 5 to 10 microns. Standard cladding diameter is 125 microns. Since the fiber carries only one mode, modal dispersion does not exist. Therefore, it has less loss per kilometer than multimode fiber, and is used in long haul situations. Singlemode fibers easily have a potential bandwidth of 50 to 100 Ghz/km. However, it is more difficult to couple light into the fiber and although modal dispersion is reduced, waveguide dispersion may create problems.

The point at which a single-mode fiber propagates only one mode depends on the wavelength of the light carried. Single-mode operation begins when the wavelength approaches the core diameter. At 1300 m the fiber permits only one mode. It becomes a single-mode fiber.

There are three types of single-mode optical fibers usually found in typical telecommunication and data networking applications. In addition to standard single-mode fibers there are also dispersion-shifted (DS) fibers and nonzero-dispersion-shifted (NZ-DS) fibers. The purpose of these fibers is to reduce dispersion in the transmission window having the lowest attenuation. Normally, attenuation is lowest at 1550 m and dispersion at the 1300 m windows.

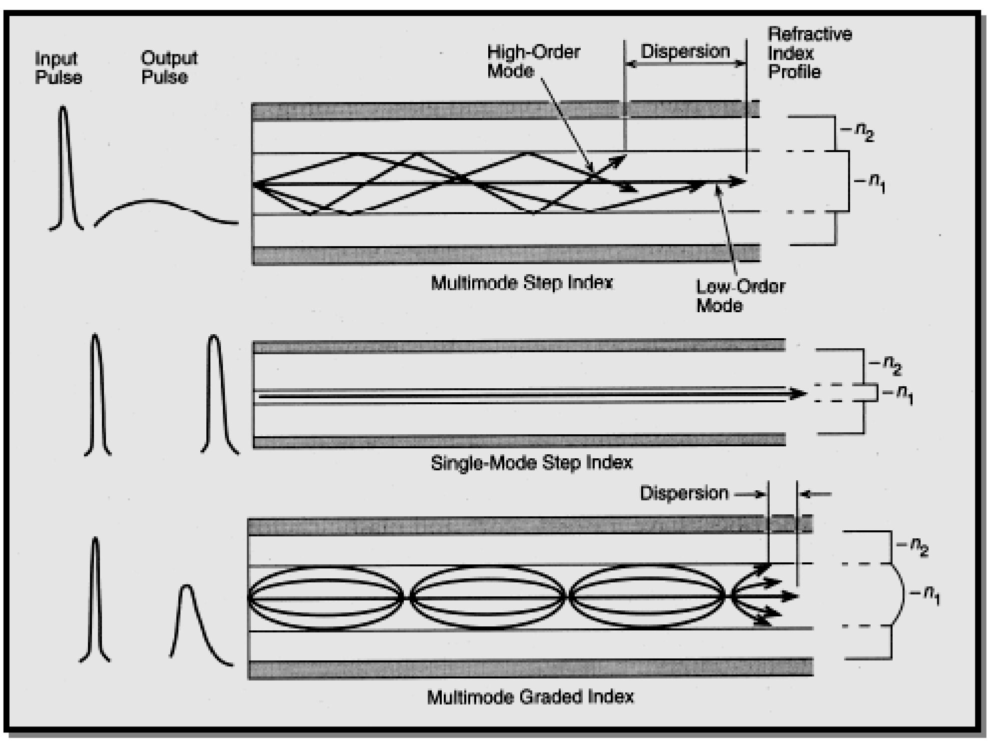


Figure 2-74. Fiber Modes

Component	Single mode	Multimode
Cable	1.5 dB/km @ 1300 nm1.5 dB/km @ 1550 nm	4.5 dB/km @ 850 nm 2.0 dB/km @ 1300 nm
Single terminus (light duty) connectors (mated pair)	0.75 dB	0.75 dB
Multiple terminus (heavy duty) connectors (mated pair)	0.75 dB	0.75 dB
COTS connectors (mated pair)	0.75 dB	0.75 dB
Mechanical splice	0.2 dB tuned 0.6 dB untuned	0.2 dB tuned 0.6 dB untuned

Table 2-10. Maximum Component Loss Values

NOTE: If components other than those listed in table 2-10 are used, the loss value of these components must be included in the maximum acceptable loss. If the loss value for a component is not known, contact the Naval Surface Warfare Center for assistance in determining the appropriate loss value.

2.17.3 FIBER OPTIC GENERAL REQUIREMENTS

Fiber optic cables for Naval shipboard application shall be in accordance with MIL-PRF-85045.

2.17.3.1 Cable Selection

Cables selected shall be those referenced in ship specifications, ship installation drawings, contract drawings, or other approved drawings as specified in the contract or by the cognizant Government activity. Substitute cables shall not be used without authorized approval. In those instances where the installing activity is responsible for determining the correct type and size cable for a specific application, the fiber optic cables shall be selected in accordance with MIL-PRF-85045. Fibers shall be in accordance with MIL-PRF-49291, either type SU (single mode) or type MM (multimode) as required by the system.

2.17.3.2 Spare Optical Fibers

The number of spare optical fibers shall be in accordance with the ship specification and system drawings. Spare fibers are provided in both trunk cables and local cables that penetrate bulkheads or decks.

2.17.3.3 Cable Storage and Handling

Cable storage-Cables shall be stored in a dry place protected from the weather and limited to a temperature range of not less than -40 degrees Celsius (^{o}C) [- 40 degrees Fahrenheit (^{o}F)] nor greater than +70^{o}C (+158^{o}F). It is recommended that cables be limited to a maximum temperature +30^{o}C (+86^{o}F). A cable that has been in storage for less than one year may be installed if a visual inspection of the cable shows no mechanical damage that would impair the watertight integrity of the cable's outer sheath or the integrity of the interior components. A conventional optical fiber cable that has been in storage for one year or longer may be installed if it passes the visual inspection and if the optical attenuation is less than the value specified. A BOF cable that has been in storage for one year or longer may be installed if it passes the visual inspection, and if a ball bearing with a minimum outer diameter of 4 mm will pass through each BOF tube within the cable. Cables shall be stored on reels with minimum diameters of 24 times the cable outside diameter, or coiled so that the bend diameter shall be not less than 24 times the cable outside diameter. Bare ends of stored cables shall be sealed against moisture using heat shrink end caps as specified herein. Terminated cables shall be sealed against moisture using connector dust covers (for multiple terminus connectors), plastic caps or heat shrink end caps as specified herein.

Cable handling-During handling, the conventional optical fiber cable and the BOF cable shall be protected from crushing, kinks, twists, and bends that violate the minimum short term bend diameter of the cable. The minimum short-term bend diameter of conventional optical fiber cable is eight times the cable outside diameter. The minimum short term bend diameter of BOF cable is 0.13 m (5 inches) for single tube BOF cable and 0.45 m (18 inches) for seven tube BOF cable. It is recommended that cables not be handled in ambient temperatures at or below 36^{o}F (2^{o}C).

2.17.3.4 Installation of Optical Fiber Cables in Cableways

Cable pulling-Optical fiber cables shall be installed by feeding the cable through the cableway in a segment by segment fashion for the entire route and then securing it into the cableways. Block and tackle, chain falls, or other mechanical devices shall not be used to pull optical fiber cable. The cable shall be pulled to avoid kinking, twisting, sharp bending, or stretching by applying excessive pulling force. The optical fiber cable should be monitored at all bend points and at multiple points on long straight runs to ensure that the cable does not encounter sharp objects. It is recommended that the cable be pulled slowly, so that if it does get caught, it will be readily noticeable and cable pulling can be stopped before any damage occurs.

Cable pulling in armored cable cableways-Cableways containing armored cable should be avoided where possible. Where installation of optical fiber cables into cableways containing armored cable cannot be avoided, additional personnel shall be used to monitor during pulling due to the increased possibility for mechanical damage to the optical fiber cable.

Cable bend diameter-During handling and installation in cableways, cable bends in optical fiber cables shall not violate the minimum short term bend diameter of the cable. The completed installation shall not violate the minimum long-term bend diameter of the cable. The installation of optical fiber cables at or below temperatures of $2^{o}C$ ($36^{o}F$) is not recommended. If cable must be installed when its temperature is $2^{o}C$ ($36^{o}F$) or lower, the cable shall be warmed thoroughly using a portable heater (or equivalent) before installing the cable in the cableway.

CAUTION: Continuously monitor the cable if it is directly exposed to the heat source. Prolonged exposure of the cable jacket to a temperature above $160^{o}C$ ($320^{o}F$) could cause damage to the cable jacket.

Conventional optical fiber cable minimum bend diameters-The minimum short-term bend diameter for conventional optical fiber cable is eight times the cable outside diameter. The minimum long-term bend diameter for conventional optical fiber cable is sixteen times the cable outside diameter.

Optical fibers would not be practical transmission media if their ability to guide light required them to be kept perfectly straight. It must be realized that any deviation from perfect straightness causes some light to scatter into the cladding and be lost. Such deviations can occur in two ways; via large bends that can be seen by the human eye, called macrobends, and by microscopically small deviations in the fiber axis, called microbends.

For bending radii larger than a couple of inches, macrobending losses are small and imperceptible. For bending radii less than a few inches, loss increases rapidly and becomes prohibitively large at a certain critical radii.

Microbends can cause high-order modes to reflect at angles that will not allow further reflection. The light is lost. Microbends can occur during the manufacture of the fiber or can be caused by the cable. Manufacturing and cabling techniques have advanced to minimize microbends and their effects. See figure 2-75.

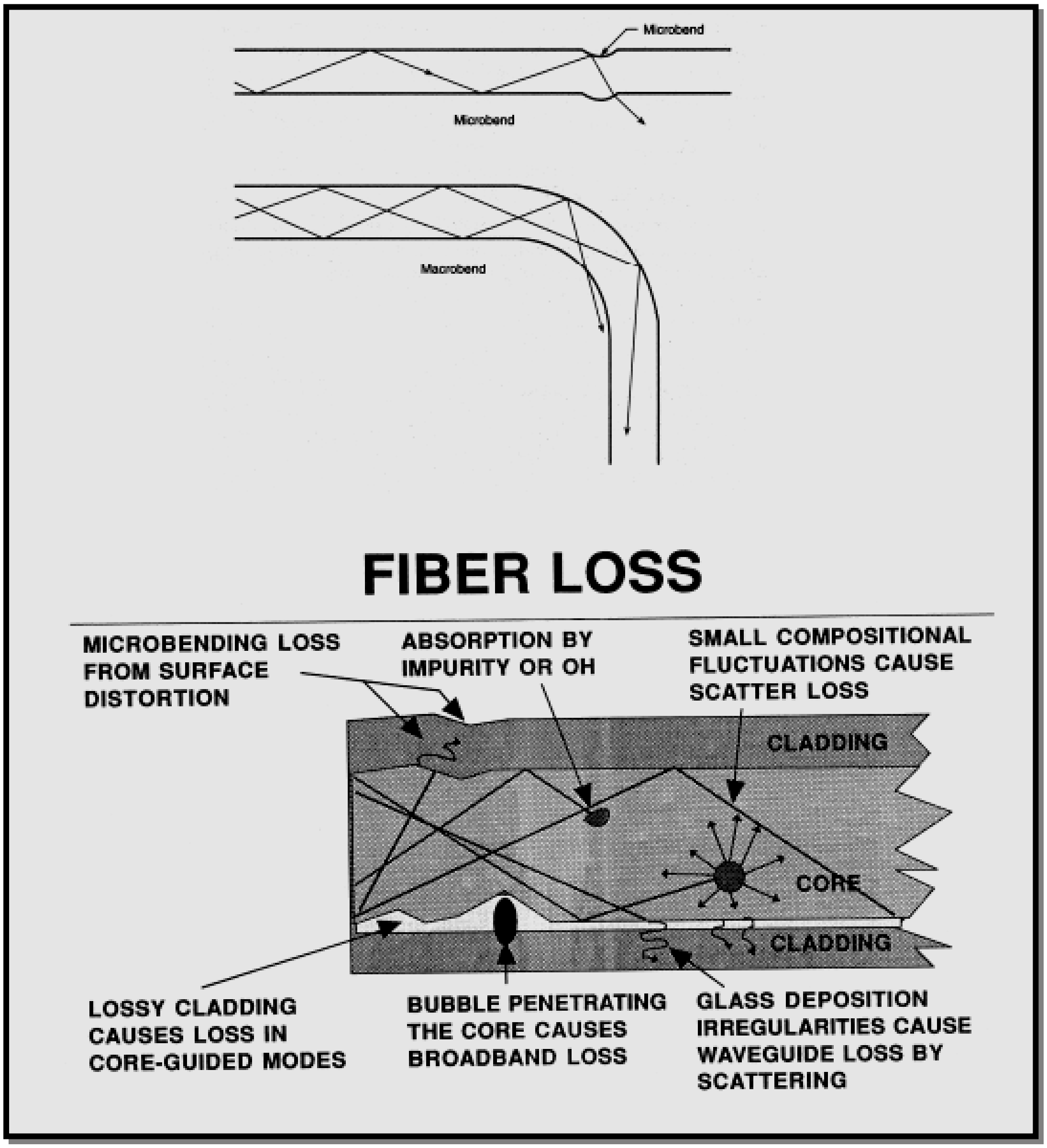


Figure 2-75. Causes of Attenuation | Loss and Bends

BOF cable minimum bend diameters-The minimum short term and long term bend diameter for 7-tube BOF cable is eighteen inches.

Installed cable slack-Cables shall be installed in accordance with the following:

a. Sufficient slack shall exist to allow for deflection of bulkheads.

b. The sag between hangers shall be uniform for each row of cables so that clearance between rows will be the same throughout the cable run.

c. Where cables spread out to enter bulkhead stuffing tubes or MCP's, bends shall have a liberal sweep to provide as much flexibility as practicable.

d. Cables having only a minimum spread where they pass through bulkhead stuffing tubes shall have enough slack to give them the same flexibility as other cables in the group.

e. Cables from equipment shall enter cableways in a curve of sufficient radius to prevent transmission of stresses to the equipment during severe cableway deflection.

f. Cables entering or connected to equipment shall have additional slack as specified in Part 2 of MIL-STD-2042-4B (SH).

g. Cables crossing expansion joints shall have slack allowance at such points not less than the maximum movement of the expansion joints.

Cable placement in cable hangers-Optical fiber cables shall not be run through the cross-tier mounting holes of cable hanger vertical support channels. Where optical fiber cables are to be mixed with electric cables in the same cableway, the optical fiber cables shall be installed last and be run on top of the electric cables where possible, and shall be located in the center of the cableway. If electric cables are installed on top of optical fiber cables, they shall be installed in accordance with MIL-STD-2042-4B (SH) Section 4.3.

2.17.4 VISUAL INSPECTION OF FIBER OPTIC COMPONENTS

This method describes a procedure for a visual inspection of conventional fiber optic cables, BOF tube cables and associated FOCT components.

2.17.4.1 Required Equipment and Materials

Safety glasses are required if bare fibers are present.

2.17.4.2 Procedures

The following safety precautions shall be observed:

a. Safety glasses shall be worn when handling bare fibers.

b. Do not touch the ends of fibers as they may be razor sharp. Wash your hands after handling bare fiber.

Procedure I. Cable inspection.

NOTE: During handling, conventional optical fiber cable and BOF cable shall be protected from kinks, twists, crushing, and sharp bends.

Step 1 - Examine the cable documentation to ensure that the optical fiber cable conforms to the requirements of MIL-PRF-85045. Record all of the optical fiber cable information (including the manufacturer's cable identification number and any optical performance information) from the cable documentation. (Acceptance Test only)

Step 2 - Examine the conventional optical fiber cable and BOF tube cable for the following: (NOTE: For optical fiber cable on a reel, examine that portion of the optical fiber cable that can be seen without removing the cable from the reel.)

a. Damage - cuts, burnt areas, abrasions, holes, roughened areas, bulges, thin spots, kinks, or wrinkles.

b. Marking - As a minimum, the part number, manufacturer's identification, the words "fiber optic cable", and a four-digit date code (Acceptance Test only).

c. Color code - OFCC jacket colorations should be easily discernable (conventional optical fiber cable only).

Step 3 - Examine the BOF fiber and BOF bundles for the following: (NOTE: For items on a reel, examine that portion of the item that can be seen without removing the item from the reel.)

a. Damage - cuts, burnt areas, abrasions, holes, roughened areas, bulges, thin spots, kinks, or wrinkles.

b. Marking - As a minimum, the part number and manufacturer's identification.

c. Color code - BOF fiber colorations should be easily discernable.

Procedure II. Connector, splice and interconnection box inspection.

Step 1 - Examine the documentation to ensure that the components conform to the requirements of the applicable Military Specifications.

Step 2 - Examine the components for the following:

a. Damage - missing or loose parts, dents, cracks, chips, burrs, or peeling or chipping of the plating or finish.

b. Marking - As a minimum, the part number and manufacturer's identification (Acceptance Test only).

2.17.5 CABLE CONTINUITY TEST

This method describes a procedure for performing a optical fiber cable continuity test on conventional or BOF cables with or without connectors or terminations of any type.

2.17.5.1 Required Equipment and Materials

The equipment and materials in table 2-11 shall be used to perform this procedure.

Description	Quantity
Safety glasses	1
Alcohol bottle with alcohol/2-propanol (sealable type)	As required
Wipes (NAVSEA DWG 6872811-18 or equal)	As required
Canned air or compressed air	As required
Flashlight or high intensity light source	1
Bare fiber adapter	As required

Table 2-11. Equipment and Materials

The following safety precautions shall be observed:

a. Safety glasses shall be worn when handling bare fibers.

b. Do not touch the ends of the fibers as they may be razor sharp. Wash your hands after handling bare fiber.

c. Observe warnings and cautions on equipment and materials.

d. When visually inspecting an optical fiber, never stare into the end of a fiber connected to a laser source or LED.

2.17.5.2 Procedures

Step 1 - Establish communications, if required, using available communication equipment.

Step 2 - Using a wipe dampened with alcohol, clean the fibers on both ends of the optical fiber cable and blow them dry with air.

Step 3 - Using a flashlight or equivalent, shine light in each fiber and verify that light is present at the opposite end.

NOTE: For continuity testing of single mode fiber, a high intensity light source specifically for single mode continuity testing should be used.

NOTE: A bare fiber adapter may be used to optimize the connection between the flashlight and unterminated optical fibers.

2.17.6 CABLE END SEALING

This method describes a procedure for conventional fiber optic cable and BOF cable end sealing during temporary and long-term storage to prevent water or other liquids from entering into the cable and damaging the fibers.

2.17.6.1 Required Equipment and Materials

The equipment and materials in table 2-12 shall be used to perform this procedure.

Description	Quantity
Safety glasses	1
Ruler	1
Heat gun (Raychem 500B or equal)	1
Alcohol bottle with alcohol/2-propanol	1
End cap (Raychem SSC series or equal)	1
Wipes	As required
Canned air	As required

Table 2-12. Equipment and Materials

The following safety precautions shall be observed:

a. Safety glasses shall be worn at all times when handling bare fibers.

b. Do not touch the ends of the fiber as they may be razor sharp. Wash your hands after handling bare fiber.

c. Observe warnings and cautions on the equipment and materials.

d. Never stare into the end of a fiber connected to a laser source or LED.

e. Never look into the end of a BOF tube connected to a pressure source.

2.17.6.2 Procedures

NOTE: End caps shall meet the requirements of MIL-I-81765/1 and table 2-13. The cap interior shall be coated with a heat-activated adhesive.

Step 1 - Clean the end of conventional cable or BOF cable with a wipe dampened with alcohol and blow dry as necessary.

Step 2 - Select an end cap in accordance with table 2-13.

Cable Type	Cable OD mm (inches) nominal	End cap dimensions mm (inches)		
		Length (min)	Expanded I.D.(min)	Recovered I.D.(max)
4-Fiber	8.1 (0.32)	33.5 (1.32)	9.9 (0.39)	4.1 (0.16)
8-Fiber	11.1 (0.44)	55.4 (2.18)	20.1 (0.79)	7.6 (0.30)
36-Fiber	20.8 (0.82)	90 (3.54)	35.1 (1.38)	15 (0.59)
Single-Tube	11.1 (0.44)	55.4 (2.18)	20.1 (0.79)	7.6 (0.30)
7-Tube	29.0 (1.14)	90 (3.54)	35.1 (1.38)	15 (0.59)
7-Tube	31.5 (1.24)	90 (3.54)	35.1 (1.38)	15 (0.59)

Table 2-13. End Cap Data and Sizes for Fiber Optic Cable

Step 3 - Slide the end cap over the end of the cable or BOF cable to be sealed. Position the end cap to ensure a 25 mm (1 inch) minimum overlap (see figure 2-76).

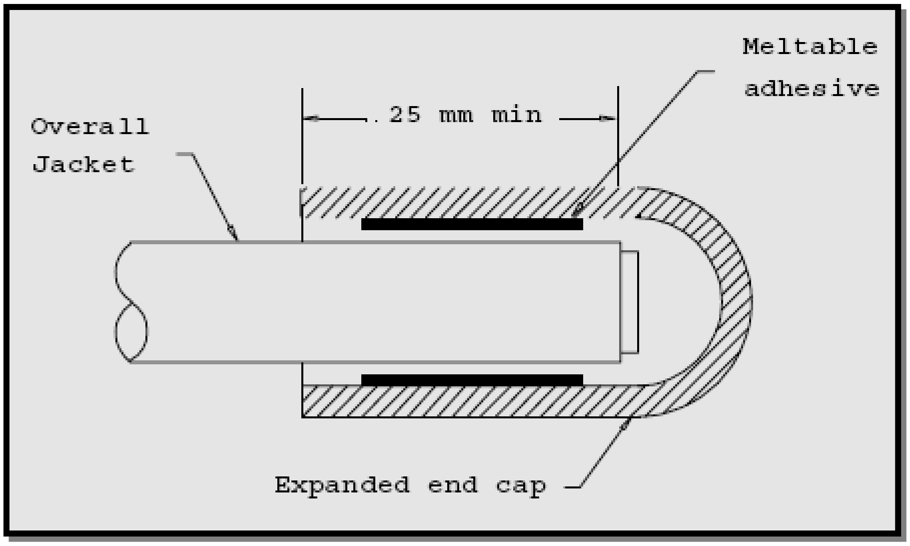


Figure 2-76. Installing Expanded End Cap on Cable

Step 4 - CAUTION: Do not overheat the cable. Prolonged exposure of the jacket to temperatures above 160°C (320°F) may damage the cable jacket. Discontinue heating of the sleeve and allow the cable jacket to cool before reheating, if the cable jacket shows any signs of bubbling. Hold the heat gun approximately 100 mm (4 inches) from the end cap and as heat is applied, move the heat gun back and forth over the end cap. Shrink the end cap from closed end to open end to avoid trapping air.

(**NOTE:** Minimum recovery temperature is 121°C (250°F).

Step 5 - When the end cap has recovered enough to assume the configuration of the cable and excess adhesive appears at the end of the cap, discontinue heating (see figure 2-77).

(**NOTE:** Additional heat will not make end cap shrink more tightly.)

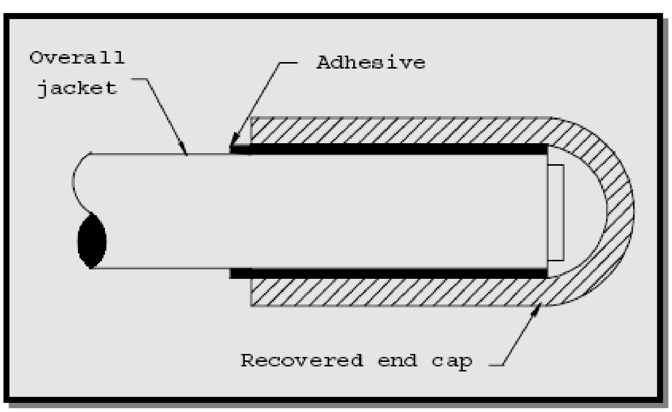


Figure 2-77. Completed End Seal

2.17.7 CABLE JACKET REPAIR

This method describes procedures for repairing the damaged outer jacket of a conventional cable or a BOF cable, with kevlar strength members intact.

2.17.7.1 Required Equipment and Materials

The equipment and materials in the tables located in the applicable sections of this method shall be used to perform these procedures.

The following safety precautions shall be observed:

a. Safety glasses shall be worn when handling bare fibers.

b. Do not touch the ends of the fiber as they may be razor sharp. Wash your hands after handling bare fiber.

c. Observe warnings and cautions on equipment and materials.

d. Never stare into the end of a fiber connected to a laser source or LED.

e. Never look into the end of a BOF tube connected to a pressure source.

Procedure I. Wraparound sleeve with rail closure.

The equipment and materials in table 2-14 shall be used to perform this procedure.

Description	Quantity
Safety glasses	1
Ruler	1
Electricians knife	1
Emery cloth (or fine file)	As required
Adhesive and sealant tape (Raychem Thermofit S1030 or equal)	As required
Repair sleeve (Raychem CRSM-x-1200 or equal)	1
Heat gun (Raychem 500B or equal)	1
Alcohol bottle with alcohol/2-propanol	1
Wipes	As required
Canned air (or compressed air)	As required

Table 2-14. Equipment and Materials

NOTE: The cable jacket repair sleeve material shall meet the requirements of SAE AMS-DTL-23053/15 and table 2-15. The material shall be coated with a heat-activated adhesive and fabricated into a wrap around sleeve with a rail closure system as shown on the figures below.

Step 1 - Select a repair sleeve in accordance with table 2-15.

Cable type	Cable OD nominal mm (inches)	B dimension mm (inches)	Repair sleeve dimensions mm (inches)			
			Length (minimum)	Rail to rail		Wall thickness after shrinking (+/- 10%)
				Expanded (minimum)	Recovered (maximum)	
4-fiber	8.1 (.32)	76 (3.0)	A + 2B	45.7 (1.8)	23.9 (.94)	2.0 (0.08)
8-fiber	11.1 (.44)	76 (3.0)	A + 2B	45.7 (1.8)	23.9 (.94)	2.0 (0.08)
36-fiber	20.8 (.82)	76 (3.0)	A + 2B	79.8 (3.14)	48.5 (1.91)	2.0 (0.08)
Single-tube	11.1 (.44)	76 (3.0)	A + 2B	45.7 (1.8)	23.9 (.94)	2.0 (0.08)
7-tube	29.0 (1.14)	76 (3.0)	A + 2B	215.5 (8.48)	75.8 (2.98)	2.0 (0.08)
7-tube	31.5 (1.24)	76 (3.0)	A + 2B	215.5 (8.48)	75.8 (2.98)	2.0 (0.08)

Table 2-15. Repair Sleeve Dimensions (Wraparound)

Step 2 - Trim off the frayed, burned, or protruding jacket material with a knife using care not to damage the kevlar or OFCC jacket (see figure 2-78). Square up the jacketing where required.

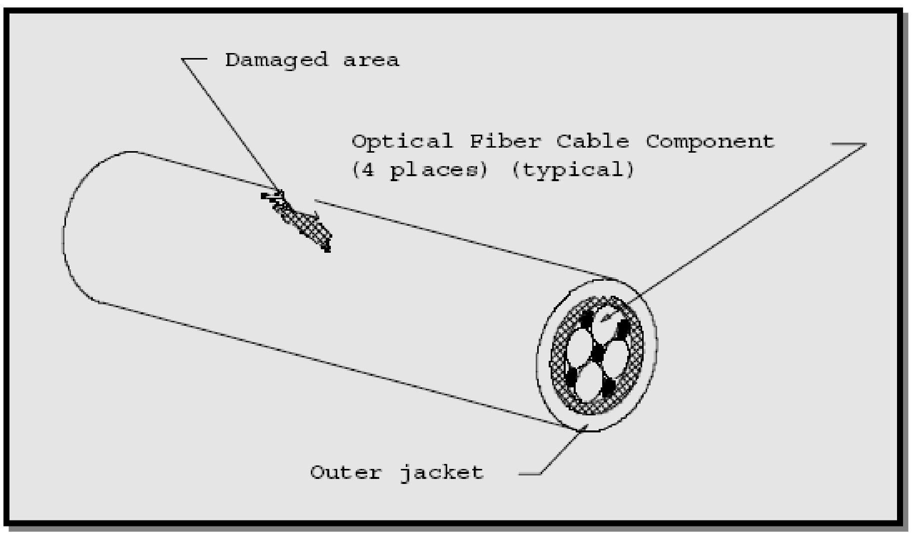


Figure 2-78. Damaged Cable

NOTE: Refer to figure 2-79 for a definition of A and B dimensions.

Step 3 - Abrade the jacket circumferentially to the dimension shown using emery cloth or a fine file (see table 2-15 and figure 2-79)

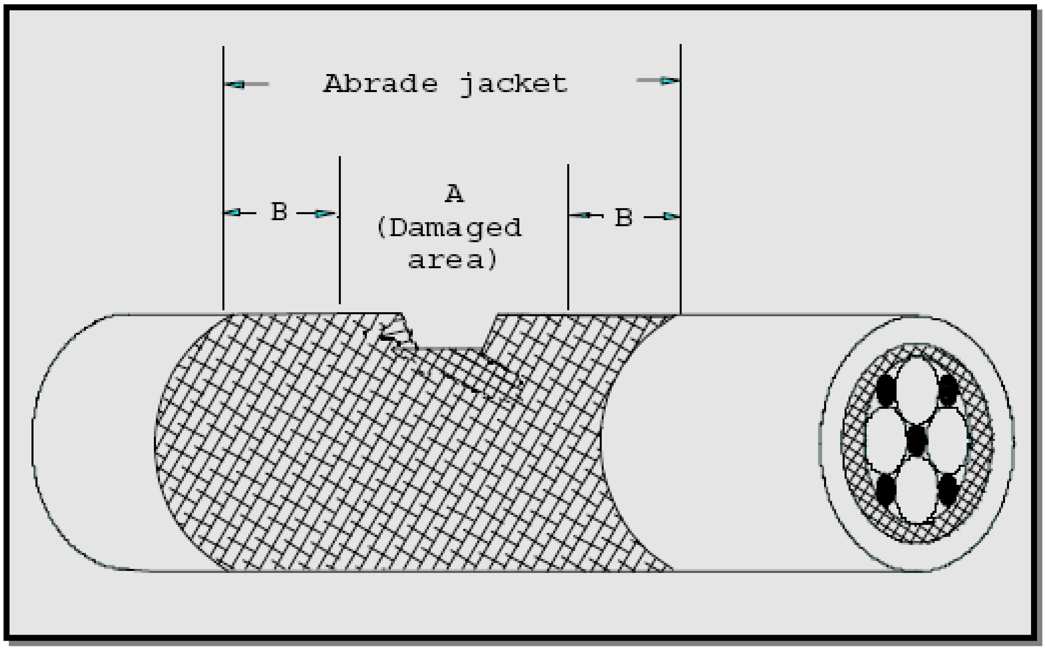


Figure 2-79. Cable Preparation

Step 4 - Clean the abraded areas with a wipe dampened with alcohol, and blow dry with air.

Step 5 - Fill any large depressions or voids with tape, as required, to restore the cable contour as follows:

WARNING: Application of too much heat will cause the adhesive to flow and may cause burns if it comes in contact with the skin.

Cut off short strips of the adhesive tape and heat them slightly with the heat gun to soften them. Roll the tape with your fingers and press it into the damaged area. Repeat the process until the damaged area is filled, then, holding the heat gun approximately 100 mm (4 inches) away, apply just enough heat to the tape to form and contour the tape to the cable (see figure 2-80).

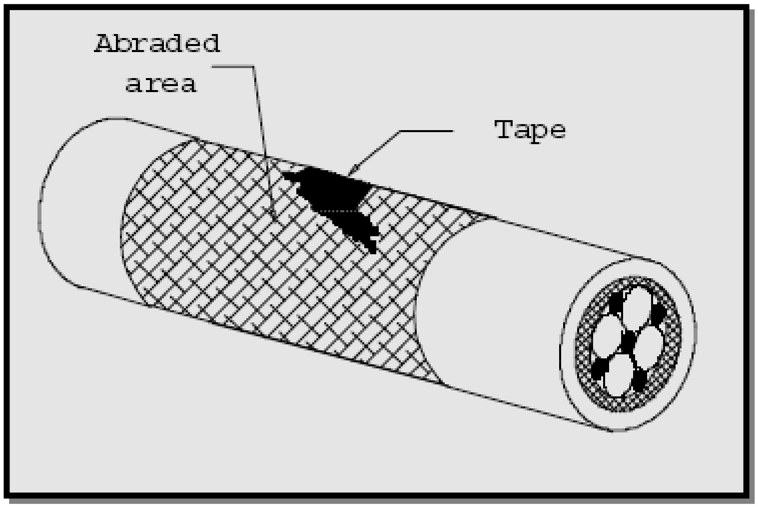


Figure 2-80. Tape Contoured to Cable

Step 6 - Cut the cable jacket repair sleeve to the proper length (see table 2-15).

Step 7 - CAUTION: Do not overheat the cable. The jacket should be just warm to the touch. Prolonged exposure of the jacket to temperatures above 160°C (320°F) may damage the cable jacket.

Hold the heat gun approximately 100 mm (4 inches) away from the cable and apply heat to all parts of the cable jacket to which the repair sleeve is to be applied.

Step 8 - Assemble the repair sleeve as shown (see figure 2-81). Leave approximately 13 mm (0.5 inch) overhang of channel on both sides of sleeve (see figure 2-82).

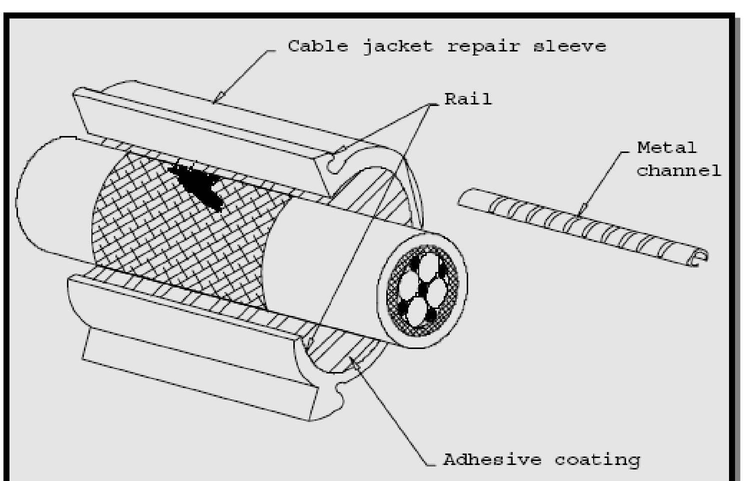


Figure 2-81. Installing Sleeve

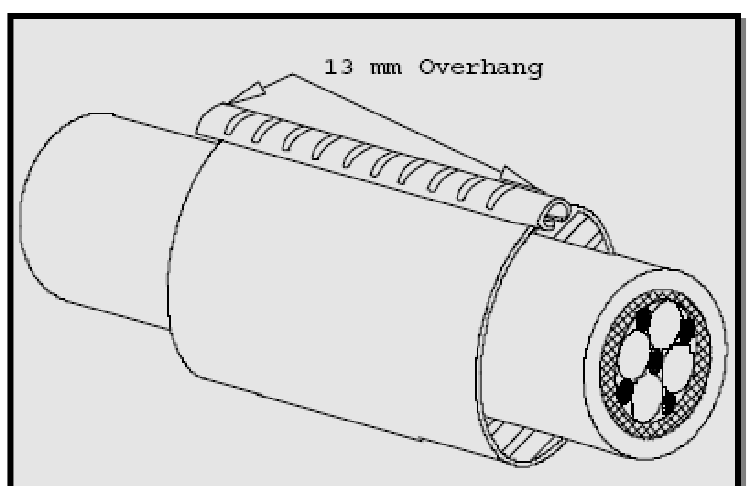


Figure 2-82. Assembled Sleeve

Step 9 - CAUTION: Do not overheat the cable. Prolonged exposure of the jacket to temperatures above 160oC (320oF) may damage the cable jacket. Discontinue heating of the sleeve and allow the cable jacket to cool before reheating if the cable jacket shows any signs of bubbling.

Center the sleeve over the damaged area and, holding the heat gun approximately 100 mm (4 inches) away, heat evenly from the center to the ends around the entire sleeve until the sleeve changes color indicating a full recovery (see figure 2-83). Melted sealant should be visible at the end of sleeve.

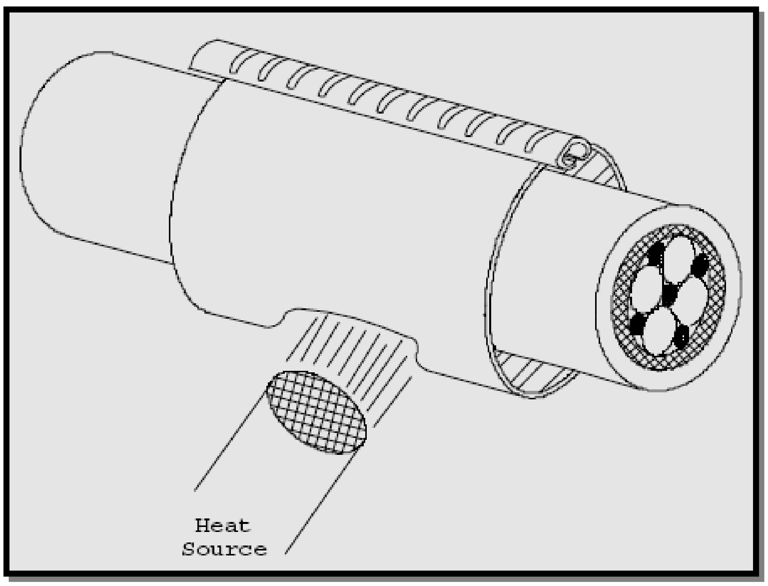


Figure 2-83. Shrinking Sleeve

Step 10 - When the sleeve has cooled, the rail and metal channel may be trimmed from the sleeve to provide greater flexibility to the cable (see figure 2-84).

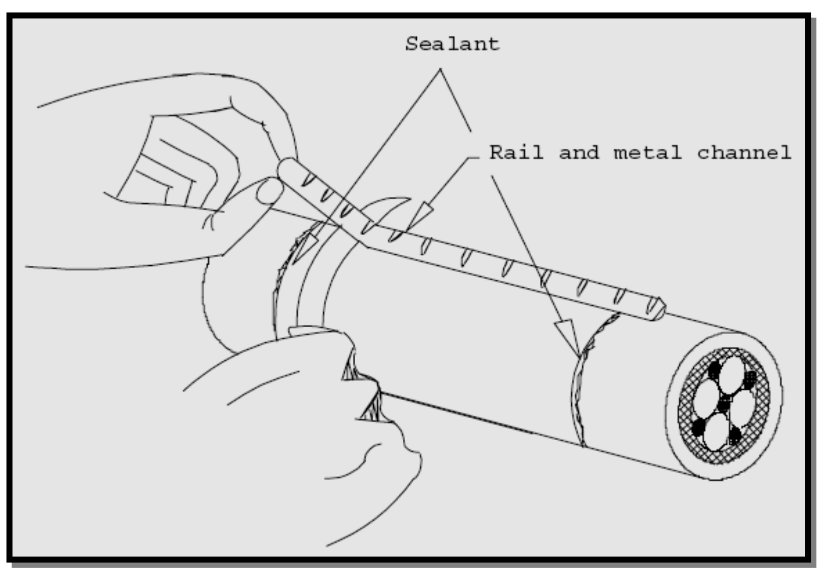


Figure 2-84. Trimming Rails and Metal Channel

Procedure II. Tube Sleeve.
The equipment and materials in table 2-16 shall be used to perform this procedure.

Description	Quantity
Safety glasses	1
Ruler	1
Electricians knife	1
Emery cloth (or fine file)	As required
Repair sleeve (Raychem SST-FR series or equal)	1
Adhesive and sealant tape (Raychem Thermofit S1030 or equal)	As required
Heat gun (Raychem 500B or equal)	1
Alcohol bottle with alcohol/2-propanol	1
Wipes	As required
Canned air (or compressed air)	As required

Table 2-16. Equipment and Materials

NOTE: The cable repair sleeve material shall meet the requirements of SAE AMSDTL-23053/15 and table 2-17. The material shall be coated with a heat activated adhesive and fabricated into a tube shape as shown on the figures below.

Step 1 - Select a repair sleeve in accordance with table 2-17.

Step 2 - Trim off the frayed, burned, or protruding jacket material with a knife using care not to damage the kevlar or OFCC jacket (see figure 2-85). Square up the jacketing where required.

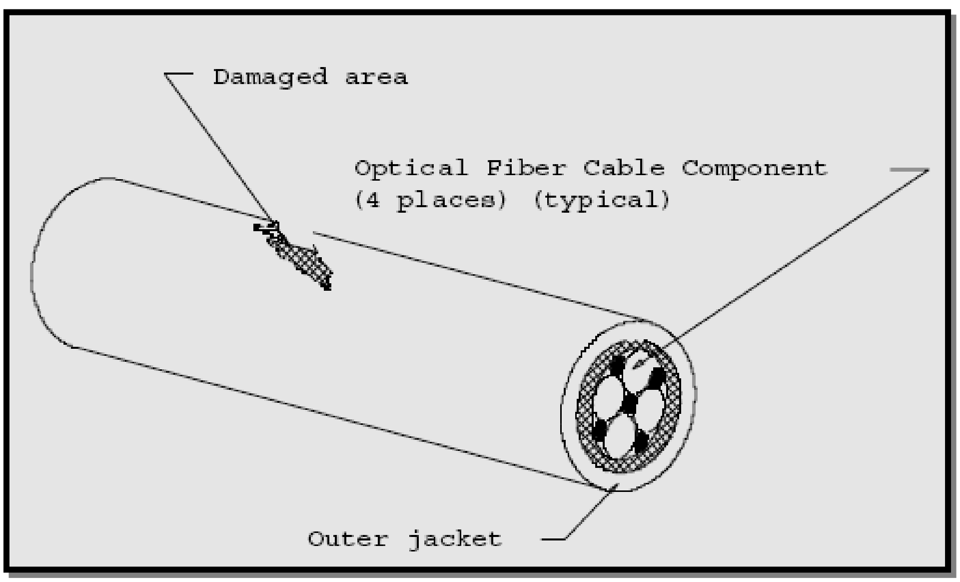


Figure 2-85. Damaged Cable

Cable type	Cable OD mm (inches) nominal	B dimension mm (inches)	Repair sleeve dimensions mm (inches)			
			Length (minimum)	Inside Diameter		Wall thickness after shrinking (+/- 10%)
				Expanded (minimum)	Recovered (maximum)	
4-fiber	8.1 (.32)	101 (4.0)	A + 2B	19.1 (0.75)	5.6 (0.22)	3.0 (0.11)
8-fiber	11.1 (.44)	101 (4.0)	A + 2B	19.1 (0.75)	5.6 (0.22)	3.0 (0.11)
36-fiber	20.8 (.82)	101 (4.0)	A + 2B	27.9 (1.10)	9.5 (0.38)	3.0 (0.12)
Single-tube	11.1 (.44)	101 (4.0)	A + 2B	19.1 (0.75)	5.6 (0.22)	3.0 (0.11)
7-tube	29.0 (1.14)	101 (4.0)	A + 2B	38.1 (1.50)	12.7 (0.50)	3.6 (0.14)
7-tube	31.5 (1.24)	101 (4.0)	A + 2B	38.1 (1.50)	12.7 (0.50)	3.6 (0.14)

Table 2-17. Repair Sleeve Dimensions (Tube)

NOTE: Refer to figure 2-86 for a definition of A and B dimensions.

Step 3 - Abrade the jacket circumferentially to the dimension shown using emery cloth or a fine file (see table 2-17 and figure 2-86).

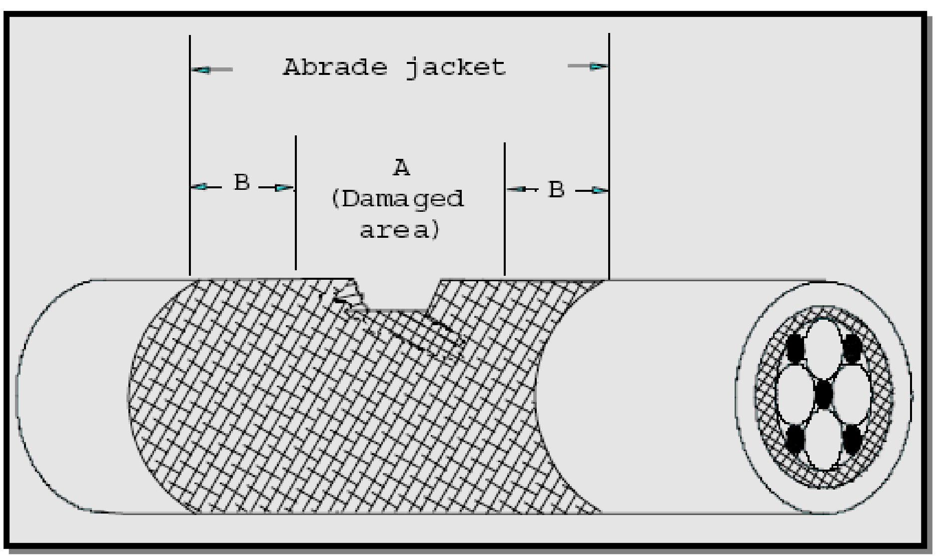


Figure 2-86. Cable Preparation

Step 4 - Clean the abraded area with alcohol and blow dry with air.

Step 5 - Fill any large depressions or voids with tape, as required, to restore the cable contour as follows:

WARNING: Application of too much heat will cause the adhesive to flow and may cause burns if it comes in contact with the skin.

Cut off short strips of the adhesive tape and heat them slightly with the heat gun to soften them. Roll the tape with your fingers and press it into the damaged area. Repeat the process until the damaged area is filled, then, holding the heat gun approximately 100 mm (4 inches) away, apply just enough heat to the tape to form and contour to the cable (see figure 2-87).

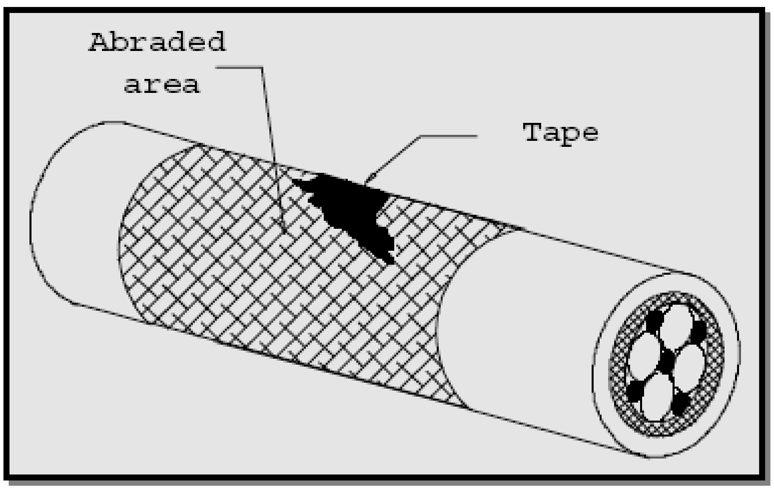


Figure 2-87. Tape Contoured to Cable

Step 6 - Cut the cable jacket repair sleeve to the proper length (see table 2-17.)

Step 7 - CAUTION: Do not overheat the cable. Prolonged exposure of the jacket to temperatures above 160°C (320°F) may damage the cable jacket. Discontinue heating of the sleeve and allow the cable jacket to cool before reheating if the cable jacket shows any signs of bubbling.

Center the repair sleeve over the damaged area. Hold the heat gun approximately 100 mm (4 inches) away and heat the center by applying heat evenly around the sleeve until it shrinks over cable (see figure 2-88). Working towards one end, shrink the sleeve to the cable until sealant is flowing at end of the sleeve. Repeat the procedure on the other half of the sleeve (see figure 2-89).

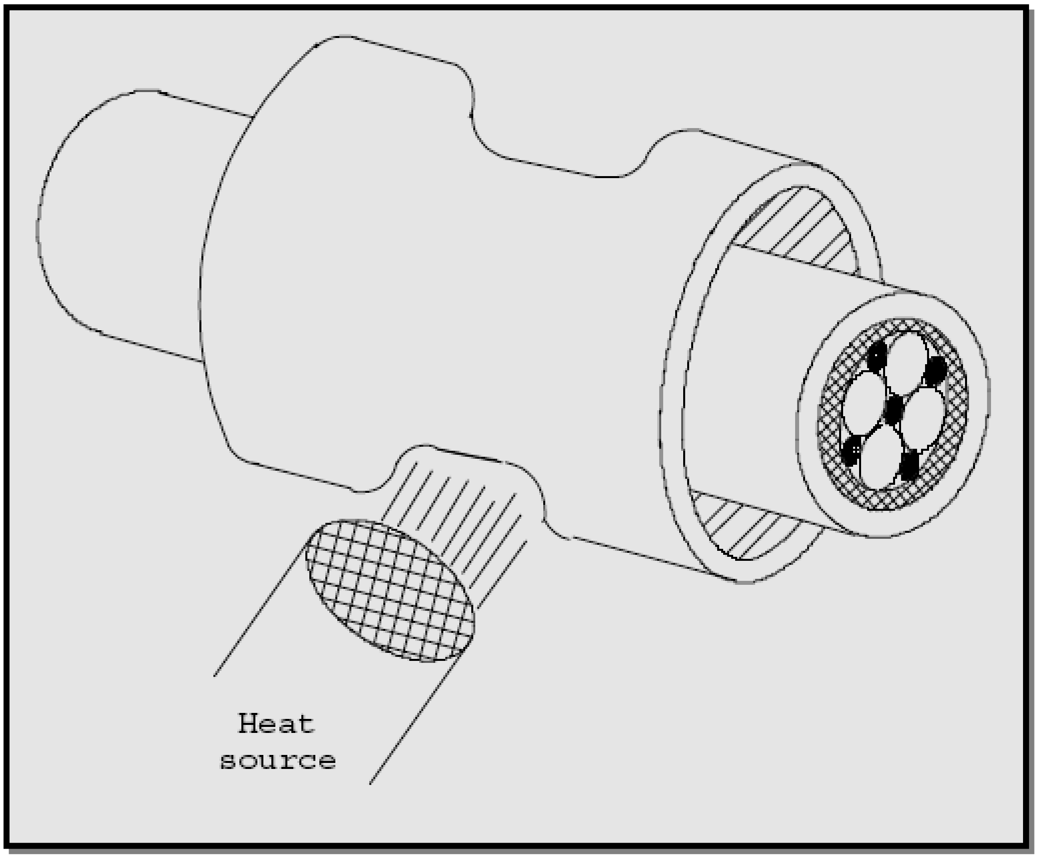


Figure 2-88. Shrinking the Sleeve

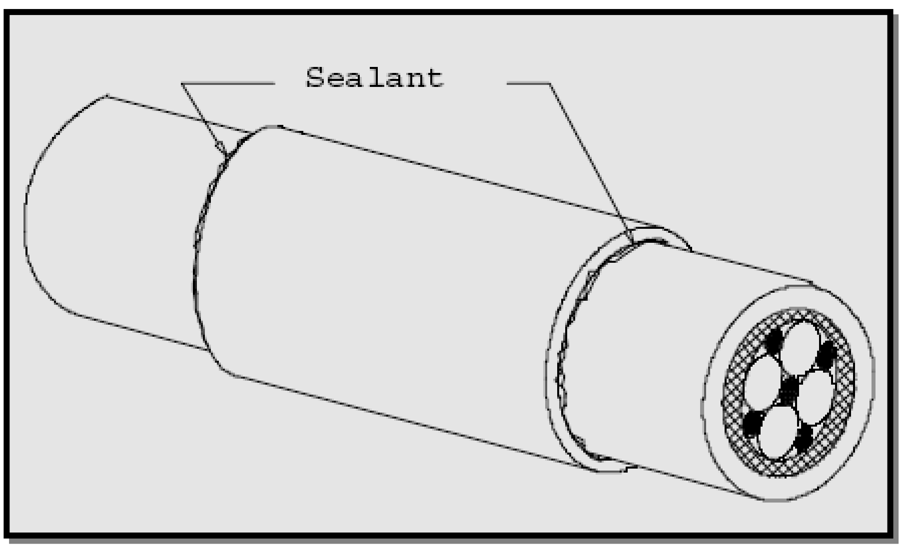


Figure 2-89. Completed Repair

Step 8 - Remove heat and allow the sleeve to cool.

Procedure III. Rubber Tape.
The equipment and materials in table 2-18 shall be used to perform this procedure.

Description	Quantity
Safety glasses	1
Ruler	1
Electricians knife	1
Emery cloth (or fine file)	As required
Adhesive and sealant tape (Raychem Thermofit S1030 or equal)	As required
Heat gun (Raychem 500B or equal)	1
Fiberglass tape (1 in.)	As required
Electrical coating (3M Scotch Kote or equal)	As required
Alcohol bottle with alcohol/2-propanol	1
Wipes	As required
Canned air (or compressed air)	As required

Table 2-18. Equipment and Materials

Step 1 - Trim off any frayed, burned, or protruding jacket material with a knife using care not to damage the kevlar or the OFCC jacket (see figure 2-90). Square up the jacketing where required.

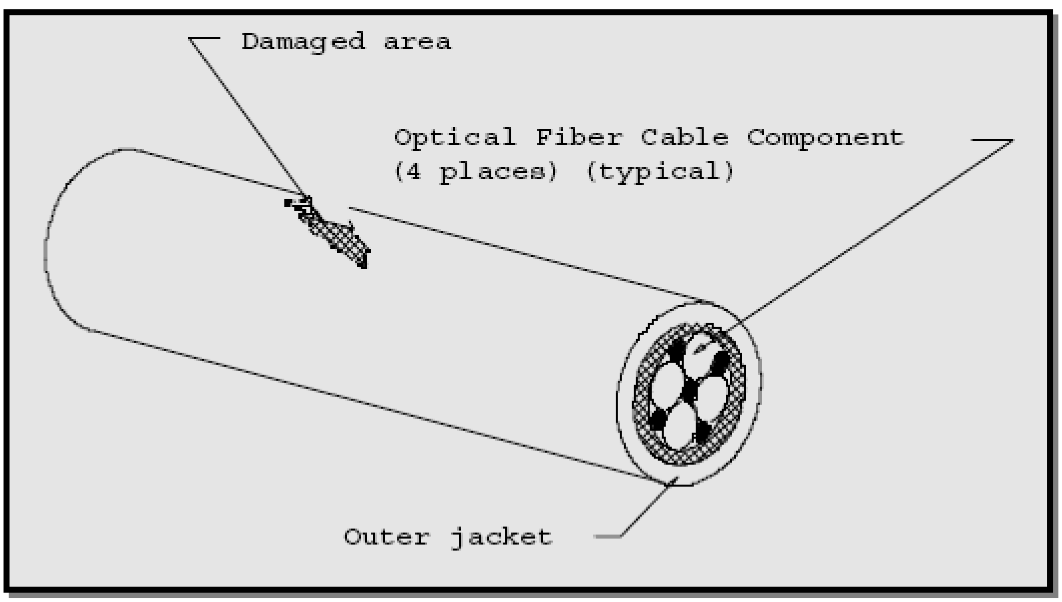


Figure 2-90. Damaged Cable

Step 2 - Abrade the jacket circumferentially approximately 80 mm (3 inches) on either side of the damaged area using emery cloth or a fine file (see figure 2-91).

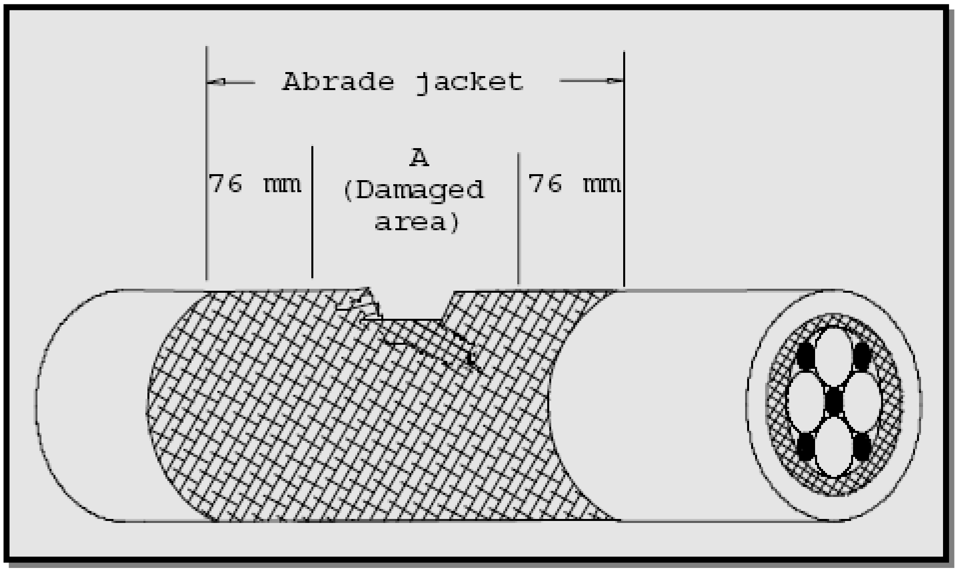


Figure 2-91. Cable Preparation

Step 3 - Clean the abraded area with alcohol and blow dry with air.

Step 4 - Fill any large depressions or voids with adhesive tape as required to restore the cable contour as follows:

WARNING: Application of too much heat will cause the adhesive to flow and may cause burns if it comes in contact with the skin.

Cut off short strips of adhesive tape and heat them slightly with the heat gun to soften them. Roll the tape with your fingers and press them into the damaged area. Repeat process until the damaged area is filled, then, holding the heat gun approximately 100 mm (4 inches) away, apply just enough heat to the tape to form and contour to the cable (see figure 2-92).

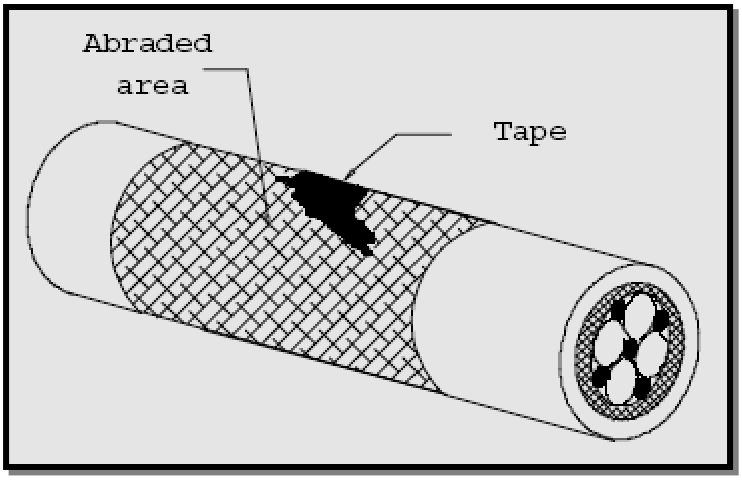


Figure 2-92. Tape Contoured to the Cable

Step 5 - Cover the entire abraded area with one layer of half lapped adhesive and sealant tape, pulling the tape to approximately one-half its original thickness.

Step 6 - Cover the adhesive and sealant tape with one layer of half lapped fiberglass tape.

Step 7 - CAUTION: Do not over heat the cable. Prolonged exposure of the jacket to temperatures above 160°C (320°F) may damage the cable jacket. Discontinue heating of the tape and allow the cable jacket to cool before reheating if the cable jacket shows any signs of bubbling.

Holding the heat gun approximately 100 mm (4 inches) away from the cable, heat the entire area covered by the tape for approximately 3.5 minutes with the heat gun to blend the adhesive and sealant into the fiberglass tape.

Step 8 - Apply a coat of electrical coating to the entire area and let it set a minimum of 10 minutes.

Procedure IV. Wraparound sleeve with adhesive closure.
The equipment and materials in table 2-19 shall be used to perform this procedure.

Description	Quantity
Safety glasses	1
Ruler	1
Electricians knife	1
Emery cloth (or fine file)	As required
Adhesive and sealant tape (Raychem Thermofit S1030 or equal)	As required
Repair sleeve (Raychem SFR series or equal)	1
Heat gun (Raychem 500B or equal)	1
Alcohol bottle with alcohol/2-propanol	1
Wipes	As required
Canned air (or compressed air)	As required

Table 2-19. Equipment and Materials

NOTE: The cable repair sleeve material shall meet the requirements of SAE AMSDTL-23053/15 and table 2-20. The material shall be coated with a heat-activated adhesive and fabricated into a wrap with a self adhesive closure system as described below.

Step 1 - Select a repair sleeve in accordance with table 2-20.

Cable type	Cable OD mm (inches) nominal	B dimension mm (inches)	Repair sleeve dimensions mm (inches)			
			Length (minimum)	Inside Diameter		Wall thickness after shrinking (+/- 10%)
				Expanded (minimum)	Recovered (maximum)	
36-fiber	20.8 (.82)	76 (3.0)	A + 2B	31.8 (1.25)	12.7 (.50)	2.0 (0.08)
7-tube	29.0 (1.14)	76 (3.0)	A + 2B	31.8 (1.25)	12.7 (.50)	2.0 (0.08)
7-tube	31.5 (1.24)	76 (3.0)	A + 2B	31.8 (1.25)	12.7 (.50)	2.0 (0.08)

Table 2-20. Repair Sleeve Dimensions (Wraparound)

NOTE 1: Refer to figure 2-94 for a definition of A and B dimensions.

NOTE 2: Repair sleeves are not currently available for the conventional 4-fiber, 8-fiber cable and single-tube BOF cable sizes.

Step 2 - Trim off any frayed, burned, or protruding jacket material with a knife using care not to damage the kevlar or the OFCC jacket (see figure 2-93). Square up the jacketing where required.

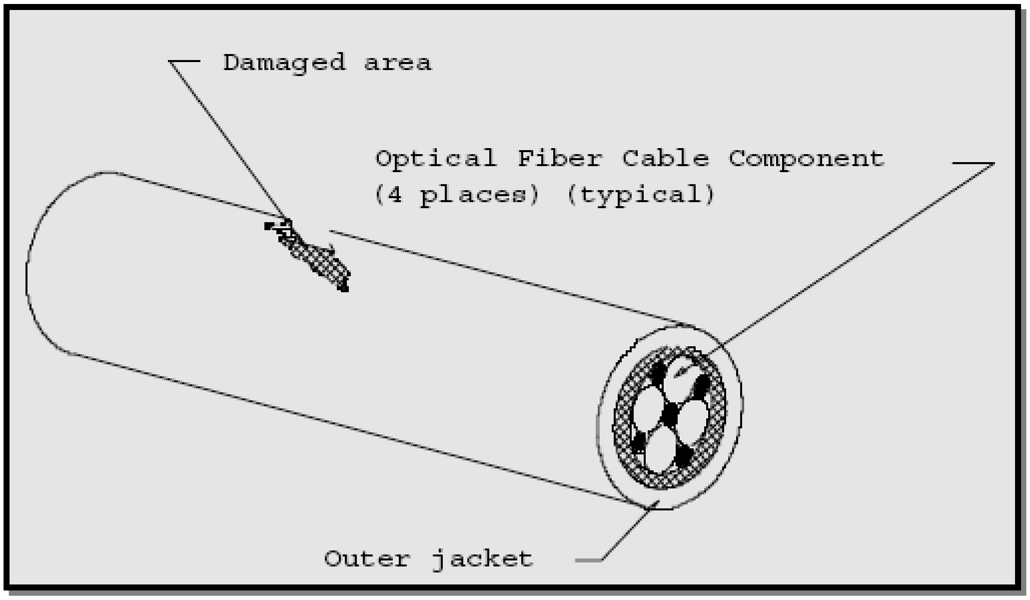


Figure 2-93. Damaged Cable

Step 3 - Abrade the jacket circumferentially to the dimension shown using emery cloth or a fine file (see figure 2-94).

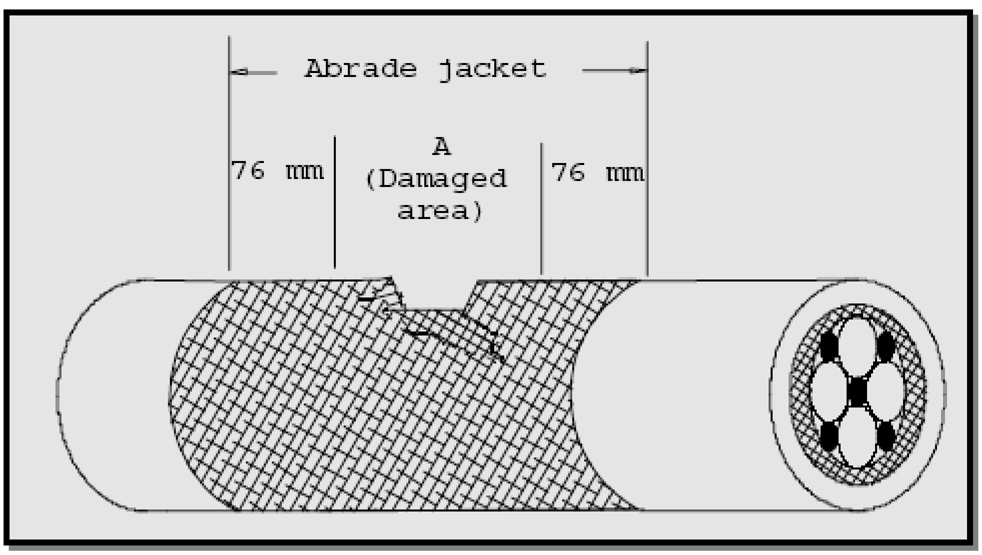


Figure 2-94. Cable Preparation

Step 4 - Clean the abraded area with alcohol and blow dry with air.

Step 5 - Fill any large depressions or voids with adhesive tape as required to restore the cable contour as follows:

WARNING: Application of too much heat will cause the adhesive to flow and may cause burns if it comes in contact with the skin.

Cut off short strips of adhesive tape and heat them slightly with the heat gun to soften them. Roll the tape with your fingers and press them into the damaged area. Repeat process until the damaged area is filled, then, holding the heat gun approximately 100 mm (4 inches) away, apply just enough heat to the tape to form and contour to the cable (see figure 2-95).

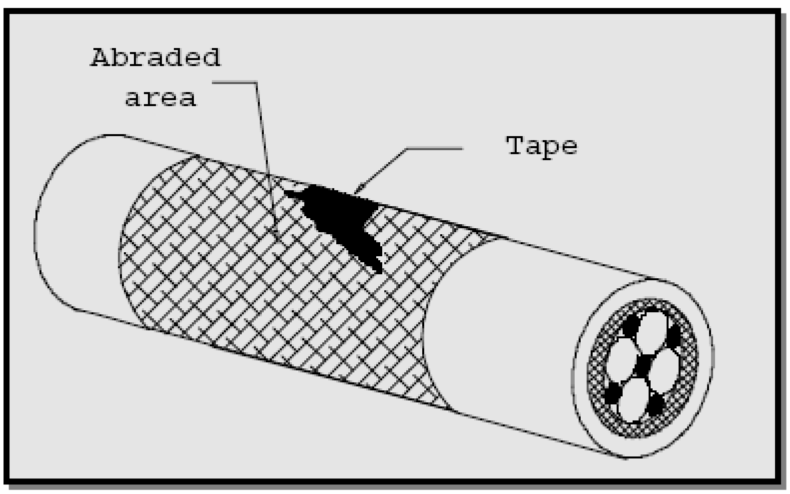


Figure 2-95. Tape Contoured to Cable

Step 6 - Cut the cable jacket repair sleeve to the proper length (see table 2-20.)

Step 7 - CAUTION: Do not overheat the cable. The jacket should be just warm to the touch. Prolonged exposure of the jacket to temperatures above 160°C (320°F) may damage the cable jacket.

Hold the heat gun approximately 100 mm (4 inches) away from the cable and apply heat to all parts of the cable jacket to which the repair sleeve is to be applied.

Step 8 - Remove the protective release tape from both flaps of the sleeve to expose the surfaces of the contact adhesive.

Step 9 - Place the sleeve around the cable so that the sealant side of the sleeve is next to the cable, align the sleeve side edges, and press the contact surfaces together along the full length of the sleeve (see figure 2-96).

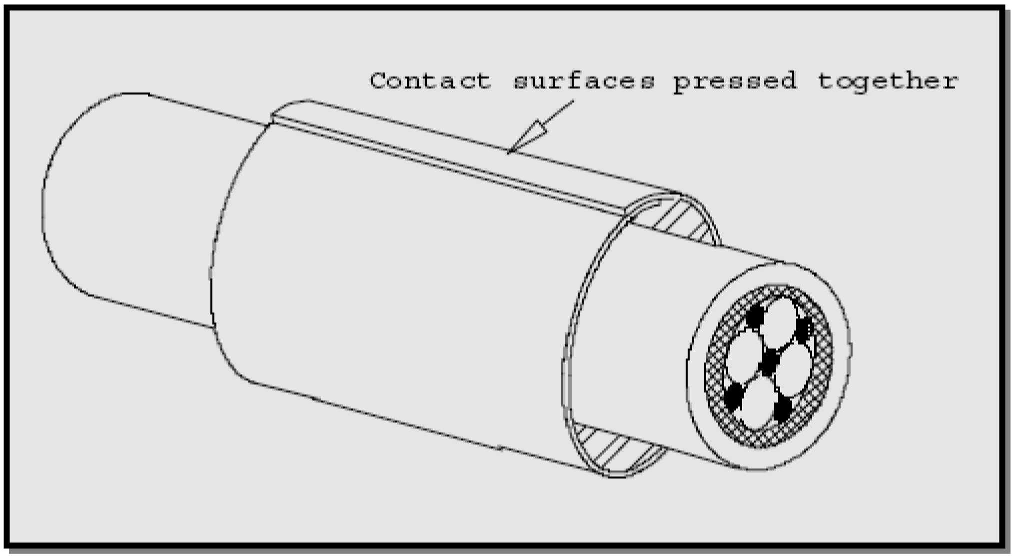


Figure 2-96. Assembled Sleeve

Step 10 - CAUTION: Do not over heat the cable. Prolonged exposure of the jacket to temperatures above 160°C (320°F) may damage the cable jacket. Discontinue heating of the tape and allow the cable jacket to cool before reheating if the cable jacket shows any signs of bubbling.

Center the repair sleeve over the damaged area. Hold the heat gun approximately 100 mm (4 inches) away and heat the center by applying heat evenly around the sleeve until it shrinks over cable (see figure 2-97). Working towards one end, shrink the sleeve to the cable until sealant is flowing at end of the sleeve. Repeat the procedure on the other half of the sleeve (see figure 2-98).

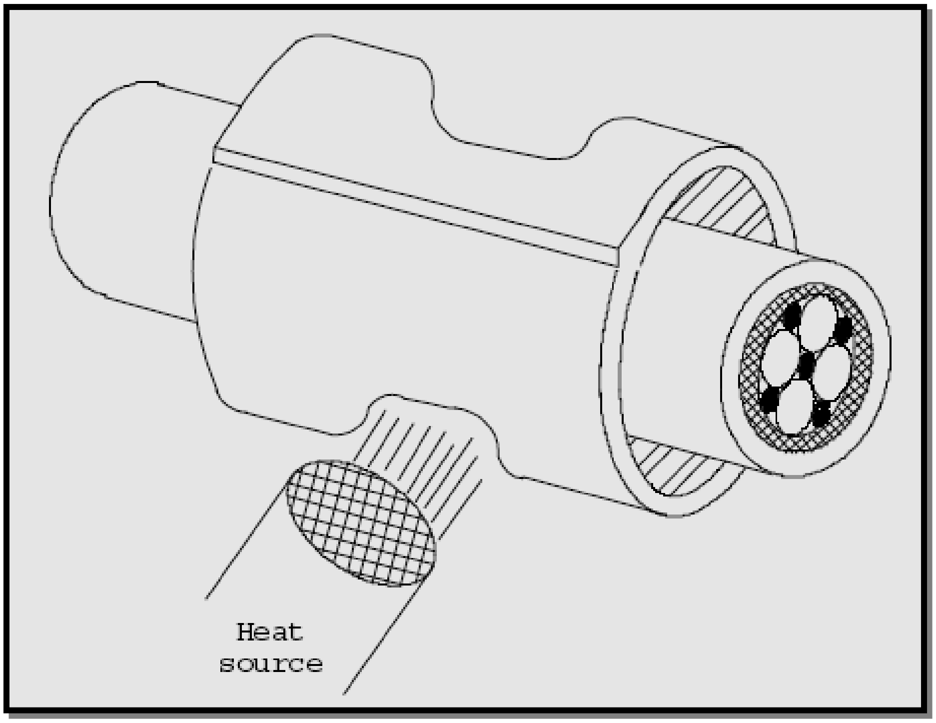


Figure 2-97. Shrinking the Sleeve

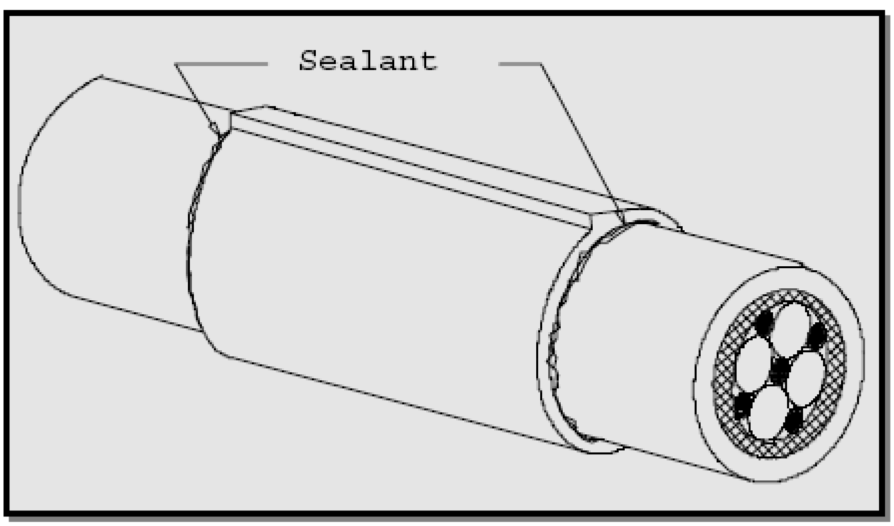


Figure 2-98. Completed Repair

Step 11 - Remove heat and allow the sleeve to cool.
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2.17.8 SINGLE TERMINUS CONNECTOR INSTALLATION

This method shall be used for installing MIL-C-83522 single terminus (light duty) connectors onto OFCCs.

2.17.8.1 Required Equipment and Materials

The equipment and materials in table 2-21 shall be used to perform this procedure:

Description	Quantity
Wipes (NAVSEA DWG 6872811-18)	As required
Alcohol bottle with alcohol/2-propanol or equal (sealable type)	1
Canned air or compressed air	As required
OFCC strip tool (NAVSEA DWG 6872811-10 or equal)	1
Kevlar shears (NAVSEA DWG 6872811-16)	1
Safety glasses	1
Ruler	1
Buffer strip tool (NAVSEA DWG 6872811-9 or equal)	1
Cleaning wire (NAVSEA DWG 6872811-24 or equal)	As required
Epoxy (MIL-PRF-24792)	As required
Syringe with dispensing needles (NAVSEA DWG 6872811-22 or equal)	As required
Cure adapters (NAVSEA DWG 6872811-27 or equal)	As required
Crimp tool (NAVSEA DWG 6872811-1 or equal)	1
Die for crimp tool (NAVSEA DWG 6872811-2 or equal)	1
Heat gun (Raychem 500B or equal)	1
Curing oven (NAVSEA DWG 6872811-13 or equal)	1
Holder block	As required
Cleaver (NAVSEA DWG 6872811-7 or equal)	1

Table 2-21. Equipment and Materials

Description	Quantity
Glass polishing plate (NAVSEA DWG 6872811-3 or equal)	1
Polishing paper (5 um aluminum oxide, foam backed) (NAVSEA DWG6872811-20 or equal)	As required
Polishing tool (NAVSEA DWG 6872811-4, NAVSEA DWG 6872811-30 orequal)	1
Polishing paper (1 um aluminum oxide, mylar backed) (NAVSEA DWG6872811-19 or equal)	As required
Water bottle (sealable type)	1
Optical microscope 400X (NAVSEA DWG 6872811-25 or equal)	1
Protective caps (plastic)	As required
Boot ring tool (NAVSEA DWG 6872811-32 or equal)	1
Polishing paper (0.1 um diamond, mylar backed) (NAVSEA DWG6872811-31 or equal)	As required
Resilient pad (70 to 90 durometer)(NAVSEA DWG 6872811-32 orequal)	1
Polishing paper (ultrafine, mylar backed) (JDS Optics HF5D orequal)	As required

Table 2-21(Cont'd). Equipment and Materials

CAUTION: Throughout the termination process, cleanliness is critical to obtaining a high optical quality connector. Make sure that your hands and the work area are as clean as possible to minimize the ingress of dirt into the connector parts.

NOTE: Verify that the epoxy shelf life has not expired. Do not use epoxy with an expiration date that has passed. Epoxy shelf life can be extended if the epoxy is refrigerated. Contact the epoxy vendor or the Naval Surface Warfare Center for additional information.

The following safety precautions shall be observed:

a. Safety glasses shall be worn at all times when handling bare fibers or dispensing epoxy.

b. Do not touch the ends of the fiber as they may be razor sharp. Wash your hands after handling bare fiber.

c. Avoid skin contact with epoxies.

d. When visually inspecting an optical fiber, never stare into the end of a fiber connected to a laser source or LED.

2.17.8.2 Procedure Cable and Fiber Preparation

NOTE: If the cable jacket has not been removed, refer to Method 2A1 and Method 2B1 of Part 2 of MIL-STD-2042-5B (SH).

NOTE: Keep the OFCCs and connector parts free from oil, dirt and grease throughout the installation procedure. If cleaning is necessary, use a wipe dampened with alcohol and blow the part dry with air.

NOTE: This procedure utilizes heat shrink tubing (with identification markings) for the identification of individual OFCCs. Other permanent methods of identification may be used with authorized approval.

Step 1 - Measure the OFCCs to the required length (refer to the equipment drawings or to Method 2C1 of Part 2 of MIL-STD-2042-5B (SH)). Then add sufficient slack to allow for at least two reterminations [40 mm (1.6 in) of slack should be sufficient for one retermination].

Step 2 - Slip the heat shrink tubing (with the fiber identification), the connector boot ring (FSI connectors only), the connector boot, and the crimp sleeve over the OFCC (see figure 2-99).

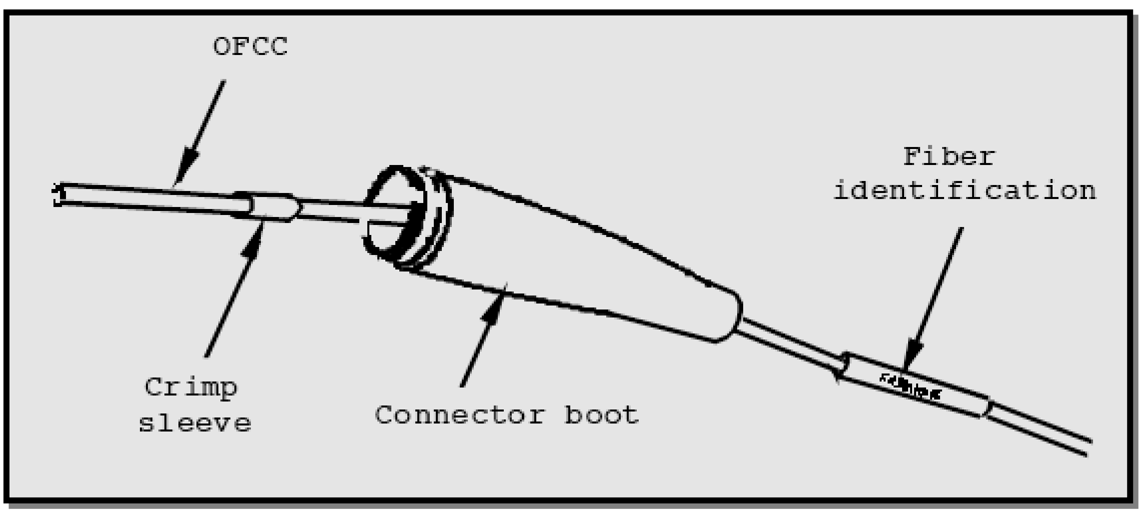


Figure 2-99. Installing the Identification Sleeve and Connector Boot (Typical)

Step 3a - For Lucent Technologies connectors only: remove the OFCC jacket back 30 mm (1.20 in) from the end of the fiber using the OFCC stripper and trim the OFCC kevlar with the kevlar shears so that approximately 6 mm (0.25 in) extends past the OFCC jacket (see figure 2-100).

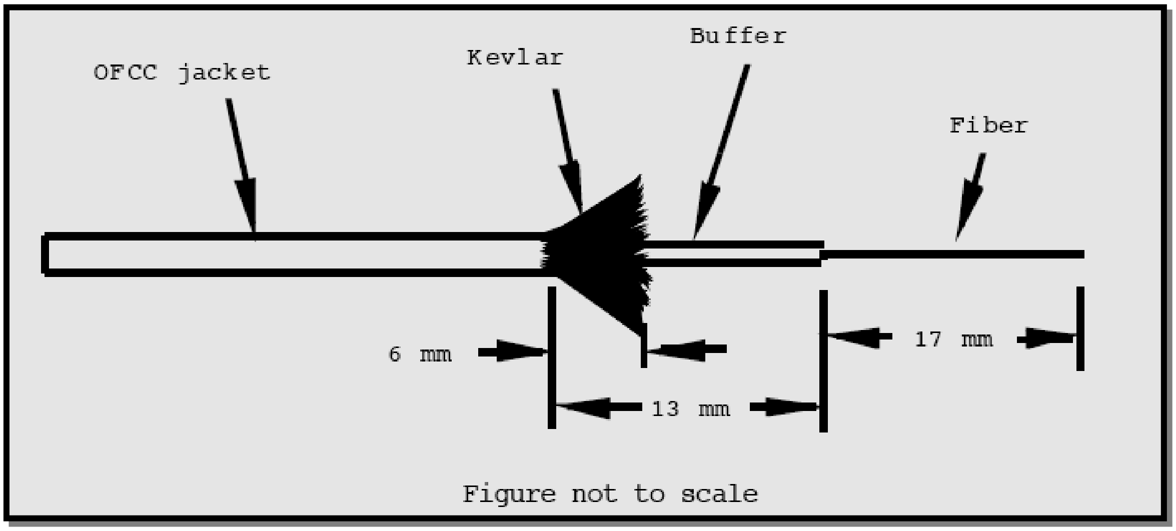


Figure 2-100. Prepared OFCC Dimensions for Lucent Connectors

NOTE: 13 mm = 0.51 in.

NOTE: The tolerance on dimensions is +/- 1 mm (+/- 0.04 in).

NOTE: An exposed fiber length less than 17 mm (0.67 in) may be used.

Step 3b - For Fiber Systems International connectors only: remove the OFCC jacket back 34 mm (1.34 in) from the end of the fiber using the OFCC stripper and trim the OFCC kevlar with the kevlar shears so that approximately 6 mm (0.25 in) extends past the OFCC jacket (see figure 2-101).

NOTE: The optimum way to remove the OFCC jackets is to ring cut the jacket with the OFCC stripper and pull the jacket off by hand. Pushing off the OFCC jacket with a tightly held OFCC stripper can lead to fiber breakage.

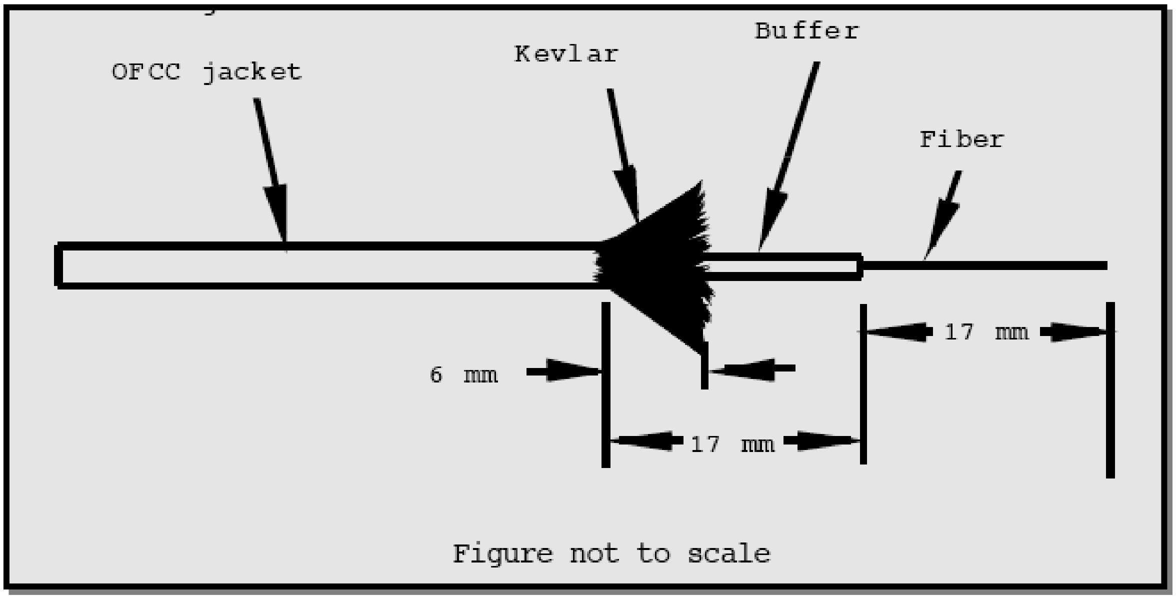


Figure 2-101. Prepared OFCC Dimensions for Fiber Systems International Connectors

NOTE: 17 mm = 0.67 in.

NOTE: The tolerance on dimensions is +/- 1 mm (+/- 0.04 in).

NOTE: An exposed fiber length less than 17 mm (0.67 in) may be used.

Step 4 - WARNING: Wear safety glasses when removing the fiber buffer and coating to avoid possible eye injury.

Mark the fiber buffer to the dimension shown in figure 2-100 or figure 2-101 and remove the fiber buffer and coating back to the mark using the buffer stripper. Remove the buffer and coating in small sections (approximately 6 mm (0.25 in) at a time.)

(**NOTE:** Normally, the buffer and coating are tightly adhered to one another and come off of the fiber at the same time.)

Step 5 - CAUTION: The uncoated fiber is in its most vulnerable state. Take extreme care not to damage the fiber. Remove any residual coating material from the bare fiber with a wipe dampened with alcohol. Wipe once from the end of the buffer towards the end of the fiber.

(**NOTE:** Do not repeatedly wipe the bare fiber as this will weaken the fiber.)

2.17.8.3 Installation of the Connector onto the Fiber
NOTE: The curing oven may be turned on at this time to allow proper warm up (Approximately 20 minutes) before the connector is placed into it.

Step 1 - Inspect the connector and verify that the ferrule hole is free and clean of dirt. This can be accomplished by holding the front of the connector up to a light and verifying that the light is visible from the rear of the connector. If light cannot be seen through the connector, push music wire through the ferrule hole to clear it. Then blow dry air through the hole to remove any debris.

Step 2 - Remove the divider from a 2-part epoxy package and mix the two parts together until the epoxy is a smooth uniform color (see figure 2-102). The epoxy can be mixed by either repeatedly rolling or gently sliding the divider over the package.

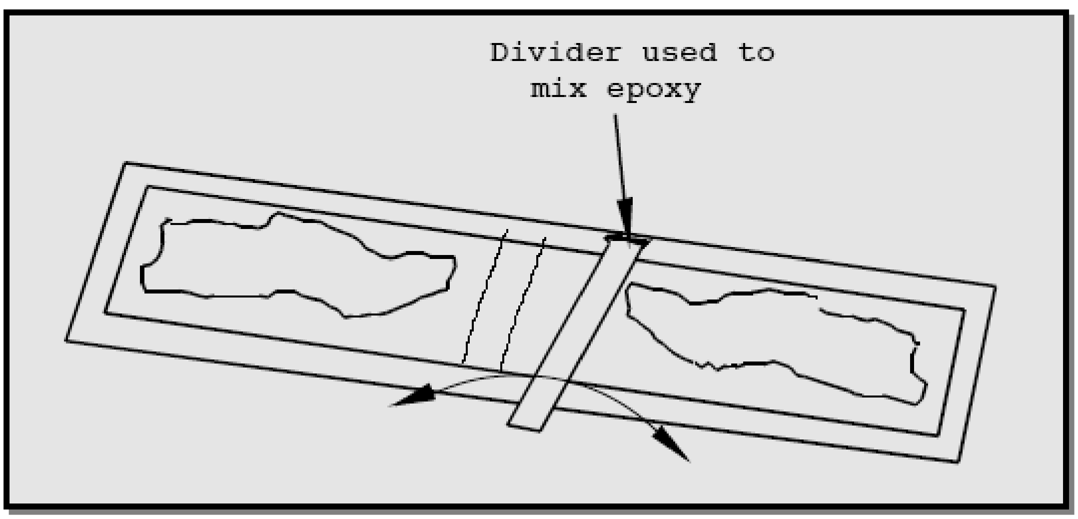


Figure 2-102. Mixing the Epoxy

NOTE: Alternatively, the epoxy may be mixed by massaging the epoxy package by hand.

CAUTION: Do not introduce large air bubbles into the epoxy during the mixing process. Large air bubbles in the epoxy can lead to connector failure during temperature extremes.

Step 3 - Install the syringe tip on the syringe, remove the plunger, and squeeze the epoxy into the syringe. Replace the plunger.

Step 4 - **WARNING:** Wear safety glasses while dispensing the epoxy to avoid possible eye injury.

Remove air pockets in the syringe by holding the tip of the syringe upward and dispensing epoxy onto a wipe until it runs free and clear.

Step 5 - Slide the connector, rear first, onto the syringe tip (see figure 2-103). Keeping the syringe vertical, depress the plunger and slowly inject epoxy into the connector until it escapes out of the ferrule, forming a very small bead.

(**NOTE:** Do not overfill. Be extremely careful not to get epoxy on the connector spring or other connector moving parts.)

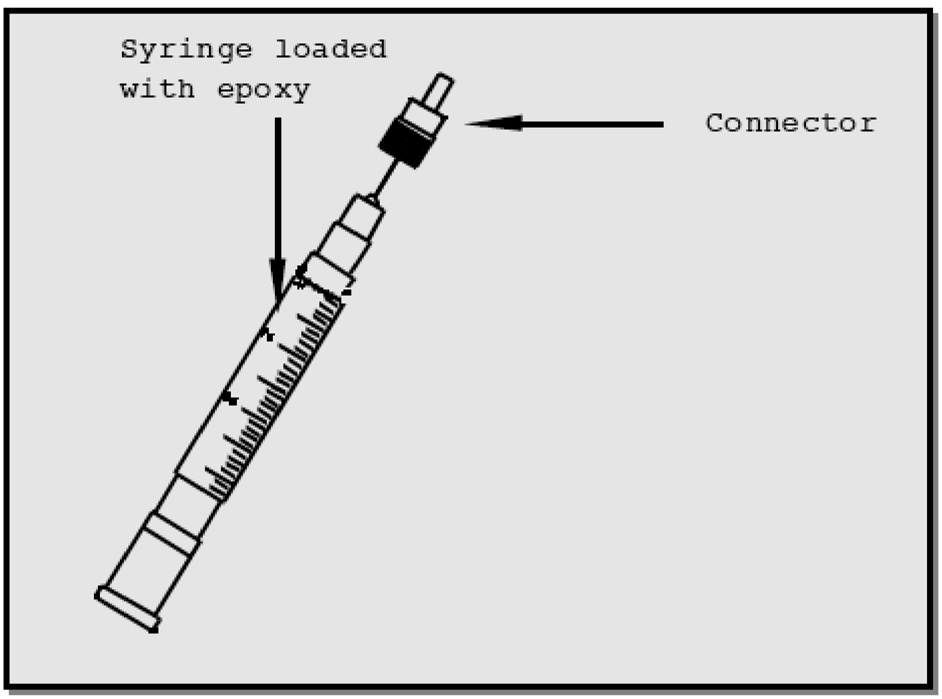


Figure 2-103. Injecting epoxy into the Connector

Step 6 - Withdraw the syringe from the connector. Maintain some pressure on the plunger as the syringe is withdrawn so that the connector is completely filled with epoxy. Using a wipe dampened with alcohol, wipe away any epoxy on the outer diameter of the ferrule without disturbing the epoxy bead.

NOTE: Alternatively, the connector may be completely filled by maintaining a light pressure on the syringe plunger and allowing the epoxy to push the connector off of the syringe tip.

Step 7 - Apply a very thin coating of epoxy to the kevlar strands and the buffer.

Step 8 - Apply a very thin band of epoxy to approximately 3 mm (0.12 in) of the connector barrel (see figure 2-104).

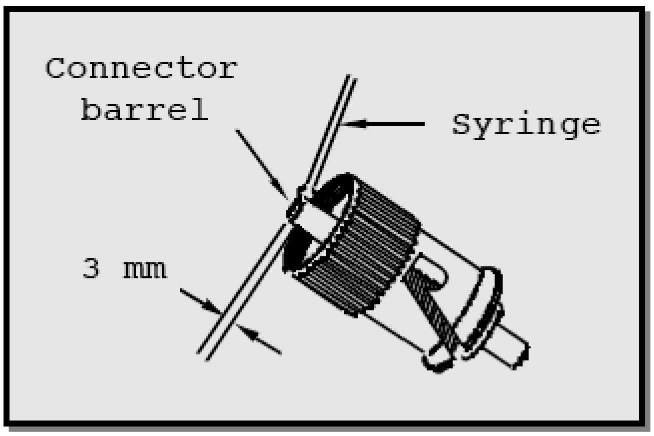


Figure 2-104. Applying Epoxy to the Connector Barrel

NOTE: At this point, the connector may be inserted into the cure adapter. Refer to Step 10 for insertion of the connector into the cure adapter.

Step 9 - Feather the kevlar evenly around the fiber and insert the fiber into the rear of the connector (see figure 2-105). Gently work the fiber through the connector until the buffer seats against the rear of the ferrule. (The connector should be rotated around the fiber as the fiber is inserted.) The OFCC jacket should come up to the rear of the connector barrel and the kevlar should surround the rear of the connector barrel. Do not allow kevlar to enter the rear of the connector. Once inserted, do not allow the fiber to slip back.

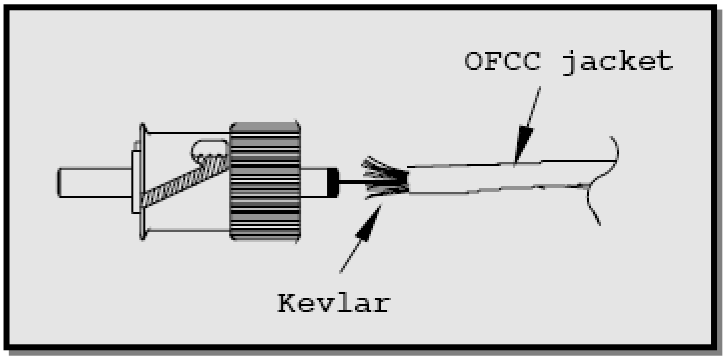


Figure 2-105. Inserting the Fiber into the Connector

Step 10 - If the cure adapter was not previously installed onto the connector, carefully place the cure adapter over the fiber and mate it to the connector so that the connector barrel is at maximum extension from the rear of the connector (place the cure adapter nub at end of the connector ramp, just before the normal mated position). Slide the crimp sleeve over the OFCC jacket and kevlar onto the connector barrel (see figure 2-106).

NOTE: The fiber must not protrude beyond the end of the cure adapter. If it does, trim the fiber end so it does not.

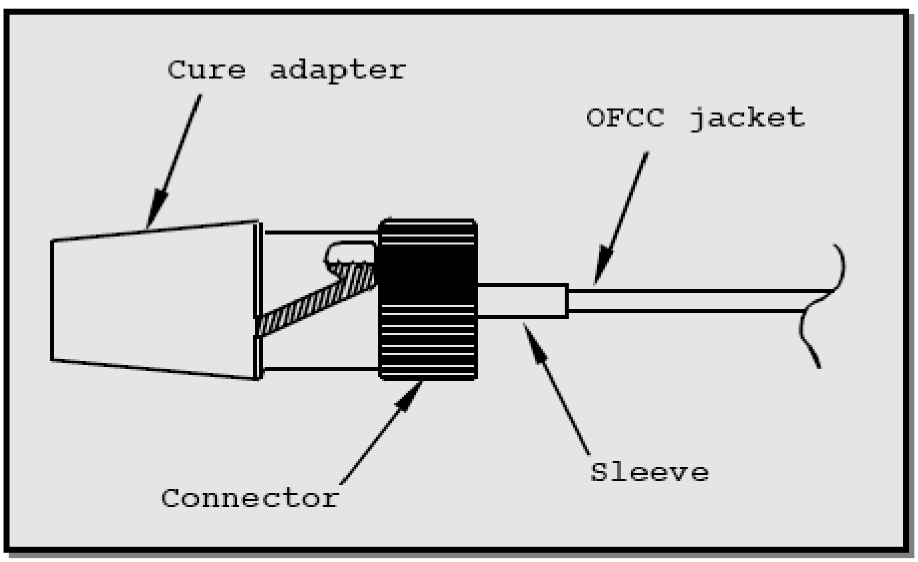


Figure 2-106. Sliding the Crimp Sleeve over the Connector

Step 11 - Place the crimping tool over the crimp sleeve and crimp it against the connector barrel. Rotate the connector 90° and crimp it again (see figure 2-107).

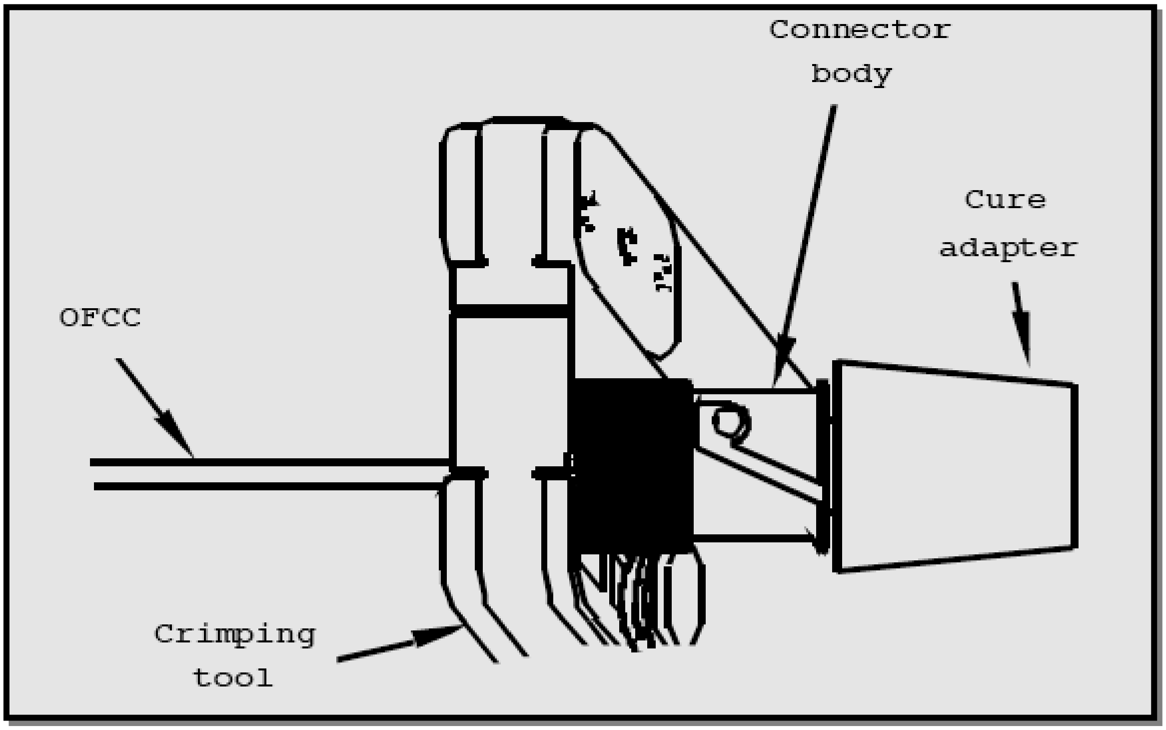


Figure 2-107. Crimping the Connector

NOTE: The cure adapter may be removed from the connector to perform steps 12 and 13.

Step 12 - Verify that there is a small amount of epoxy around the fiber where it protrudes from the ferrule. If it is found that there is no small bead of epoxy on the ferrule tip, carefully add a small amount of epoxy around the fiber.

(**NOTE:** There should only be a small amount of epoxy around the fiber to support it later during the polishing process. If too much epoxy is around the fiber during the curing process it may cause the fiber to crack.)

Step 13 - Using a wipe dampened with alcohol, carefully wipe away any epoxy on the fiber that is more than 2 mm (0.1 in) from the ferrule surface.

NOTE: If the cure adapter was removed to perform steps 12 and 13, it should be re-mated to the connector at this time.

Step 14 - For Lucent connectors only: Apply a drop of epoxy onto the rubber boot threads, slip the boot over the crimped sleeve and screw it onto the connector body.

Step 15 - For Fiber Systems International connectors only: Slip the boot over the crimped sleeve onto the connector body until it snaps into the groove (at the rear of the connector body). Using the boot ring tool, slide the boot ring up the boot until it snaps into the same groove on the connector body.

(**NOTE:** The boot ring can also be pushed up the boot by hand.)

Step 16 - CAUTION: Do not overheat the OFCC. Prolonged exposure of the OFCC to temperatures above 160^{o}C (320^{o}F) may damage the OFCC jacket. Discontinue heating of the tubing and allow the jacket to cool before reheating if the jacket shows any signs of bubbling. Slide the fiber identification tubing up the OFCC to near the connector boot and shrink it over the OFCC using a heat gun.

2.17.8.4 Curing the Epoxy

Step 1 - Turn on the curing oven so that it attains the proper temperature before the connector is placed within it (approximately 20 minutes).

NOTE: The oven may be turned on early in the connector assembly process so that it is already at the proper temperature.

Step 2 - Place the cure adapter with the connector in the curing oven, and position the OFCC vertically over the oven. Cure the epoxy for a minimum of 10 minutes (maximum of 30 minutes) at 120^{o}C (248^{o}F).

(**NOTE:** When the OFCC is positioned above the connector, make sure that no bends are placed in the OFCC. The OFCC should enter the connector parallel to the connector axis.)

NOTE: Alternate cure schedules may be used with approval of the Naval Surface Warfare Center.

Step 3 - Turn the curing oven off, remove the connector and cure adapter from the curing oven, and place them on a cure adapter holder block or nonflammable surface. Allow the cure adapter and connector to cool for approximately 4 minutes.

2.17.8.5 Polishing the Fiber Ends

A. Flat end polish. This procedure will produce a connector with a flat end polish. This procedure is applicable only for multimode applications. Procedures for hand polishing are contained herein. Machine polishing may be used as an alternate method, provided the following requirements are satisfied:

a. The manufacturer's instructions will be rigidly adhered to, except that the polishing papers or disks shall be 5 um aluminum oxide foam backed, 1 um aluminum oxide mylar backed, and 0.1 um diamond mylar backed, as used in hand polishing.

(**NOTE:** Alternate polishing materials may be used if authorized approval is obtained and the polishing machine includes the appropriate stops to prevent changes to the ferrule length.)

b. The machine polished connector shall undergo the same quality check used for the manually polished connector as described herein.

NOTE: The procedures contained herein should produce an optical terminus with a physical contact (PC) polish.

Step 1 - WARNING: Wear safety glasses when scoring the fiber to avoid possible eye injury.

Remove the connector from the cure adapter and score the fiber close to the ferrule tip at the epoxy interface using one short light stroke with the cleaving tool (see figure 2-108).

(**NOTE:** Do not break the fiber with the cleaving tool.) Pull off the fiber with a gentle, straight pull. Deposit the waste fiber in a trash container.

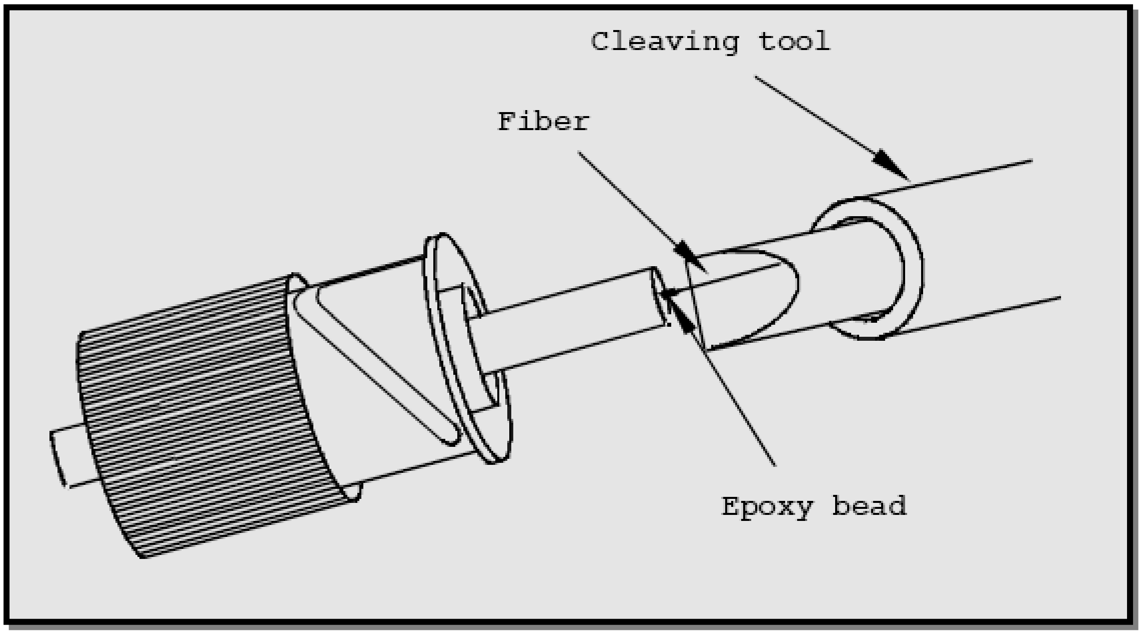


Figure 2-108. Scoring the Fiber

Step 2 - Clean the glass polishing plate, the backs of the polishing papers, and the surface of the polishing tool using a wipe dampened with alcohol. Blow all of the surfaces dry with air.

NOTE: Before inserting the connector into the polishing tool, the connector may be held vertically and the end of the fiber polished off by lightly running the 5 um polishing paper over the top of the ferrule tip. (This is referred to as air polishing the connector.)

Step 3 - Insert the connector into the polishing tool (see figure 2-109).

(**NOTE:** Difficulty in inserting the connector ferrule into the polishing tool may indicate epoxy on outside of the ferrule that must be removed before proceeding.)

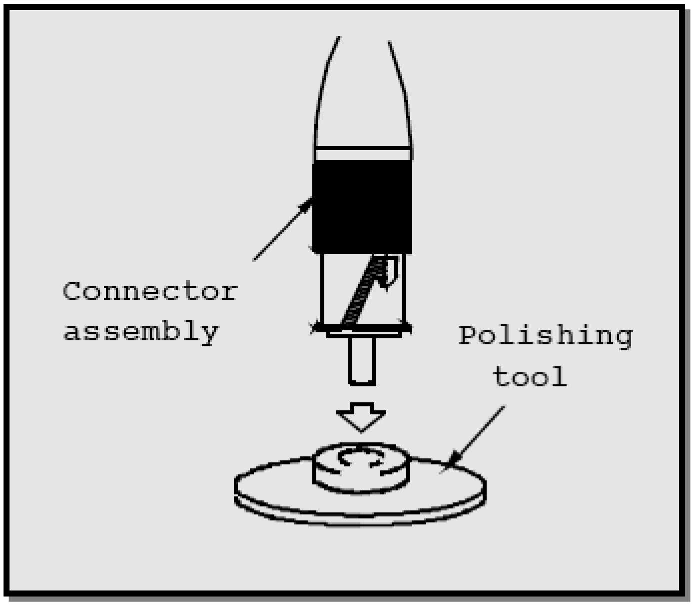


Figure 2-109. Inserting the Connector into the Polishing Tool

Step 4 - Place the 5 um polishing paper on the glass plate and start polishing the connector with very light pressure (the weight of the tool) using a figure-8 motion (see figure 2-110). Do not over polish the connector.

(**NOTE:** The first polish is complete when all of the epoxy is almost gone from the tip of the ferrule.) Since the polishing time varies with the amount of epoxy present on the tip of the ferrule, inspect the ferrule tip frequently. Whenever the polishing tool is lifted, remove the grit from the tool and the ferrule using a wipe dampened with alcohol or with air. When polishing is complete, clean the ferrule and the polishing tool using a wipe dampened with alcohol and blow them dry with air. Perform a rough inspection of the ferrule end using the eye loop.

NOTE: For some ferrule designs all of the epoxy cannot be removed during the first polish and a slight epoxy haze will naturally remain on the ferrule endface.

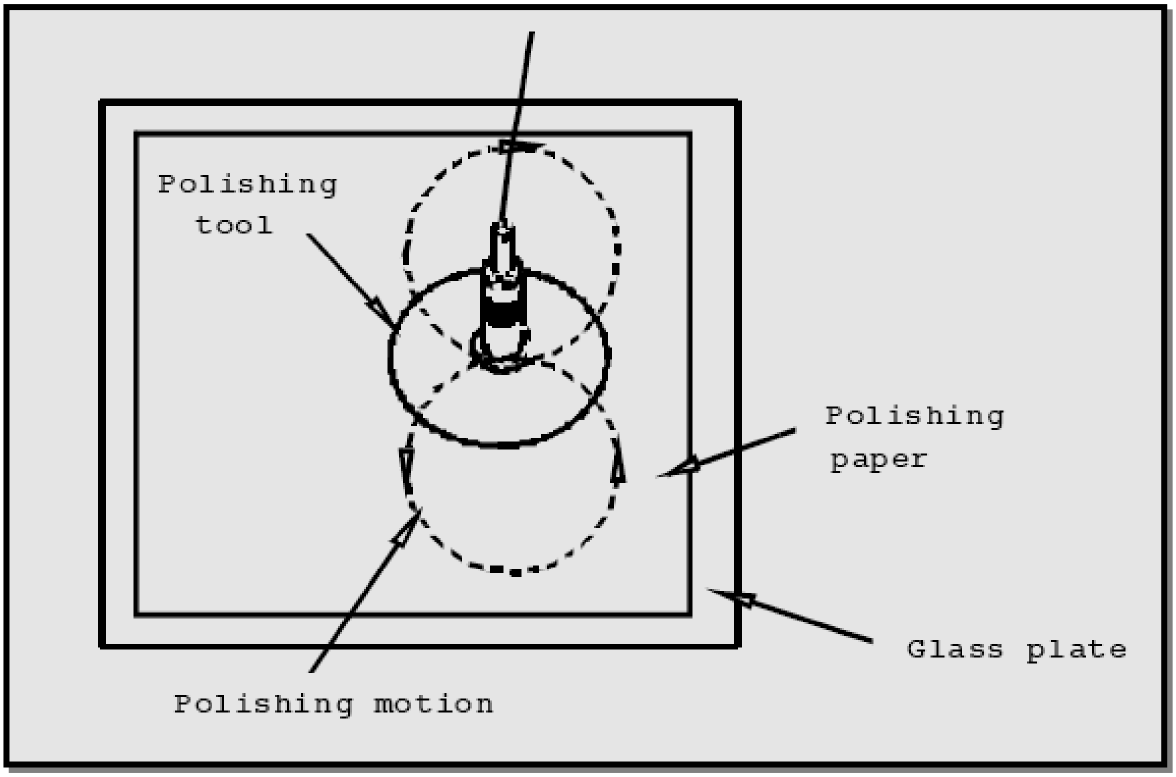


Figure 2-110. Polishing the Connector

Step 5 - Replace the 5 um paper with the 1 um paper. Polish the connector with very light pressure using a figure-8 motion for approximately 10 to 20 complete motions.

NOTE: The 1 um polish is complete when all of the epoxy is gone from the tip of the terminus.

NOTE: The 1 um polish may also be performed using wet paper.

Step 6 - Replace the 1 um paper with the 0.1 um paper. Wet the paper and polish the connector with very light pressure using a figure-8 motion for approximately 10 to 20 complete motions.

NOTE: The final polish may also be performed using dry paper.

Step 7 - Remove the connector from the polishing tool, and clean it using a wipe dampened with alcohol and blow it dry with air.

B. Domed end polish.
NOTE: For ST connectors, this procedure only works for connector ferrules that have been pre-radiused by the connector manufacturer. Some multimode optical fiber connectors may not have pre-radiused ferrules. When implementing this procedure on multimode optical fiber connectors, verify with the connector manufacturer that the connectors have pre-radiused ferrules.

This procedure will produce a connector with a domed end polish. This procedure is recommended for high quality multimode applications and single mode applications with a minimum return loss requirement of 30 db. Procedures for hand polishing are contained herein. Machine polishing may be used as an alternate method, provided the following requirements are satisfied:

a. The manufacturer's instructions will be rigidly adhered to, except that the polishing papers or disks shall be 5 um aluminum oxide foam backed, 1 um aluminum oxide mylar backed, and 0.1 um diamond mylar backed, as used in hand polishing.

(**NOTE:** Alternate polishing materials may be used if authorized approval is obtained and the polishing machine includes the appropriate stops to prevent changes to the ferrule length.)

b. The machine polished connector shall undergo the same quality check used for the manually polished connector as described herein.

NOTE: The procedures contained herein should produce an optical terminus with a physical contact (PC) polish.

Step 1 - **WARNING:** Wear safety glasses when scoring the fiber to avoid possible eye injury.

Remove the connector from the cure adapter and score the fiber close to the ferrule tip at the epoxy interface using one short light stroke with cleaving tool (see figure 2-111).

(**NOTE:** Do not break the fiber with the cleaving tool.) Pull off the fiber with a gentle, straight pull. Deposit the waste fiber in a trash container.

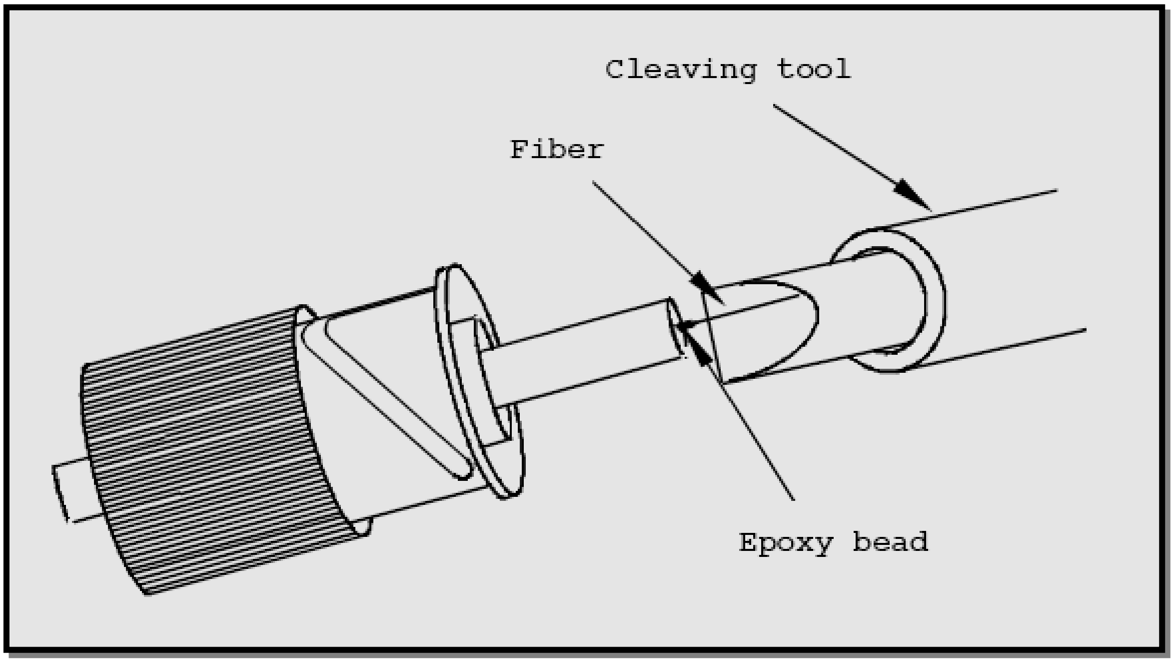


Figure 2-111. Scoring the Fiber

Step 2 - Clean the glass polishing plate, the resilient pad, the backs of the polishing papers, and the surface of the polishing tool using a wipe dampened with alcohol. Blow all of the surfaces dry with air.

NOTE: Before inserting the connector into the polishing tool, the connector may be held vertically and the end of the fiber polished off by lightly running the 5 um polishing paper over the top of the ferrule tip. (This is referred to as air polishing the connector.)

Step 3 - Insert the connector into the polishing tool (see figure 2-112).

(**NOTE:** Difficulty in inserting the connector ferrule into the polishing tool may indicate epoxy on outside of the ferrule, which must be removed before proceeding.)

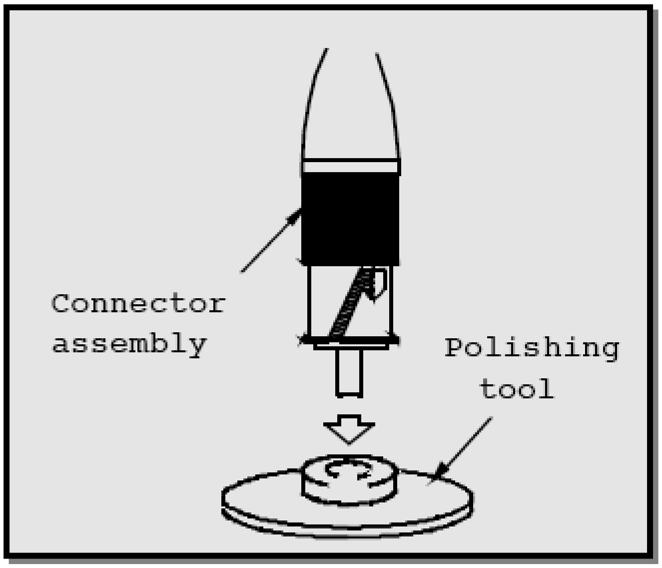


Figure 2-112. Inserting the Connector into the Polishing Tool

Step 4 - Place the 5 um polishing paper on the glass plate and start polishing the connector with very light pressure (the weight of the tool) using a figure-8 motion (see figure 2-113). Do not over polish the connector.

(**NOTE:** The first polish is complete when all of the epoxy is almost gone from the tip of the ferrule.) Since the polishing time varies with the amount of epoxy present on the tip of the ferrule, inspect the ferrule tip frequently. Whenever the polishing tool is lifted, remove the grit from the tool and the ferrule using a wipe dampened with alcohol or with air. When polishing is complete, clean the ferrule and the polishing tool using a wipe dampened with alcohol and blow them dry with air. Perform a rough inspection of the ferrule end using the eye loop.

Step 5 - Place the resilient pad on the glass plate. Place the 1 um paper on the resilient pad. Wet the paper and polish the connector with no pressure using a figure-8 motion for approximately 10 complete motions.

NOTE: The polish tool should hydroplane above the paper surface during this polish.

NOTE: The 1 um polish is complete when all of the epoxy is gone from the tip of the terminus.

NOTE: The 1 um polish may also be performed using dry paper.

Step 6 - Replace the 1 um paper with the 0.1 um paper. Wet the paper and polish the connector with no pressure using a figure-8 motion for approximately 20 to 30 complete motions.

NOTE: The polish tool should hydroplane above the paper surface during this polish.

Step 7 - Remove the connector from the polishing tool, and clean it using a wipe dampened with alcohol and blow it dry with air.

C. Enhanced Procedure
This procedure will produce a connector with a domed end polish. This procedure is typically used for single mode applications with a minimum return loss requirement of 40 dB, or when specified in the contract. Procedures for hand polishing are contained herein. Machine polishing may be used as an alternate method, provided the following requirements are satisfied:

a. The manufacturer's instructions will be rigidly adhered to, except that the polishing papers or disks shall be 5 um aluminum oxide foam backed, 1 um aluminum oxide mylar backed, 0.1 um diamond mylar backed, and ultrafine mylar backed as used in hand polishing.

(**NOTE:** Alternate polishing materials may be used if authorized approval is obtained and the polishing machine includes the appropriate stops to prevent changes to the ferrule length.)

b. The machine polished connector shall undergo the same quality check used for the manually polished connector as described herein.

NOTE: The procedures contained herein should produce an optical terminus with a physical contact (PC) polish.

Step 1 - Perform steps 1 through 7 of the standard polish procedure.

Step 2 - Replace the 0.1 um paper with the ultrafine paper. Wet the paper and polish the terminus with light pressure using a figure-8 motion for 10 to 30 complete motions.

NOTE: The glossy side of the ultrafine paper should be placed facing the resilient pad.

NOTE: The polish tool should hydroplane above the paper surface during this polish.

Step 3 - Remove the connector from the polishing tool, clean it using a wipe dampened with alcohol and blow it dry with air.

D. Quality Check

Step 1 - Examine the connector with the optical microscope to ensure that the optical surface is smooth and free of scratches, pits, chips, and fractures (see figure 2-113). If any defects are present, repeat the polish with the 0.1 um paper (and the ultrafine paper for enhanced polish connectors) or reterminate the fiber.

(NOTE: Do not polish the connector more than necessary to pass the quality check.) A high intensity back light may be used to illuminate the fiber during the quality check.

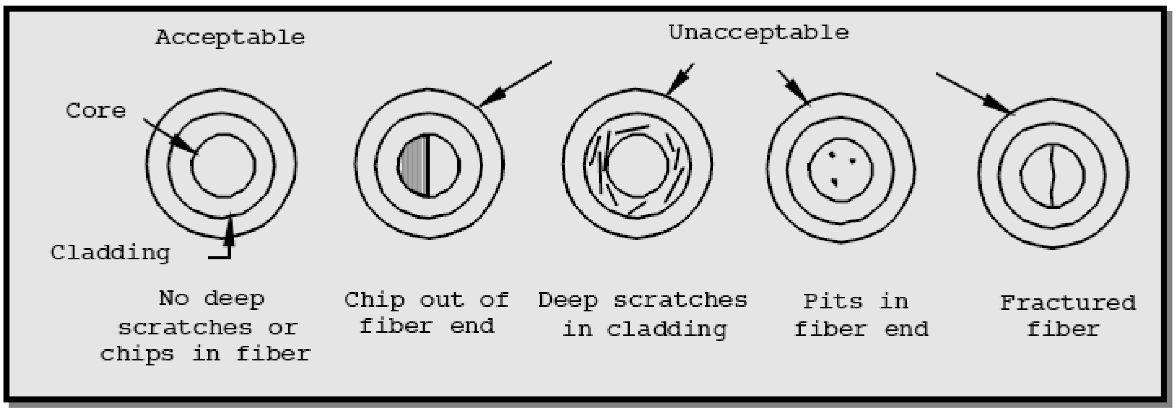


Figure 2-113. Quality Check

NOTE: Depending on the optical microscope used, viewing quality may be different.

NOTE: A small number of very light scratches (e.g. scratches that can barely be seen) is minimally acceptable.

Step 2 - If the connector is not to be immediately mated into an adapter, install a plastic protective cap over the connector ferrule.

2.18.0 STYLES OF CONNECTORS

Standardization is a serious problem throughout the military and connector selection is one of the most affected areas. Only use those connectors listed in the Fiber Optic Qualified Parts List (QPL). Let's look at some of the most widely used connectors. As you become familiar with the connectors, keep three basic considerations in mind: (1) threaded connectors can cause big problems when excessive torque is used, (2) keyed connectors allow for consistent, repeatable alignment, (3) as more fiber is installed, termination space will become more valuable.

BICONIC CONNECTORS . Named for their conical shape, many items of equipment installed during the 1980s still require interfacing using Biconic connectors. These were the first connectors used on single-mode fibers, although, they are available for single-mode or multimode applications. Biconic connectors are not keyed and early problems developed with repeatability and crushing due to over tightening. Later versions of Biconic connectors were available with a keying feature. Refer to figure 2-114.

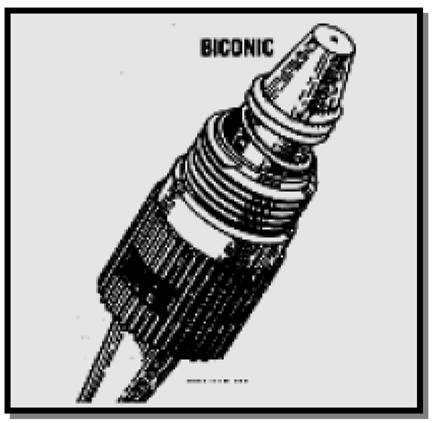


Figure 2-114. Biconic Style Connector

FC CONNECTORS . Named FC for "field connector," it was originally devised by Nippon Telephone and Telegraph (NTT) for telecommunications. It was used by MCI in its fiber optic telephone network in the 1980s. The connector has a threaded coupling feature similar to the SMA for use in high-vibration environments. The threads would be difficult to over tighten because stops have been installed to obtain repeatable torque. It also offers a keying feature similar to the ST, except that some FC connectors are "tunable." The term "tunable" means the keying slot can be rotated to find optimal alignment and will remain in that alignment until moved again. The FC connector is available for single-mode and multimode applications. Refer to 2-115.

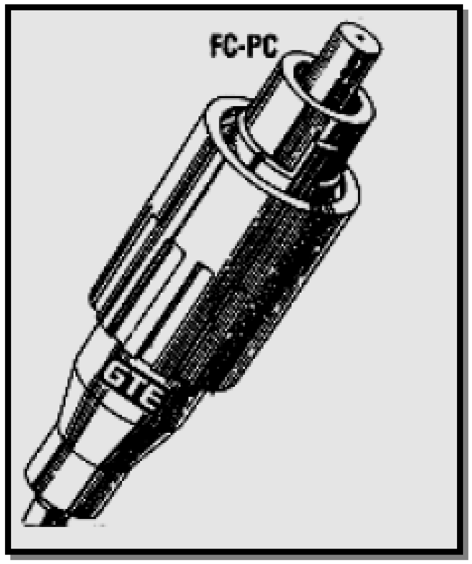


Figure 2-115. FC Style Connector

FDDI CONNECTORS . Named after the Fiber Distributed Data Interface (FDDI) Networks that ANSI designed them for, the FDDI is a duplex connector consisting of two 2.5 mm ST style ceramic ferrules.

LC CONNECTORS. First marketed by AT&T, the "Low Cost" connector is significantly smaller than its counterparts. The LC uses a 1.25mm ferrule and has an RJ-45 style push-pull housing and latching mechanism.

MT-RJ CONNECTORS . MT-RJ is a duplex connector with both fibers in a single polymer ferrule. It uses pins for alignment and has male and female versions. Multimode only, the MT-RJ is usually pre-polished and spliced in place.

SC CONNECTORS . Named SC from “subscriber connector,” it was also developed by NTT and gained popularity throughout the 1990s for both single-mode and multimode applications. They use a push-pull engagement for mating and are designed to be pull-proof so a slight pull on the cable will not disengage the connection. The SC connector is a strong competitor to the FC and ST connectors due to the ease in constructing multi-fiber connectors for duplex configurations. Connectors such as the FC, ST, and SMA that require twisting are not readily adaptable to multi-fiber connections in high-density applications because of the space required to allow rotation. Many experts agree that the SC is “the connector of the future.” AMP has already developed a mini SC for even higher density applications. Refer to figure 2-116.

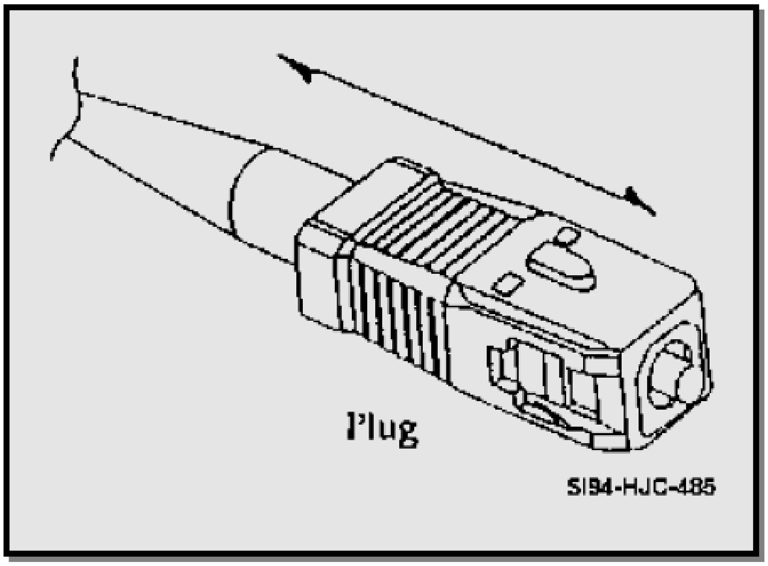


Figure 2-116. SC Connector

ST CONNECTORS . ST (Single Terminus) Connectors were designed by AT&T Bell Laboratories for use with single-mode or multimode fibers. They use quick-release keyed bayonet couplings that are preferred in situations where severe vibrations are not expected. The ST is probably the most popular and widely used connector in local area networks, premise wiring, test equipment and other applications. The keying feature ensures that the fiber is always inserted to the mating bushing with the same orientation. The bayonet coupling prevents crushing due to over-tightening. Refer to figure 2-117. ST Connectors are the most commonly used fiber connectors in Navy applications.

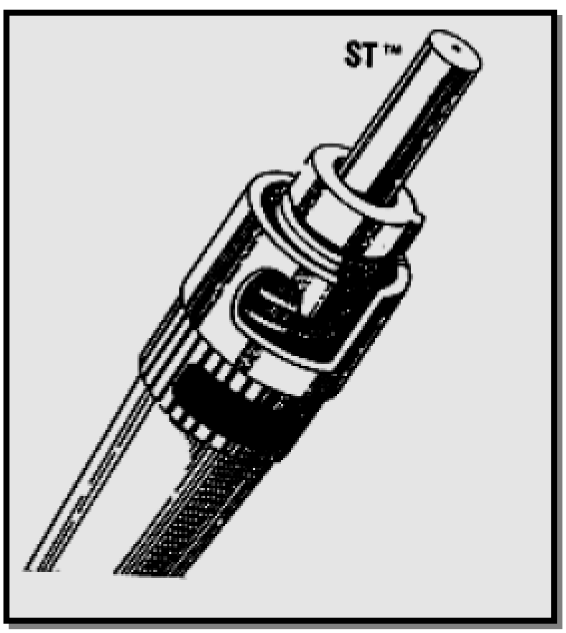


Figure 2-117. ST Style Connector

SMA CONNECTORS. SMA (Sub-Miniature, Type A) Connectors, originally designed by Amphenol, use a threaded coupling nut without a keying device. The two basic types are the 905 style and 906 style. The 905 uses a straight ferrule and the 906 has a step-down nose to allow use of plastic alignment bushings for maximum alignment. Originally designed with a steel ferrule for multimode applications, they are now available with ceramic ferrules for single-mode applications. The primary problems that arise with the use of SMA connectors are crushing due to over tightening of the threads, and repeatability of alignment because of the lack of a keying device. Refer to figure 2-118.

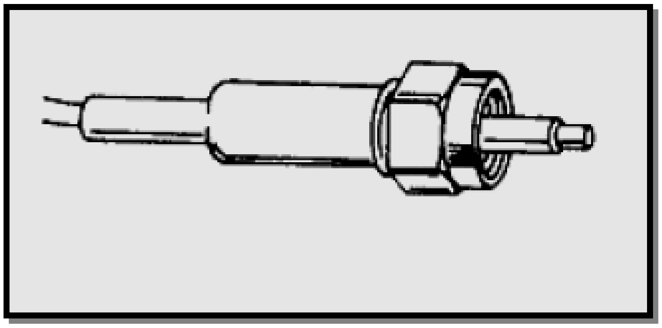


Figure 2-118. SMA Style Connector

2.19.0 OPTICAL LOSS TEST SET – ANRITSU

The Optical Loss Test Set is an invaluable asset to the Fiber Optics Technician. You will learn the importance of accurate references and the standard procedures for obtaining and comparing them.

Observe all applicable safety precautions when working with energized light-guide systems. Ensure that the fiber optic cable under test is disconnected from optical sources prior to conducting OLTS measurements and more importantly before visual inspection.

The following information details the side by side referencing method utilizing the Anritsu 9020A/B Optical Loss Test Set.

NOTE: It is very important to **CLEAN ALL CONNECTORS AND ADAPTERS** at the test points prior to performing either reference or test measurements.

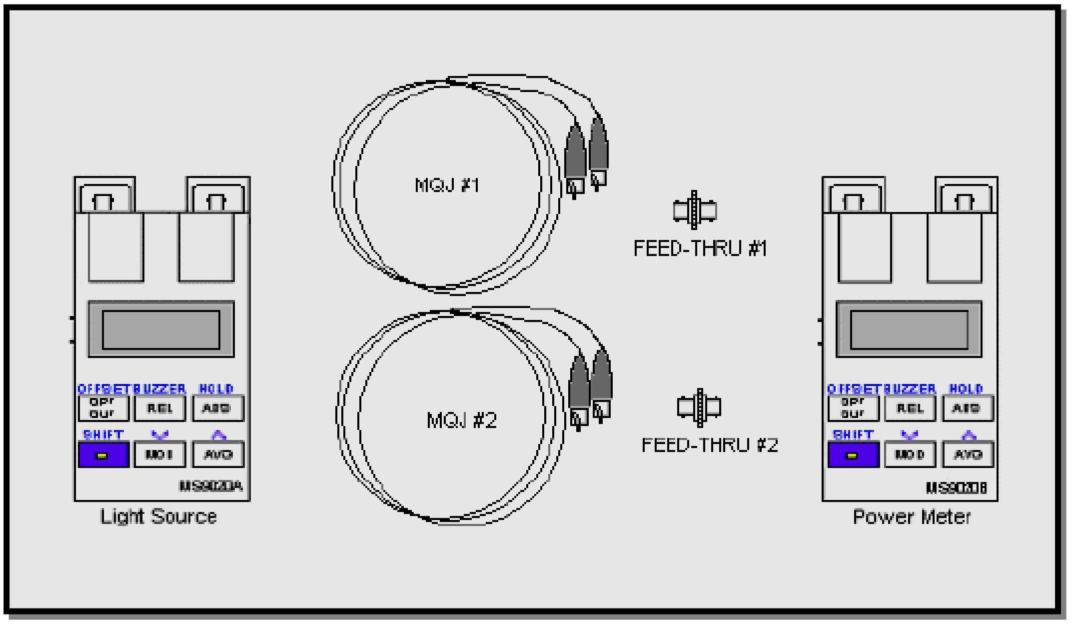


Figure 2-119. Standard OLTS Items

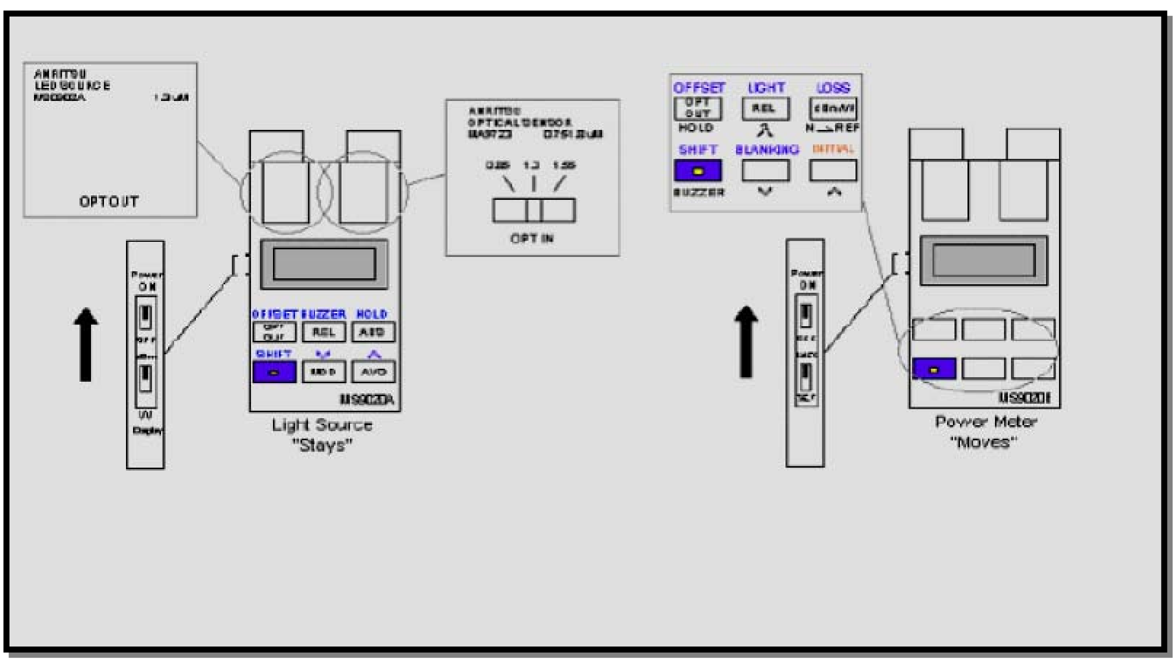


Figure 2-120. Front Panel Familiarization and Quick Set-up Procedures

1)	Side Switches Up (**ON**)	18)	Record Reading (< **-.5d**B)
2)	Depress **SHIFT** + **OFFSET**	19)	Demate / Mate MQJ #2 from Coupler #2, (3X)
3)	Check source XMT = 1.3 & RCV = 1.3	20)	Verify P/M reading consistent (< **-.5dB**)
4)	**MOD** to **CW**	21)	Depress **OPT OUT**
5)	Connect MQJ #1, from L/S to P/M	22)	Disconnect MQJ #2 from coupler #2
6)	Depress **OPT OU**T	23)	Connect Coupler #1 to MQJ #2
7)	Note reading in dBm : dBm/W	24)	Connect cable under test to couple #1 & #2
8)	Depress **REL** to zero reference	25)	Depress **OPT OUT**
9)	Depress **OPT OUT**	26)	Record Reading (< **-1.5 dB**)
10)	Disconnect MQJ #1 from P/M	27)	Depress **OPT OUT**
11)	Connect MQJ #2 & coupler #1 to MQJ #1 & P/M	28)	Reverse test cable, disconnect from coupler
12)	Depress **OPT OUT**	29)	Record reading (< **-1.5dB**)
13)	Record Reading (< **-.5dB**)		
14)	Depress **OPT OUT**		
15)	Disconnect coupler #1 from MQJ #1 & MQJ #2		
16)	Connect Coupler #2 to MQJ #1 and MQJ #2		
17)	Depress **OPT OUT**		

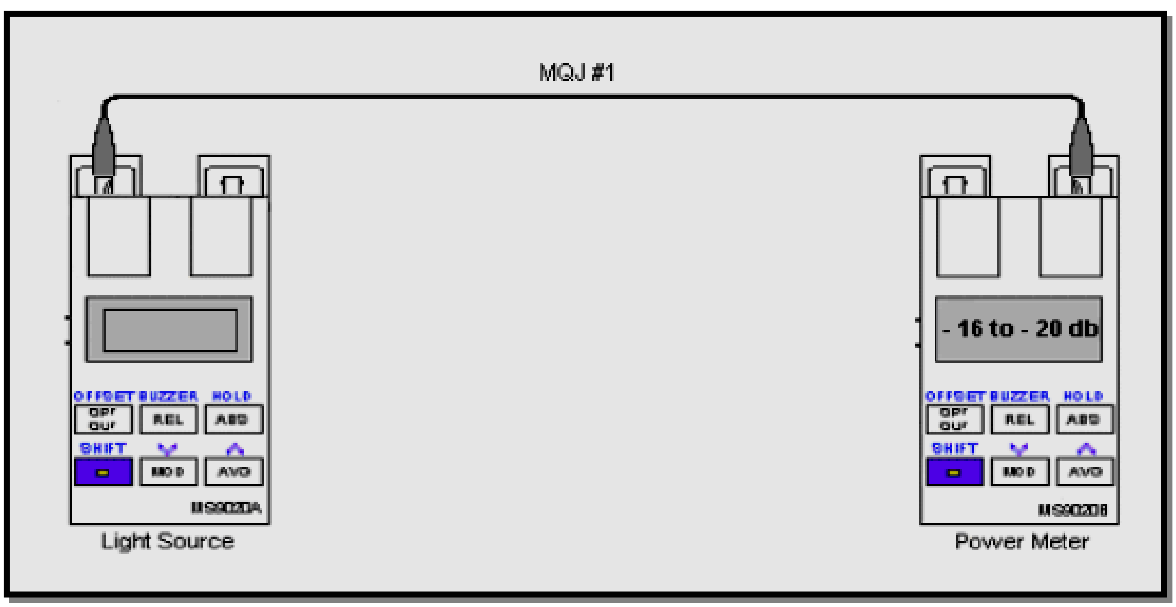


Figure 2-121.

STEP 1: Connect MQJ #1 between the Optical Light Source and the Optical Power Meter. Verify the power level displayed on the Power Meter is within the acceptable limits of the light source. (In this case between -16 & -20 dBm)

STEP 2: Disconnect MQJ #1 from the Optical Power Meter. Using a coupler connect MQJ #1 to MQJ #2. Connect MQJ #2 to the Optical Power Meter. **DO NOT DISTRURB THE CONNECTION AT THE LIGHT SOURCE.**

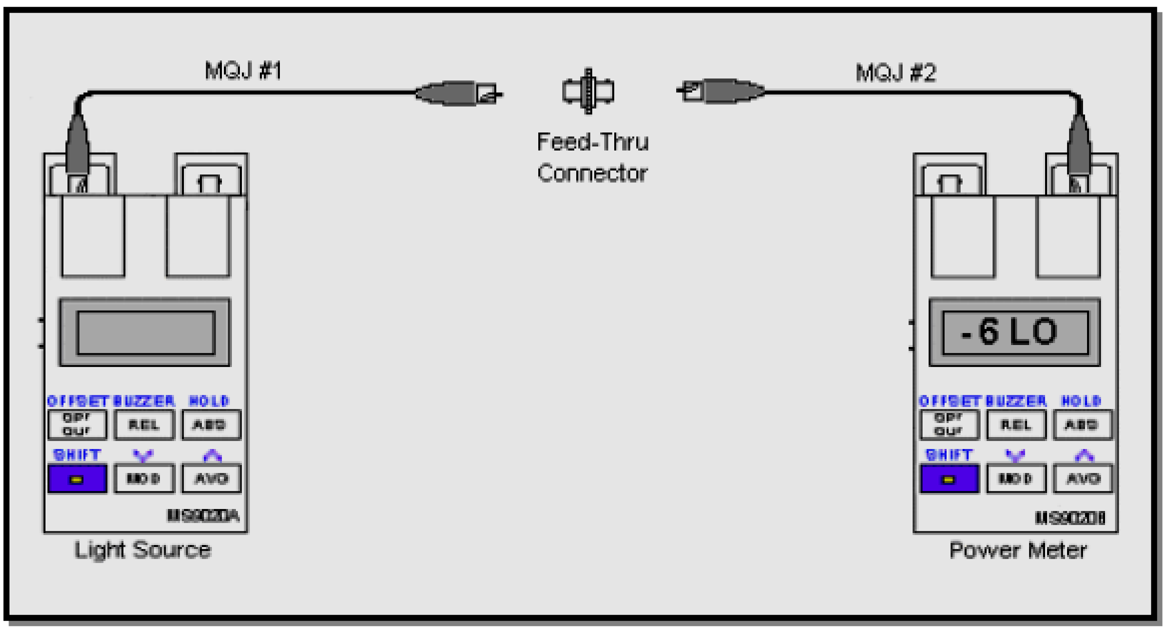


Figure 2-122.

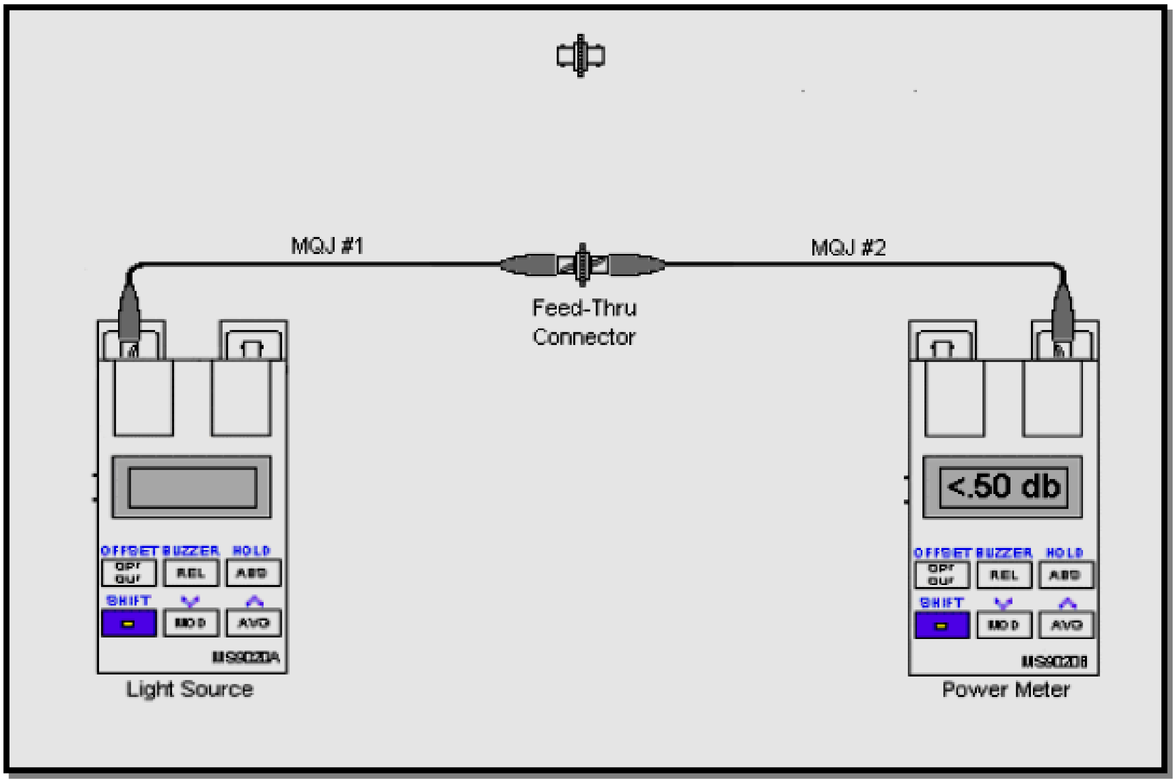


Figure 2-123.

STEP 3: Verify the loss displayed on the Power Meter is .50 dB or less. Mate and de-mate both MQJ's a minimum of 3 times. Each reading should be consistent and less than .50 dB.

NOTE: Although not a required step in the TIA /EIA or Navy procedures use step 3 to verify that your MQJ's have not degraded beyond an acceptable level.

STEP 4: Disconnect MQJ #1 and MQJ #2 from each other.

DO NOT DISTURB POWER METER AND LIGHT SOURCE CONNECTIONS.

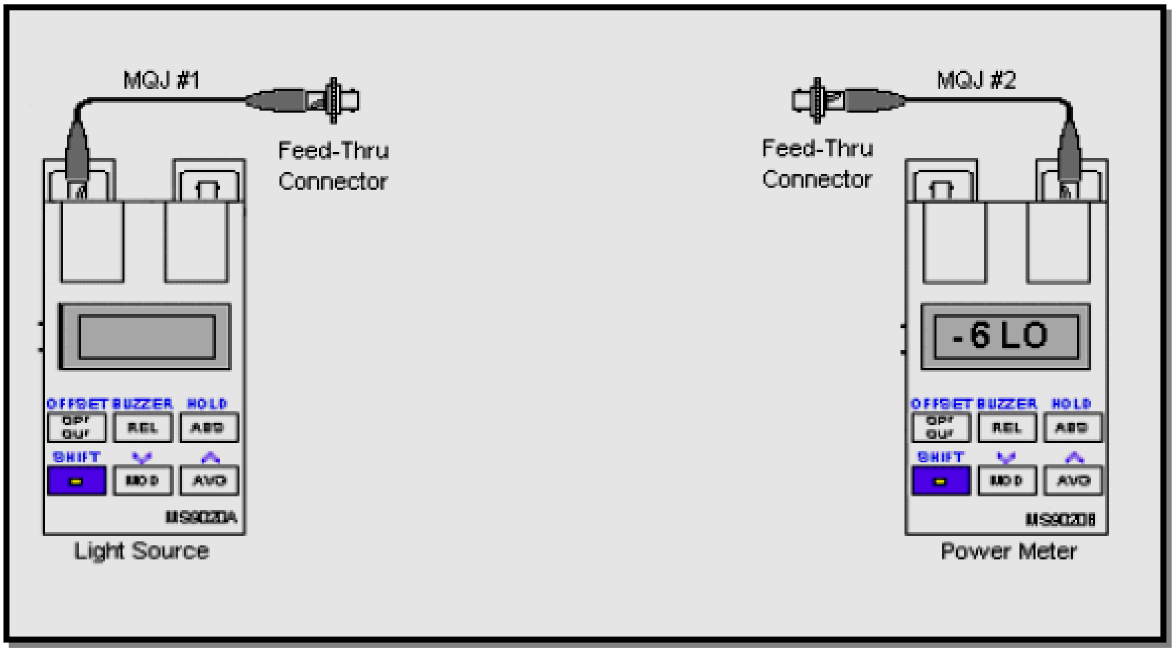


Figure 2-124.

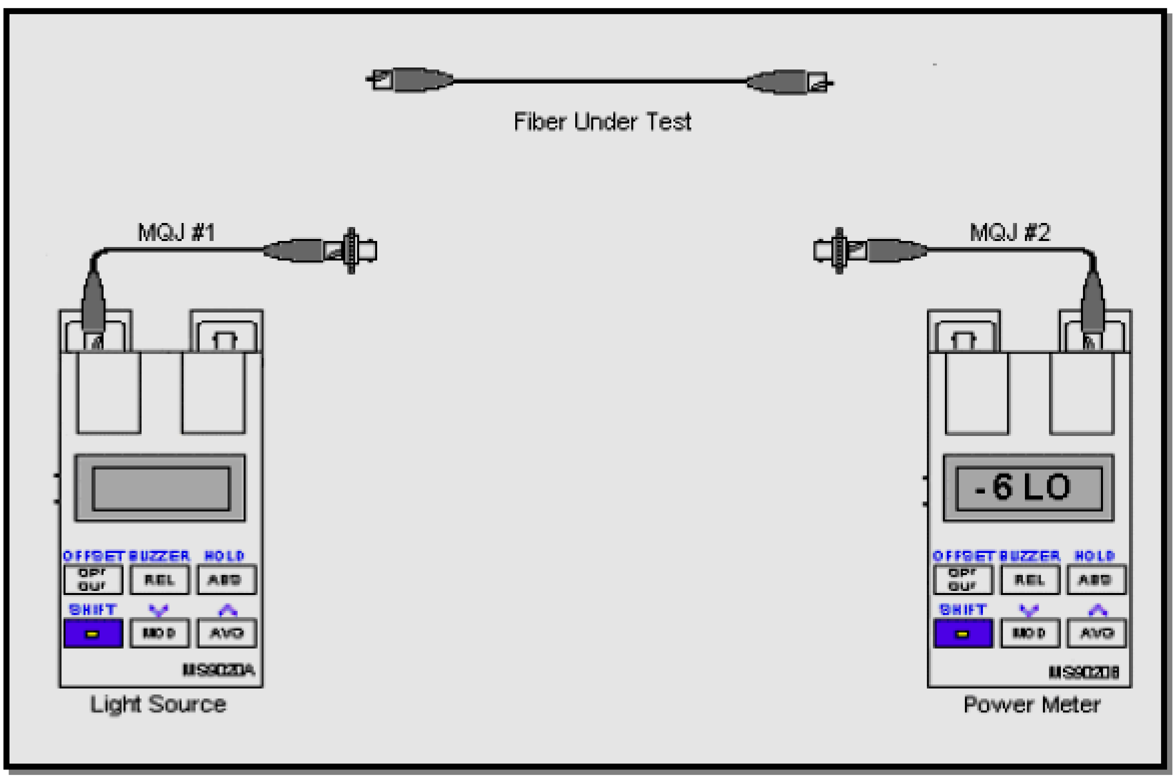


Figure 2-125.

STEP 5: Attach MQJ #1 to one end of the Fiber Under Test and MQJ #2 to the other.

STEP 6: Record the dB loss displayed on the Power Meter.

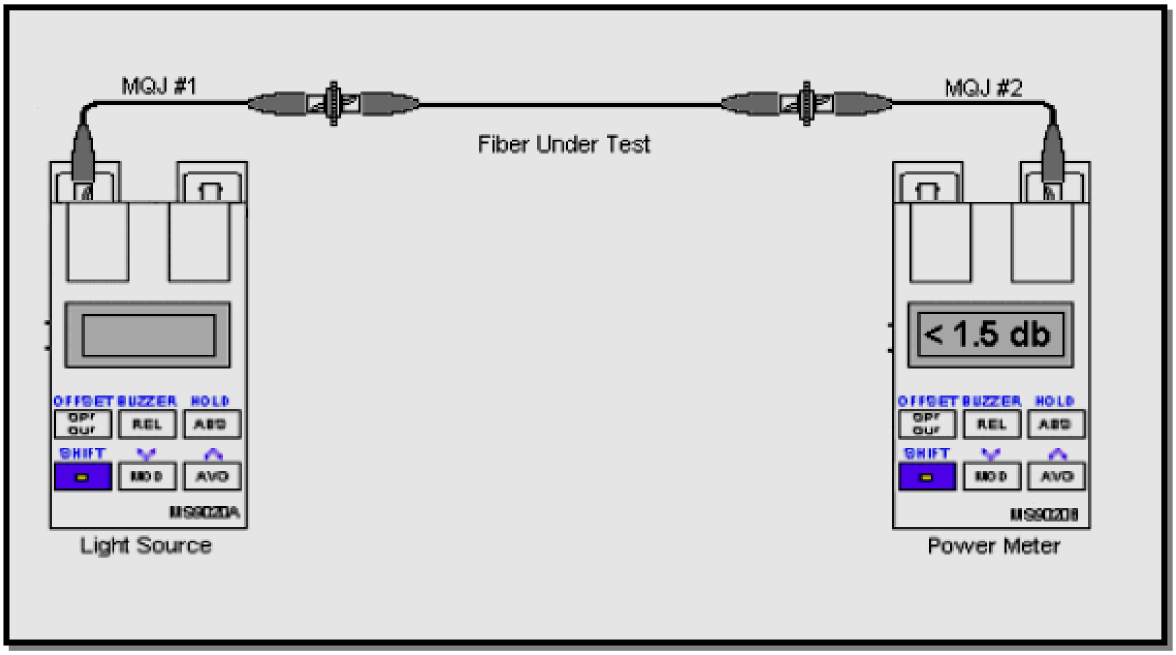


Figure 2-126.

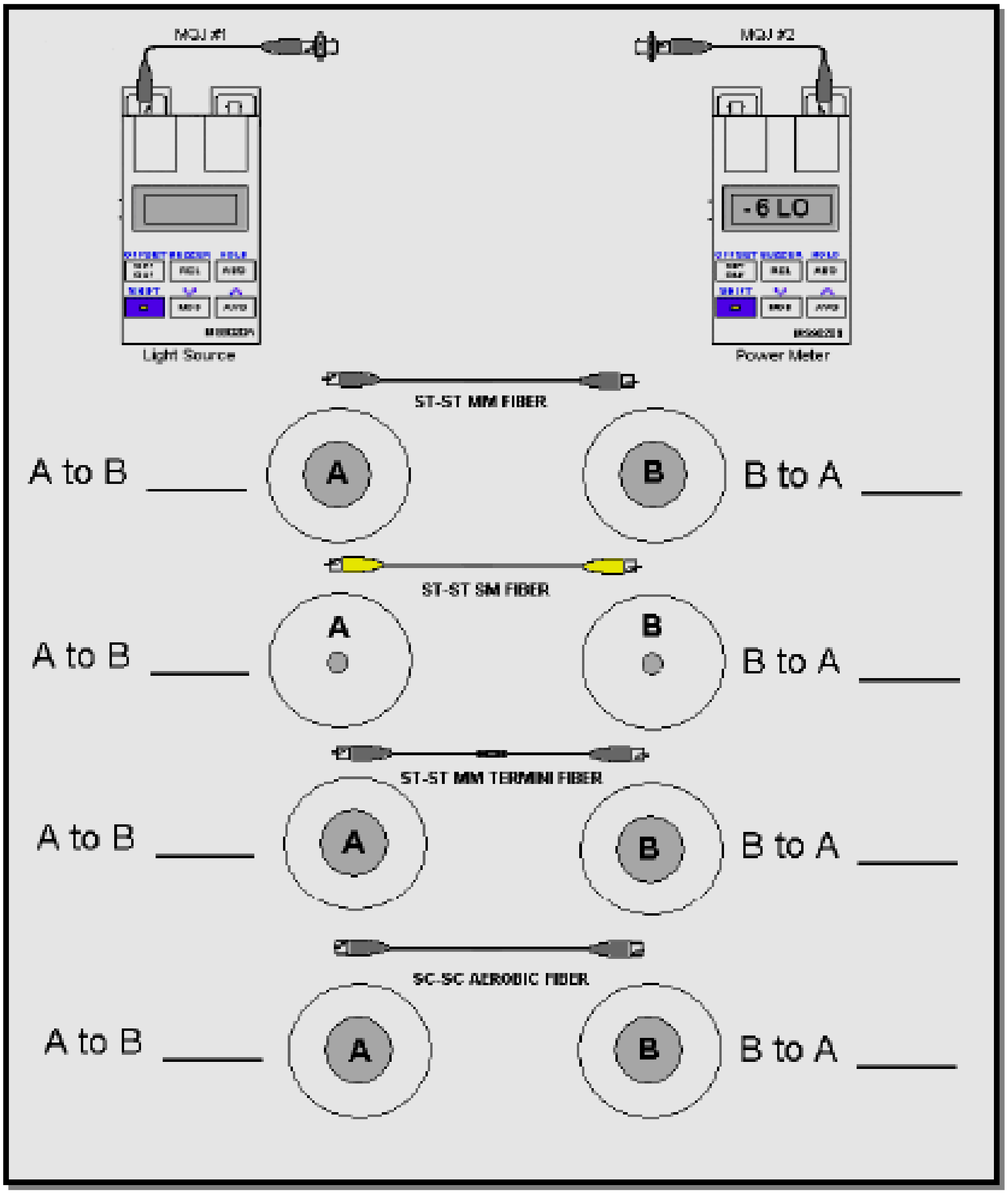

MQJ #1
MQJ #2
-6 LO
Light Source
Power Meter
ST-ST MM FIBER
A to B ______
A
B
B to A ______
ST-ST SM FIBER
A to B ______
A
B
B to A ______
ST-ST MM TERMINI FIBER
A to B ______
A
B
B to A ______
SC-SC AEROBIC FIBER
A to B ______
A
B
B to A ______

Figure 2-127.

2.20.0 MAINTENANCE CONCEPTS AND MAINTENANCE OF THE FIBER OPTIC CABLE PLANT

Fiber optic cable repair or restoration is an important consideration when designing high-speed data transfer systems for shipboard applications. One major concern is how much damage the system can suffer before it will not operate. Fiber Optic links onboard Navy ships are designed to withstand a very high level of damage and continue to operate through alternate paths for the duration of the engagement. Based on this approach, highly trained personnel are needed to maintain these systems if or when a casualty occurs. Proficiently trained Fiber Optic Technicians have a firm grasp of not only fiber optic theory and connectorization, but an understanding of these 6 basic fiber optic concepts:

- Fiber installation
- Fiber inspection
- Fiber maintenance
- Fiber restoration
- Fiber loss testing
- Fiber identification

Detailed instructions on maintenance procedures may be given in the system technical manual. If no instructions are found in the system technical manual, the general maintenance concepts and procedures discussed in the following pages may be utilized.

Repairs should be made at the lowest level possible. If ships company can not accomplish the repair or the scope is beyond the Organizational level (O Level) then the nearest Intermediate Maintenance Activity (IMA) will be assigned the task of completing the repair.

ANY TIME A MAINTENANCE ACTION IS REQUIRED ON FIBER OPTIC CABLE OR COMPONENTS A 2-KILO WILL BE GENERATED TO PLACE THE JOB ON THE SHIPS CONSOLIDATED SHIPS MAINTENANCE PLAN (CSMP).

THE LOCAL 2M PROGRAM MANAGER SHALL ENSURE THE FIBER OPTIC TECHNICIAN HAS SUFFICIENT FAMILIARIZATION WITH THE MODULE TEST AND REPAIR TRACKING SYSTEM (MTRTS) TO ENSURE SATISFACTORY DOCUMENTATION.

(**O**) **Organizational** (Shipboard) Level Maintenance - required maintenance accomplished by ship's force.

(**I**) **Intermediate** Level Maintenance (IMA) - required maintenance normally performed by Navy personnel on board tenders, repair ships, Shore Intermediate Maintenance Activities (SIMAS), aircraft carriers, and fleet support bases.

(**D**) **Depot** (Shipyard) Level Maintenance - maintenance performed by industrial activities. Depot level maintenance requires major overhaul or a complete rebuilding of parts, assemblies, subassembly and end items, including the manufacturing of parts, modifications, testing, and reclamation.

PERMANENT

Permanent fiber optic cable repair or restoration will be accomplished onboard Naval ships by trained technicians. **No splices** are permitted between interconnection boxes.

New cable shall be installed from one interconnection box to another or from an interconnection box to the equipment or end device, to replace the damaged cable. The replacement cable shall be of the same composition (fiber material and fiber type) as the damaged cable and it should be routed the same unless changed by the system designers.

This requirement is designed to ensure system integrity. Upon completion of the installation of the replacement cable, all systems shall be tested to determine the restoration of their operational level. These records will be maintained in the Combat Systems smooth log.

TEMPORARY

Temporary repair of cables can quickly be accomplished if there are spare fibers available within the damaged cable or redundant pathways are provided.
Redundant pathways are of course the quickest way to ensure system integrity in the event of a casualty.

This concept is employed by many systems and subsystems, but may not always be the case. It is therefore very important that both the system and maintenance technicians be able to recognize when a redundant pathway is being utilized. Although this condition may not warrant immediate corrective action it is important to recognize that this represents a degradation of the system and has the potential to severely impact further mission accomplishment if left unchecked.

Familiarization with the cable plant and associated equipment is therefore critical and documentation of the problem essential. If the redundant (Secondary) pathway is operational, diagnosis of the primary path can be accomplished without interruption of the mission, and restoration can be accomplished when trained personnel are available to make permanent repairs.

Temporary cable restoration will first be attempted utilizing available spares. This provides the fastest casualty correction when the exact fault in the fiber optic cable being utilized is not readily evident. Of course, if the entire fiber optic cable is damaged (ie. Severed) sparing would not be a feasible option. Without a redundant pathway the affected system would be inoperable, until repairs could be made.

These repairs will be accomplished using ST connector terminations at the fault location. In shorter sections of damage the reterminations could be connected with a single coupler. Larger sections of damage may require the reterminations to be joined with a jumper connected between a set of couplers. Carefully lashing the repair to the equipment or cableway will help prevent further damage.

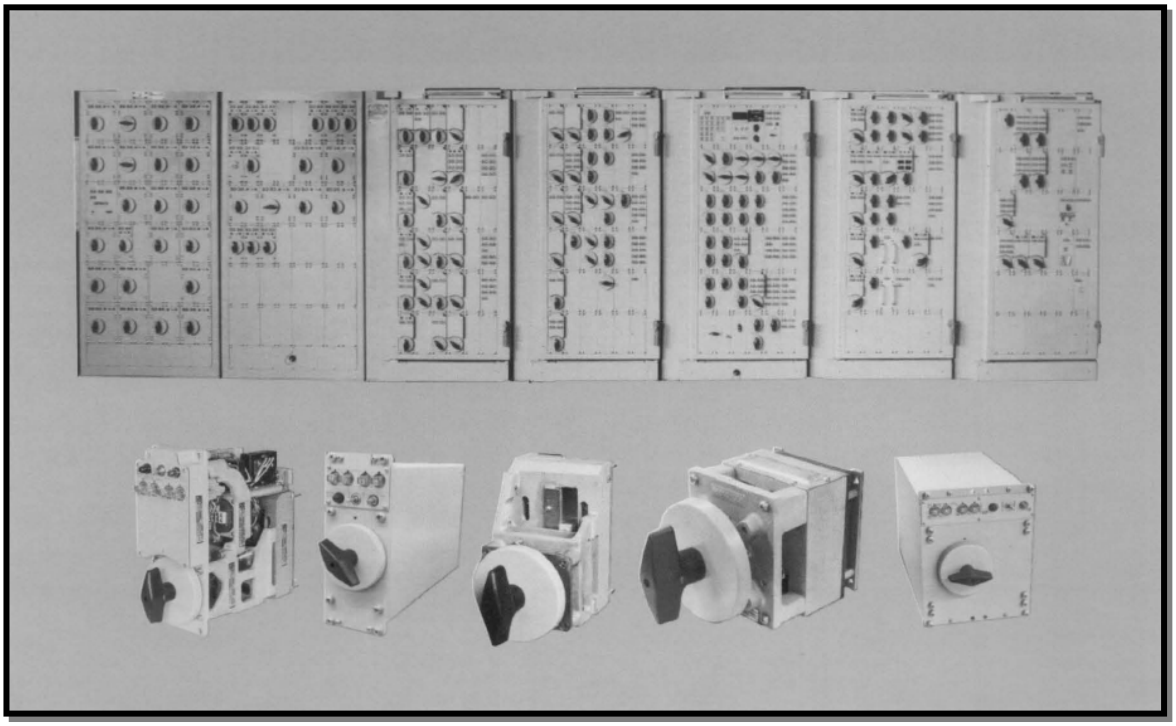
A REPAIRED CABLE IS CONSIDERED A TEMPORARY REPAIR UNTIL THE CABLE IS REPLACED AT THE NEXT SHIP REPAIR AVAILABILITY (SRA).

THE JOB WILL REMAIN OPEN ON THE CSMP UNTIL A PERMANENT REPLACEMENT CABLE IS INSTALLED.

2.21.0 SUMMARY

In this chapter, we have discussed some of the more common types of switches, relays, and solenoids used in the IC Electrician field. We have also discussed the use of fuses, circuit breakers, and overload relays in protecting IC equipment. Additionally, we have identified electrical cables used to supply power for IC equipment and the proper procedures for installing and connecting cable to the equipment. Also discussed was Inspection of Fiber Optic components; cable continuity tests, cable sealing and jacket repair, connectors, testing, and maintenance of fiber optics.

3 POWER DISTRIBUTION, IC SWITCHBOARDS, AND CONTROLLERS



Upon completion of this chapter you will be able to do the following:

- Describe the various electrical distribution systems installed on board Navy ships.
- Describe the characteristics, construction features, and functions of the various types of IC switchboards.
- Describe a typical IC power distribution system.
- Identify the various switchboard components used with IC switchboards.
- Identify IC circuits by their classification.
- Describe a typical IC test switchboard.

3.0.0 INTRODUCTION

A ship's electrical equipment requires a constant uninterrupted supply of power to function properly. The ship's service power distribution system, the emergency power distribution system, and the casualty power distribution system provide power for the IC switchboards and other IC systems aboard ship. As an Interior Communications (IC) Electrician, you should become familiar with these different power sources. Your duties as an IC Electrician includes troubleshooting, repairing, and maintaining power distribution systems assigned to your division. This includes switchboards, power supplies, and motor controllers.

3.1.0 IC SYSTEMS CLASSIFICATION

IC systems are classified by importance, readiness, and designation.

3.1.1 IMPORTANCE

The importance classification defines the extent to which a system affects the fighting effectiveness of the ship. There are three classifications of importance: vital, semivital, and nonvital.

Vital Systems

An IC system classified as vital (V), if disabled, would seriously impair the fighting effectiveness and maneuverability of the ship.

Semivital Systems

An IC system classified as semivital (SV), if disabled, would impair the fighting effectiveness of the ship to a lesser extent than the loss of a vital system.

Nonvital Systems

An IC system classified as nonvital (NV), if disabled, would not impair the fighting effectiveness or maneuverability of the ship.

3.1.2 READINESS

IC systems are also classified according to the extent to which a system contributes to the operational readiness of the ship. There are four classes of readiness: class 1, class 2, class 3, and class 4. Readiness classification only switchboard plates is indicated by color on surface ships and by a specific symbol on submarines.

Class 1

Class 1 IC systems are systems that are essential to the safety of the ship and ship personnel. Class 1 IC systems are energized at all times. The switchboard plate is colored yellow on surface ships, and the symbol for submarines is a rectangle within a hexagon.

Class 2

Class 2 IC systems are systems that, together with class 1 systems, are essential to ship control. Class 2 systems are energized when the ship is preparing to get underway, standing by, underway, and anchoring, and until the ship is secured. The switchboard plate is colored black on surface ships, and the symbol for submarines is a rectangle.

Class 3

Class 3 IC systems are systems that, together with class 1 and class 2 systems are essential to complete interior control and battle circuits. Class 3 systems are energized during condition watches and operations. The switchboard plate is colored red on surface ships, and the symbol for submarines is a circle.

Class 4

Class 4 IC systems are convenience circuits. These circuits are energized only when they are required. The switchboard plate is colored white on surface ships, and the symbol for submarines is a triangle.

DESIGNATION

All IC systems are identified by circuit designations. Designations consist of single or double letters as previously described in chapter 2 under the heading Cable Marking.

3.1.3 SHIP'S SERVICE POWER DISTRIBUTION SYSTEM

The ship's service power distribution system is the electrical system that normally supplies power to the ship's equipment and machinery. The ship's service switchboards and associated generators are usually located in separate engineering spaces to minimize the possibility that a single hit will damage more than one switchboard.

The ship's service generator and distribution switchboards are interconnected by bus ties. This interconnection allows any distribution switchboard to feed power from its generators to one or more of the other switchboards, allowing the generator plants to be operated in parallel. The power distribution to loads can be directly from the generator and distribution switchboards. The power distribution can also be from distribution panels to small loads or from load centers to larger loads. Figures 3-1 and 3-2 are examples of two typical power distribution systems found on some ships.

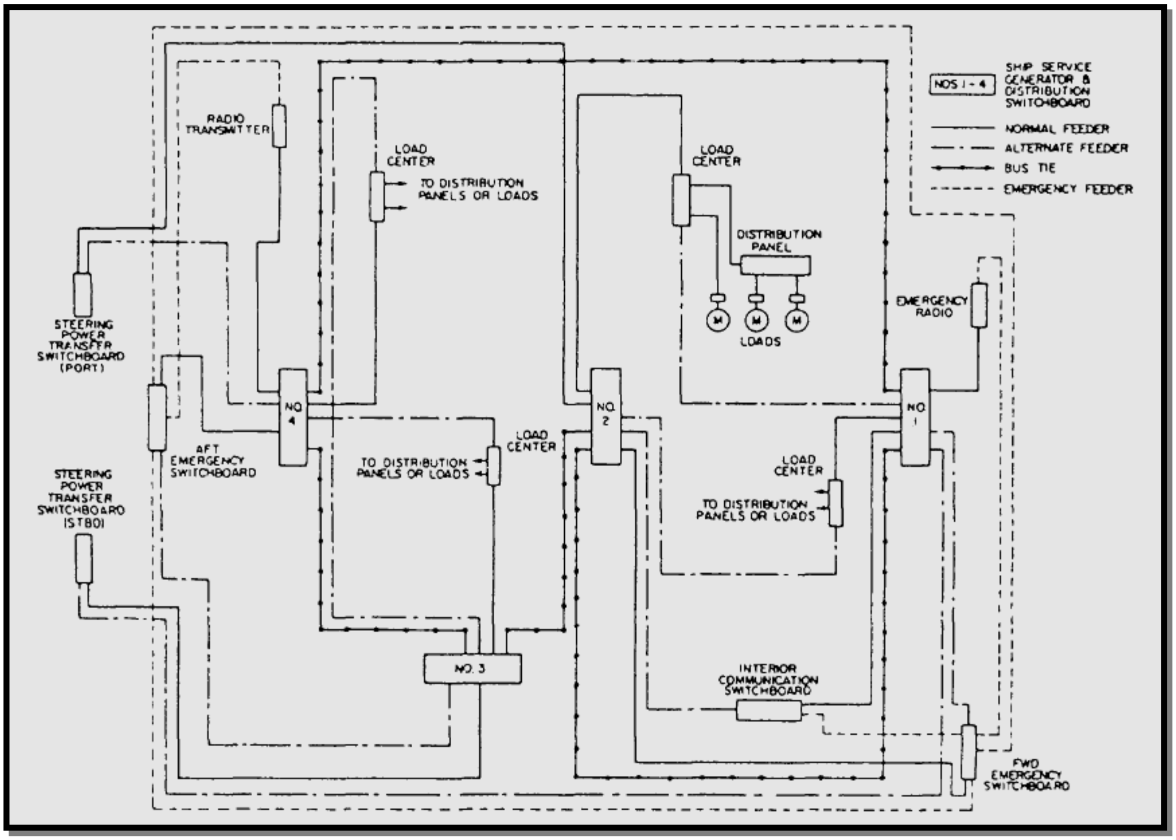


Figure 3-1.—Typical power distribution system found in a large combatant ship.

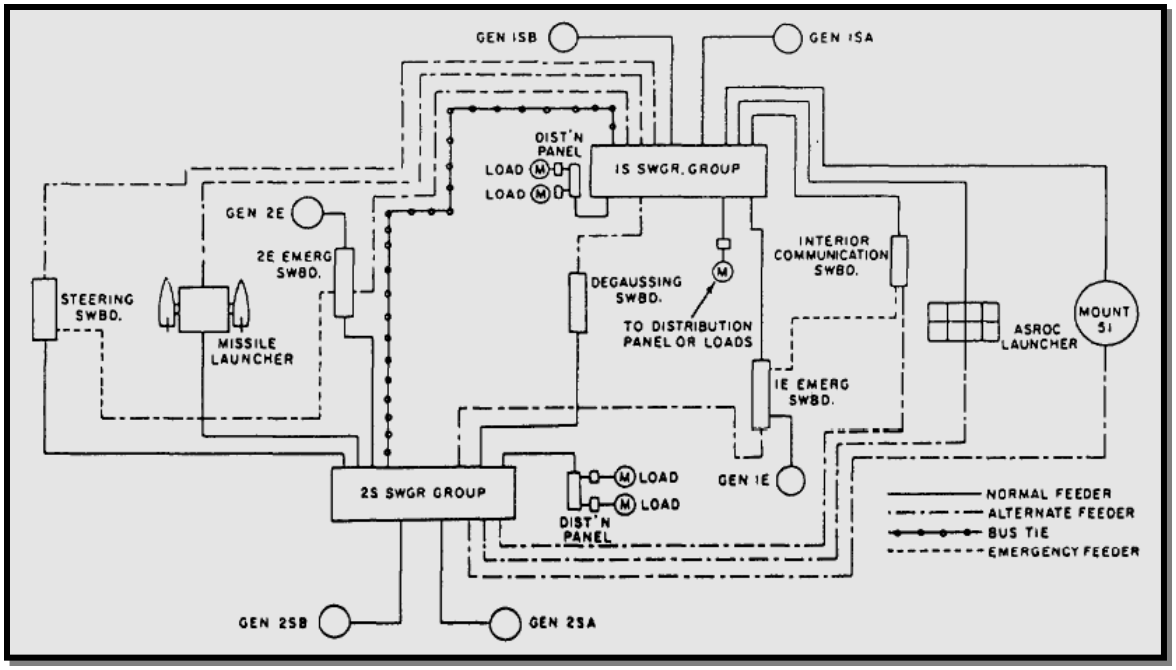


Figure 3.2-Typical power distribution system found in a guided missile destroyer.

Most ac power distribution systems in naval vessels are 450-volt, 3-phase, 60-Hz, 3-wire ungrounded systems.

3.1.4 EMERGENCY POWER DISTRIBUTION SYSTEM

The emergency power distribution system supplies a limited amount of power for ship control and for the operation of vital equipment when the ship's service distribution system fails. An emergency power distribution system is installed on most combatant ships and some auxiliary ships.

This system is separate and distinct from the ship's service distribution generators and switchboards. Each emergency switchboard is supplied by its associated emergency diesel generator. The emergency feeders run from the emergency switchboards and terminate in manual or automatic bus transfer equipment at the distribution panels or at loads for which emergency power is required.

The emergency switchboard is connected by feeders (fig. 3-3) to at least one and usually to two different ship's service switchboards. One of these ship's service switchboards is the preferred (normal) source of ship's service power for the emergency switchboard, and the other is the alternate source. The emergency switchboard and the distribution system are normally energized from the normal source of ship's service power. If this source of power should fail, bus transfer equipment automatically transfers the emergency switchboard to the alternate source of the ship's service power. If both the normal and alternate sources of power fail, the emergency generator will start automatically within 10 seconds and the emergency switchboard will automatically transfer to the emergency generator.

The emergency power distribution system is 450 volts, 3 phase, 60 Hz with transformer banks at the emergency distribution switchboards to provide 120-volt, 3-phase power for the emergency lighting system.

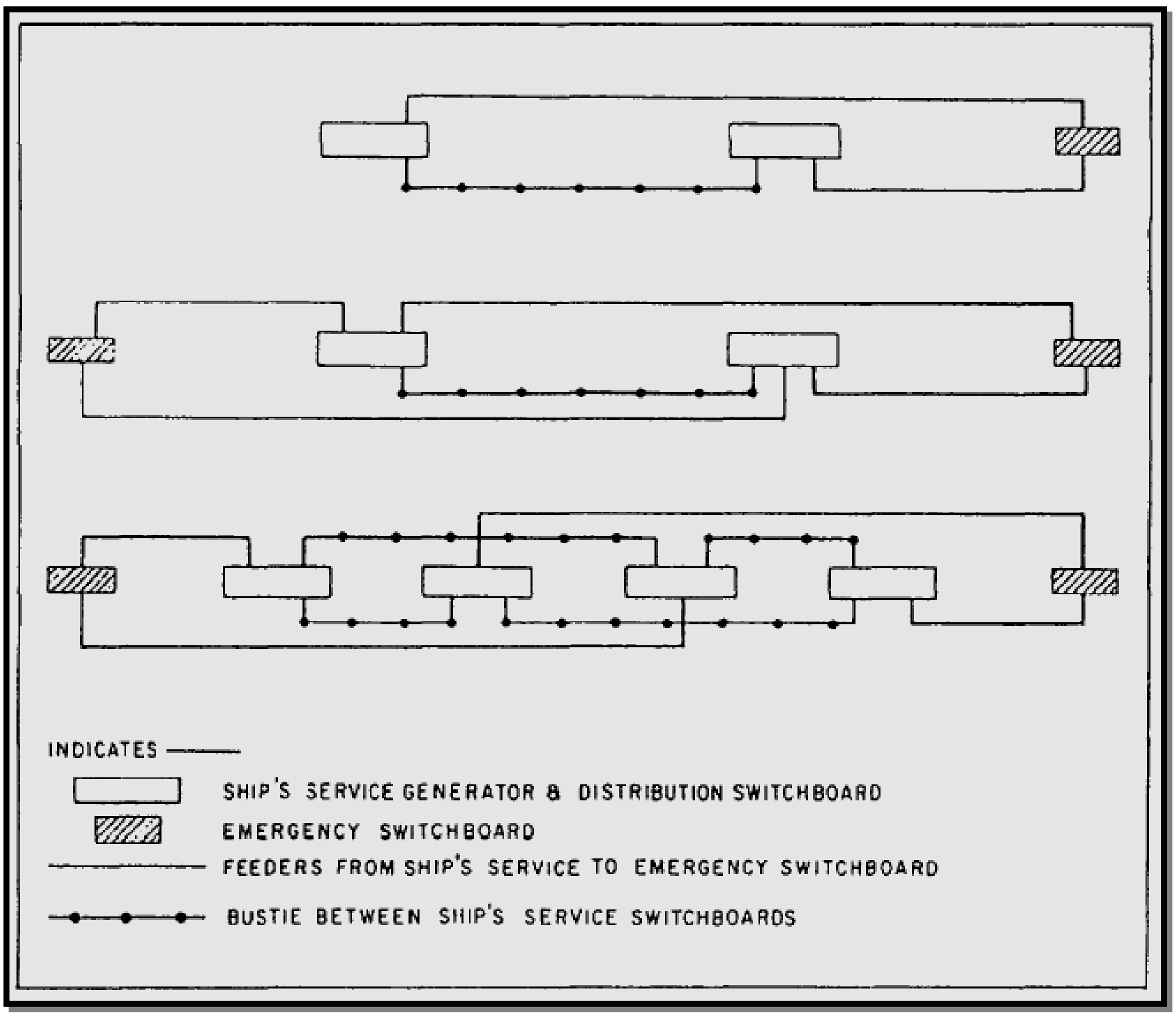


Figure 3-3.-Emergency and ship's service distribution system interconnections.

3.1.5 CASUALTY POWER DISTRIBUTION SYSTEM

A casualty power distribution system is installed on certain types of ships to provide the means for making temporary electrical connections if the permanently installed ship's service and emergency distribution systems cables are damaged. The system is limited to those facilities that are necessary to keep the ship afloat and to permit the ship to get out of a danger area. The system also supplies a limited amount of power to armament and directors to protect the ship when it is in a damaged condition.

If the ship's service and emergency circuits fail, temporary circuits can be rigged. Also, the casualty power distribution system can be used to supply power to vital auxiliaries if any of the ship's service or emergency generators can be operated.

Component parts of the casualty power distribution system include permanent and portable cables, bulkhead and switchboard terminals, risers, and portable switches.

Suitable lengths of portable cable are stowed on racks throughout the ship close to locations where they may be needed.

Risers, consisting of a terminal at each end connected by permanently installed cable, provide connection points for 3-phase portable cables between decks. Bulkhead terminals are permanently installed in watertight bulkheads in chosen locations. Bulkhead terminals are used to connect the portable cables on opposite sides of bulkheads. This enables power to be transmitted through compartments without the loss of watertight integrity.

Casualty power switchboard terminals are provided at switchboards as well as at some distribution panels. Portable cables can be connected at these points to obtain power from, or supply power to, the bus bars. Casualty power circuit breakers are also installed at switchboards to de-energize terminals for connecting cables.

Portable switches are stowed in repair party lockers and can be used, when necessary, for connecting and disconnecting circuits.

Casualty power cables are to be rigged only when they are required for use or for practice in rigging the system.

Only qualified personnel should do the actual connecting; however, other personnel may lay out the portable cables. In rigging casualty power cables, make the connections from the load to the source to avoid handling energized cables. During practice sessions, do not make connections to any terminal that is not provided with a disconnect switch to de-energize the terminal until all power is disconnected and disconnects tagged according to safety instructions. For more detailed information on rigging and unrigging casualty power, consult NSTM, chapter 079, volume 3, "Damage Control Engineering Casualty Control."

3.1.6 IC AND ACTION CUT-OUT (ACO) SWITCHBOARDS

Shipboard IC systems are defined as anything that causes an audible or visual signal to be transferred within or between the compartments of a ship. They provide a means of exercising command within a ship and include voice interior communications, alarm, warning, ship's control, entertainment, gyrocompass, and plotting systems.

IC systems receive their power from a variety of sources. The majority are energized from main IC switchboards. Some IC systems receive their power from a small local IC switchboard or a local lighting power panel.

The IC switchboard is the nerve center of the interior communications system. To obtain maximum protection, most IC switchboards are installed below the waterline and are energized from a normal, an alternate, and an emergency power supply to ensure continuous service. Since, in effect, all means of controlling the navigational systems on most ships depend upon proper functioning of the IC switchboards; their reliability is of the utmost importance. Many of the weapons and fire control (FC) circuits also receive their power from the IC switchboards; however, these systems are not part of the IC Electrician's responsibility.

In large combatant ships, there are normally two main IC switchboards. One switchboard is located in the forward IC room, and the other switchboard is located in the after IC room. This enables each system or equipment to receive its normal power supply from the nearest IC switchboard. Smaller ships may have only one main IC switchboard.

Local IC switchboards are installed in various spaces to provide local control of circuits vital to the operation of the space. These switchboards are usually found in engine rooms, central control stations, steering gear rooms, and other spaces if required.

Some of the newer ships also have a combat systems switchboard. On some ships this switchboard serves as an interface between certain IC and non-electronic navigation systems and the ship's combat system. This switchboard also supplies power and action cutout (ACO) switching for certain IC systems. On other ships, this switchboard contains no distribution facilities. The switchboard is confined to ACO switching for the various instruments at navigational stations and inputs to the weapons control systems.

3.2.0 MAIN IC SWITCHBOARD

The latest type of main IC switchboard is the front-service switchboard. This switchboard is constructed so installation, operation, and maintenance can be accomplished entirely from the front of the switchboard. The switchboard can be mounted against a bulkhead because no access space is required in the rear of the board. This results in a saving of space, which is most important aboard ship.

The switchboard is a type 1, deck-mounted, front-serviced, enclosed, box-type structure. The structure is divided into panels, with each panel having a hinged door. Lightweight items, such as switches, meters, fuse holders of up to 60-ampere capacity, and other equipment, are mounted on the front of the hinged doors. The doors are hinged on the left-hand side and are provided with two “dog-type” latches on the right-hand side and a door stop assembly.

Terminal boards are mounted on the rear of each panel. Cables are terminated at the terminal boards on the inside of the panel. Wiring between the terminal boards and the door-mounted equipment is installed to ensure free-swinging of the doors without interference from, or damage to, the wiring harness.

The switchboard consists of a power distribution section and an ACO section. The power distribution section may be subdivided into various buses, depending on the individual ship requirements. Figure 3-4 is an example of a front-service switchboard that is currently installed aboard some naval vessels. The distribution section consists of panels 1 through 4, while the ACO section consists of panels 5 and 6.

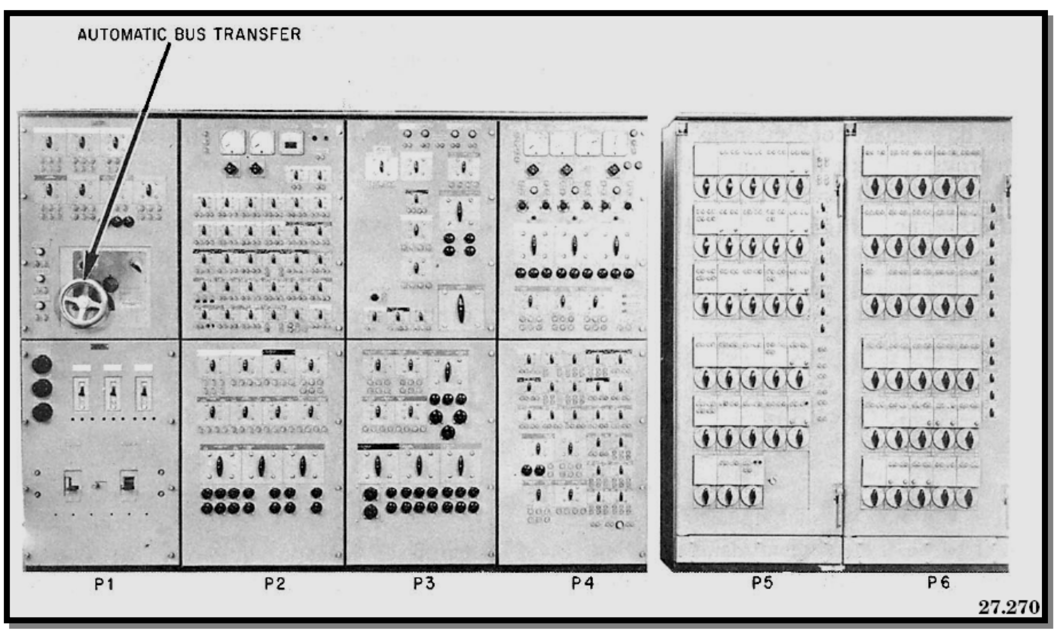


Figure 3-4.—Front-service switchboard.

The following discussion describes the general principles of a forward main IC switchboard, such as the one illustrated in figure 3-4. For a detailed description of the main IC switchboard(s) and associated equipment installed on your ship, you should consult volume 5, part 1, of the *Ship Information Book* for your ship and any related technical manuals.

3.2.1 Power Distribution Section

The power distribution section of the switchboard (panels 1 through 4) is supplied with power from as many sources as possible. The power distribution section, in turn, supplies power from its various buses to several IC and FC circuits. Power distribution by the switchboard of a particular ship depends on the requirements of the IC and FC systems installed.

PANEL 1.— The 450-volt, 3-phase, 60-Hz bus located in panel 1 is energized from one of three power sources (normal, alternate, or emergency). Power becomes available through the use of two mechanically interlocked switches and an automatic bus transfer (ABT) device located in panel 1. An indication of the power available is provided through the use of indicator lights connected via transformers to each power source. On some of the newer ships in the fleet, the ABT is located separate from the switchboard itself.

The normal power supply is from the forward ship’s service distribution switchboard. The alternate power supply comes from the after ship’s service distribution switchboard. The emergency power supply comes from the forward emergency distribution switchboard. The bus may also be energized by a casualty power terminal installed on the board, which, in turn, receives its power via portable cable from a remotely located riser nearby.

PANEL 2.— The 120-volt, 3-phase, 60-Hz bus located in panel 2 receives its power from panel 1 via a bank of three 450/120-volt, 60-Hz, single-phase transformers located in panel 2. This panel disseminates both 120-volt, single-phase, 60-Hz, and 120-volt, 3-phase, 60-Hz power to various IC and FC systems as required. A voltmeter, an ammeter, and a megohmmeter are installed on the front of panel 2 for monitoring by watch standers and maintenance personnel.

PANEL 3.— Panel 3 is supplied with 120 volts dc from the 450-volt supply of panel 1 via two remotely located rectifiers. A switch on the front of panel 3 allows the operator to select either of the two rectifiers. Indicator lights on the panel indicate which of the two rectifiers is in operation.

Panel 3 is supplied with 250 volts dc from one of two 450-volt, 3-phase, 60-Hz motor generators. Two stop-start switches, power available indicator lights for each source, and a voltmeter are located on panel 3. The motor generators obtain their power from the 450-volt, 60-Hz, 3-phase bus.

PANEL 4.— The 450-volt, 400-Hz, 3-phase power for panel 4 is received from a motor generator or a static power supply. The 120-volt, 400-Hz, 3-phase power is received from a bank of transformers. A voltmeter, a frequency meter, and an ammeter are also installed on panel 4 for monitoring by watch standers and maintenance personnel.

3.2.2 Action Cut-out (ACO) Section

The ACO section (panels 5 and 6) permits isolation of damaged portions of certain IC systems and, in addition, allows transfer control of certain systems from one station to another. Drawout switch units (fig. 3-5) are used, with each unit incorporating the associated JR switch, fuse holders, synchro overload transformers, and overload indicators.

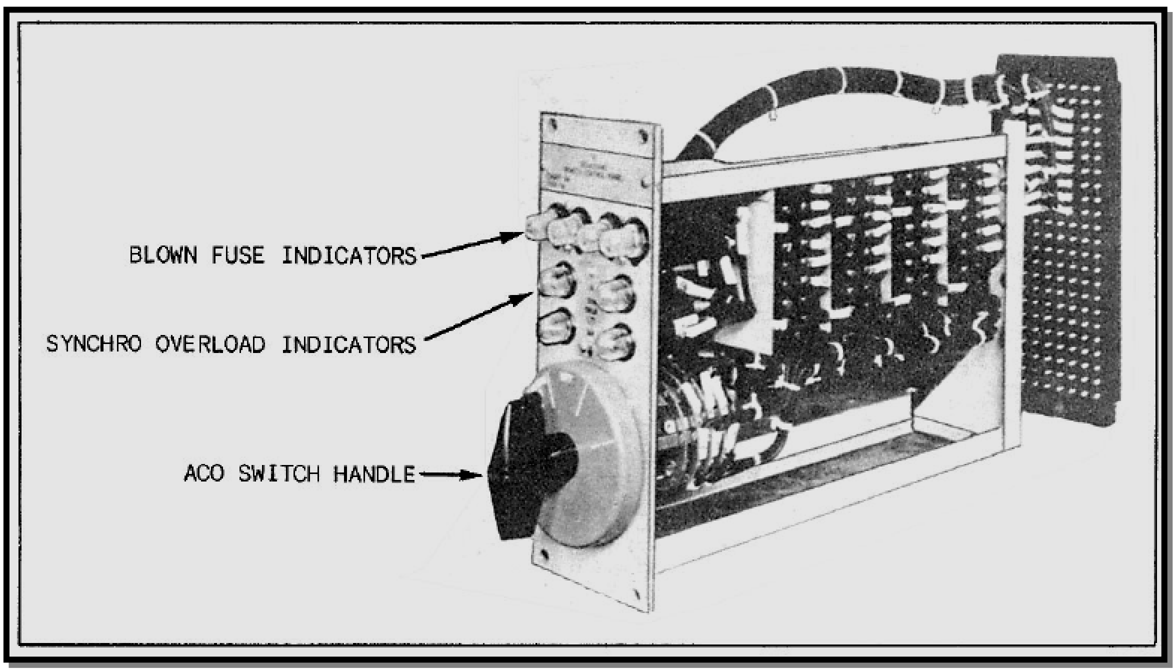


Figure 3-5.—ACO drawout switch unit.

The switches found on these panels are for the repeater and control circuits of the gyrocompass, wind indicating, propeller revolution, propeller order, engine order, and underwater log systems.

Through the proper manipulation of switches, either the main or the auxiliary gyrocompass may be selected as the information-sending device to the many gyrocompass repeaters of the system. In addition, each of the individual repeaters in the system may be cut in or out of the system without having any adverse effect on the operation of the system. The switches for the other systems may be used in the same manner as those for the gyrocompass.

A bank of SR switches is also located on the ACO section of some switchboards. These switches are used to isolate the various speaker groups and alarm contact makers of the general announcing system circuit 1MC.

3.2.3 Switchboard Components

There are several components used with the main IC switchboards. The need for these components range from providing a means of receiving and distributing power to the various IC systems to alerting watch standers of existing troubles within the systems. The components commonly used with main IC switchboards are ABT devices, switches, bus failure alarm units, fuses and fuse holders, lamps and lamp holders, synchro overload transformers and indicators, and power monitoring instruments.

ABT DEVICE.— The ABT device used with IC switchboards transfers the load from the preferred source of supply if it fails to an alternate source that remains energized. When the preferred source is restored, the load is then transferred back to the preferred source automatically by the ABT device. ABTs are designed for use in ac or dc, and 60- or 400-Hz systems.

ABTs may have either two or three bus transfer switch positions. Bus transfer switch positions indicate the number of power supplies the ABT is designed to handle. Two-way transfers indicate that the ABT is capable of transferring the load between two sources of power available to the ABT. The two sources are identified as normal (ship’s service) and alternate (ship’s service) or normal (ship’s service) and emergency (service).

Three-way transfers indicate that the ABT is capable of transferring the load between three sources of power available to the ABT. These three sources of power are identified as normal, alternate, and emergency. Either the normal or alternate source may be selected as the preferred source.

One of the more common ABTs used with IC switchboards is the ABT-1A2. This model operates on 120-volt, 60-Hz, single- or 3-phase systems.

The ABT-1A2 (fig. 3-6) has a control disconnect switch that allows the ABT to be operated in the manual or automatic mode. It also has a manual switch for selecting the normal or emergency power sources and a test switch.

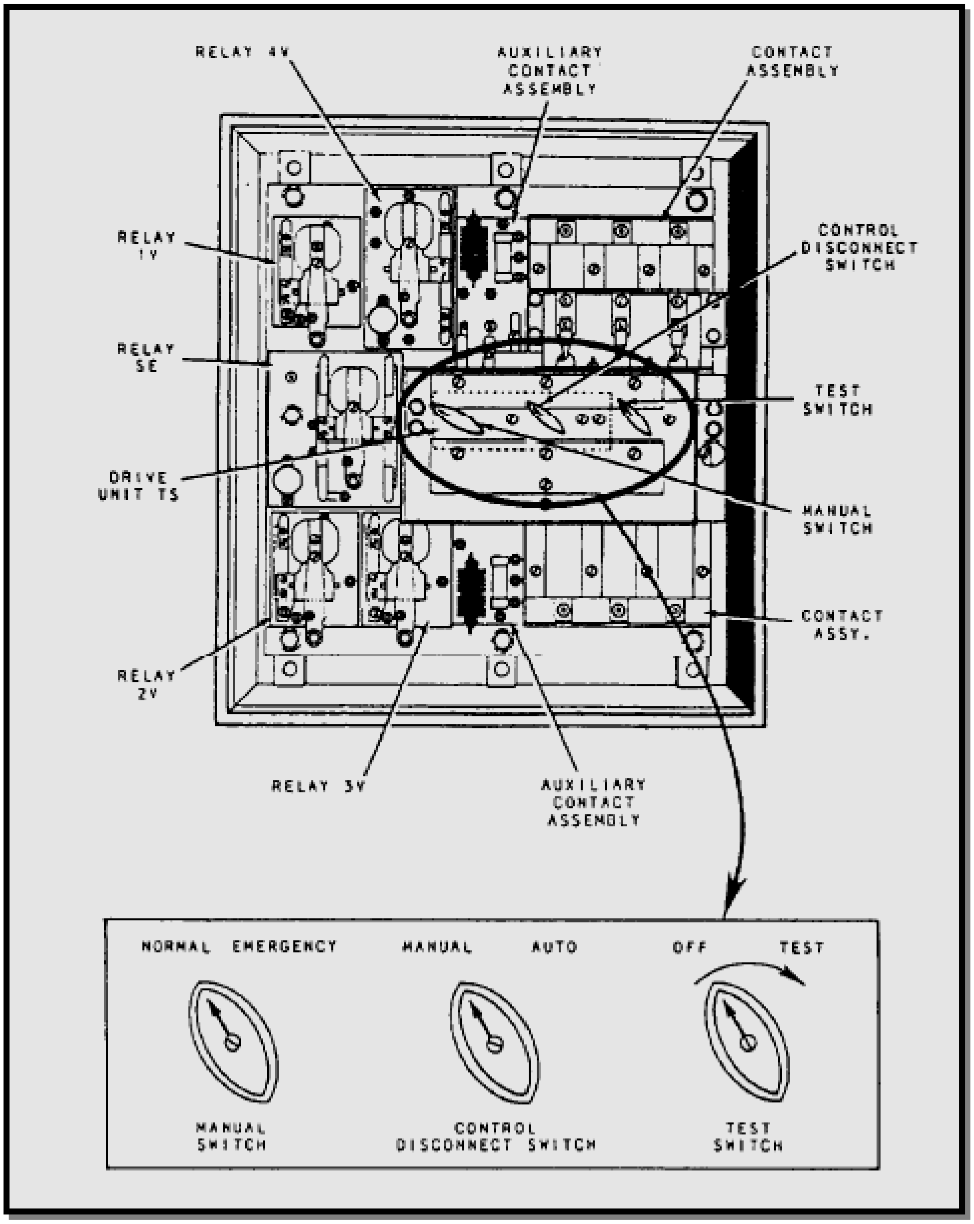


Figure 3-6.—Pictora1 view of ABT-1A2.

For purposes of explanation, the 3-phase model will be discussed. The ABT-1A2 is designed to transfer automatically from normal to emergency supply upon a decrease in voltage to within the 81- to 69-volt range across any two of its three phases in a 120-volt system. Upon restoration of the voltage to the range of 98 to 109 volts, the unit is adjusted to retransfer to the normal source of supply. An intentional time delay of 0.3 to 0.5 seconds is included in the circuitry for both transfer and retransfer. This allows for surges in line voltage and short duration losses of power.

Automatic operation (refer to fig. 3-7) is accomplished when the normal supply voltage drops to the dropout range and relays 1V, 2V, and 3V drop out. Contact 1Val opens, disconnecting relay SE. After a time delay of 0.3 to 0.5 seconds, relay SE opens, closing its SEb1 and SEb2 contacts and energizing relay 4V from the emergency source. When contact 4Val closes, it connects the emergency source to coil TS of the transfer switch, which, in turn, operates, transferring the load to the emergency source.

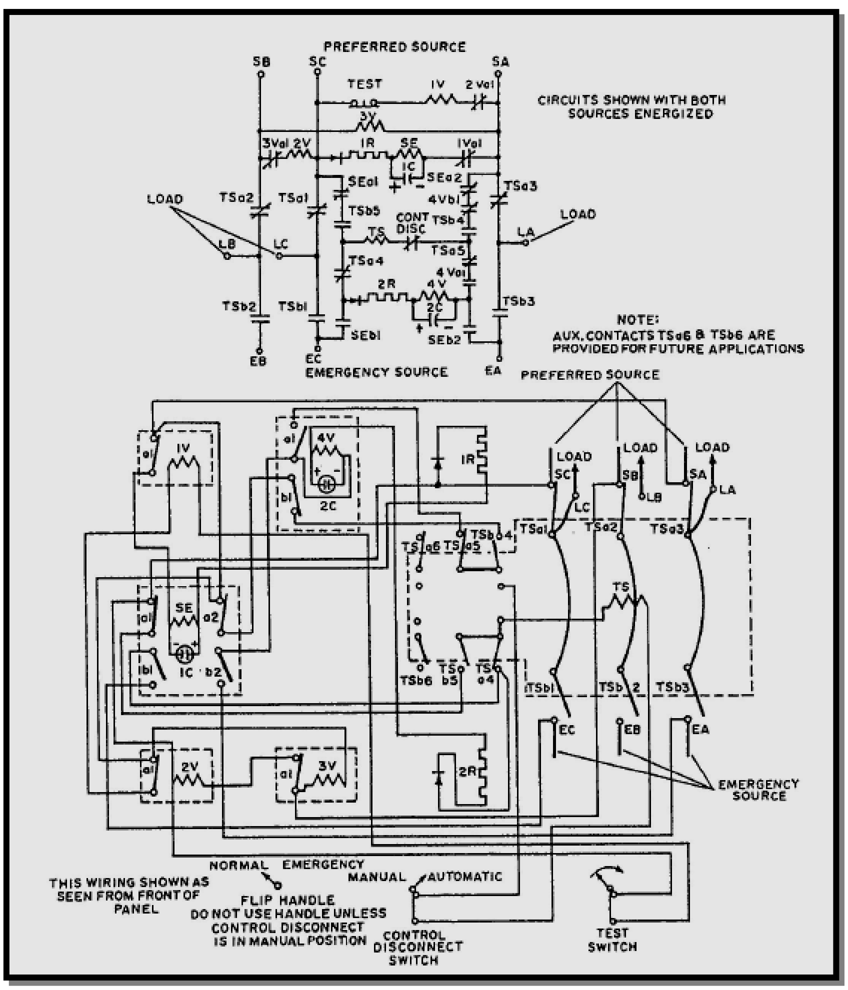


Figure 3-7.—Schematic and wiring diagram of ABT-1A2.

After a short delay, contacts TSa4 and TSa5 open, disconnecting coil TS from its operating circuit. However, TS is now being held in the operated condition mechanically. This completes the transfer to the emergency supply.

Upon restoration of the normal power to the selected range, the retransfer is begun by the energizing of relays 1V, 2V, and 3V, which close, energizing relay SE. Contacts SEb1 and SEb2 now open, disconnecting relay 4V from the emergency source. After the time delay, relay 4V opens, closing its 4Vb1 contact and completing the normal supply circuit to the transfer switch coil, TS, which again operates, transferring the load back to the normal supply.

When you put the ABT in the manual mode, you no longer have the automatic transfer capability. You may select either the normal or emergency source of power by putting the manual switch in the position desired.

The test switch is used to test the ABT for its automatic transfer capability. The control disconnect switch must be in the AUTO position when using the test switch.

SWITCHES.— The types of switches usually found on IC switchboards are the JR, JL, toggle, and rotary snap switches. These switches were discussed in chapter 2 of this manual.

3.2.3.1 Linear Switches and Switching Equipment

The new Navy Switchboards serve key functions in their operating systems on board combatant vessels. They provide power, amplify signals and route data from various data collecting systems for navigation or fire control of missiles and guns. Where computers are involved, the Computer Switching Control Panel gives command the option of selecting computers and the routing of data to the peripheral equipment.

To perform these functions, Switchboards also provide circuit protection and change voltage levels to affect compatibility between systems.

There are Switchboards for Navigation, Missile Fire Control, Director Control Room. Gun Fire Control, Command and Control, and Digital Fire Control.

These Switchboards are located in their respective functional areas. They vary in size from single section bulkhead-mounted units to a bank of deck-mounted sections. Each Switchboard is a custom installation, designed to serve the required needs of a particular type of vessel and its specific mission.

The heart of the Switchboard is the plug-in, modular linear movement switch. It replaces the rotary barrel switch. The linear switch is superior because of its distinct advantages: compact design, factory-wired and tested for immediate use, greater switching capability, and remote control. Also, the linear switch offers additional advantages such as lower cost, decreased maintenance, greater reliability and standardization for new construction and updating existing installations.

Linear Movement Switches.— These switches are assembled from four basic modules. The front module consists of the front panel, front plate and handle. The mechanism module consists of the drive gears, the Geneva driver indexing mechanism, star detent, stop screw, drive shaft and related mechanical components. The housing module serves as a support bracket to maintain the mechanical integrity of the switch assembly. The contact assembly module contains the connector terminals that are integral with the stationary plate and a linear movement plate, containing contacts that mate with those on the stationary plate. Remote-operated switches also have the drive motor assembly containing the necessary mechanisms to drive the switch and circuitry to command the motor.

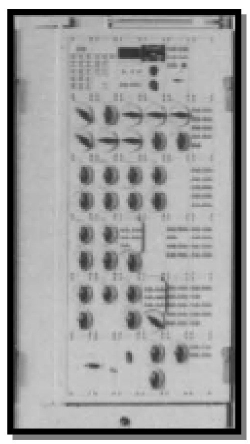


Figure 3-8.—Typical Navy System Switchboard.

Each type of linear switch offers a number of versions designed to satisfy a particular requirement. The type designation of the switch describes its basic features. It is an alphanumeric designation and is explained in the following example:

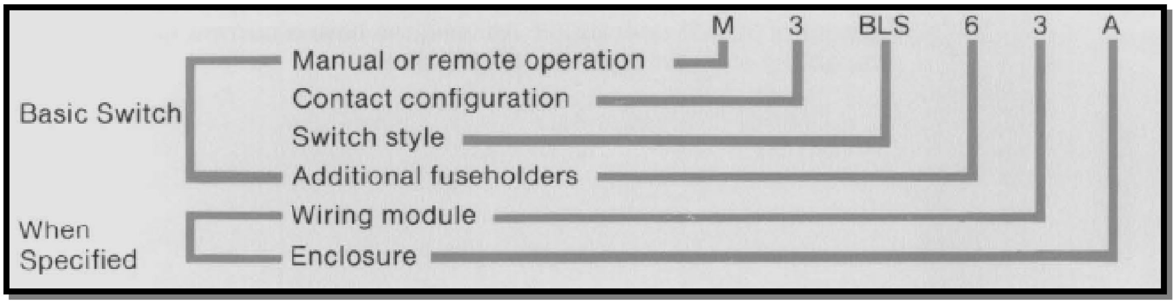


Figure 3-9.—Linear Switch Type Designation.

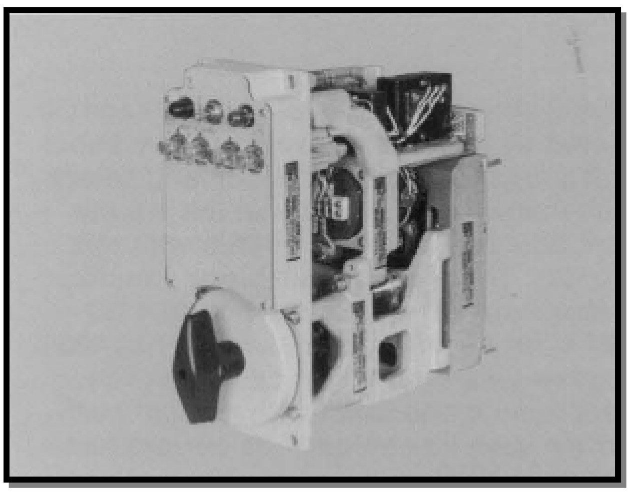


Figure 3-10.—Type LS Linear Switch.

TYPE LS. Can be remote or manually operated. It has provisions for six double fuseholders, contact module with up to 56 poles which can be switched from off to seven positions. This switch is constructed to withstand an excess of 30,000 operations. All LS versions have the capability of handling 10 amperes at 115 VAC, 60 HZ.

TYPE BLS. Offers three switching actions with up to four positions, remote operation, 98 available poles with 93 wired-load switching poles. Complying with the linear switch specification, the BLS is built to withstand an excess of 30,000 operations. It has provisions for 12 fuses in six, front-mounted double fuseholders. The current handling capability is 4 amperes at 115VAC, 60 Hz.

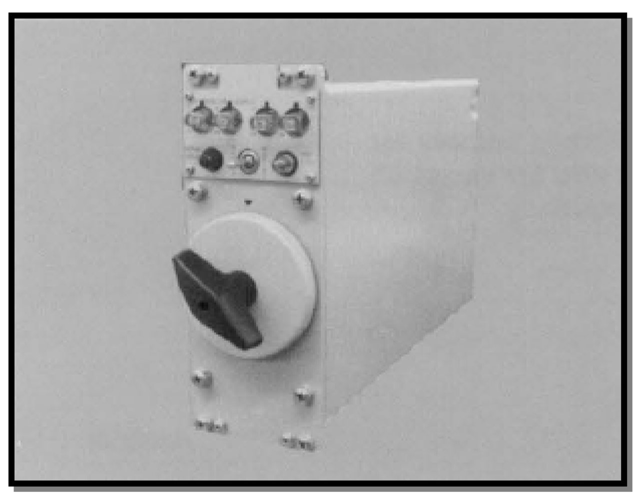


Figure 3-11.—Type BLS Linear Switch.

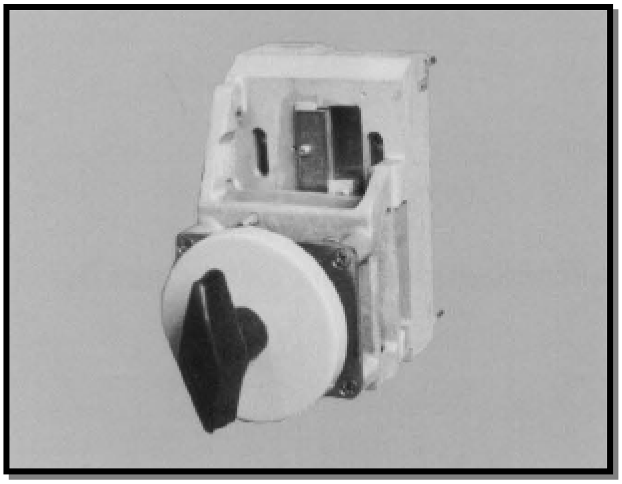


Figure 3-12.—Type CLS Linear Switch.

TYPE CLS. Has the same switching configuration as the Type LS, except that it is only available in the manual version. The CLS is ideal for installation where space is restricted.

TYPE KLS. A manual-only linear switch has up to 28 poles in four contact configurations, arranged in a combination of break-before-make and make-before-break contacts. Its reliability is also in excess of 30,000 operations. All versions have a current handling capability of 10 amperes at 115VAC, 60 Hz.

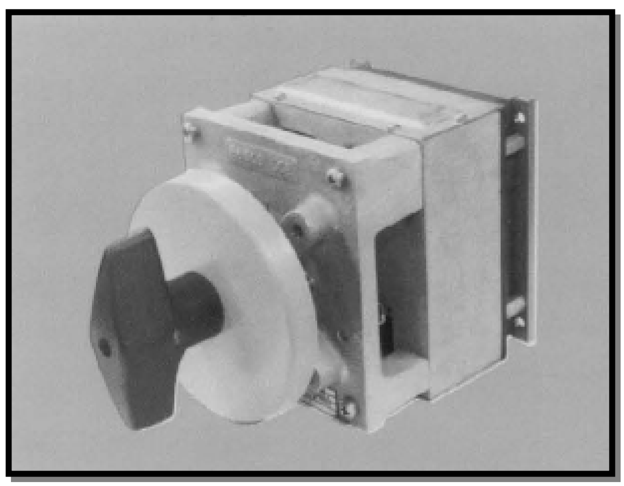
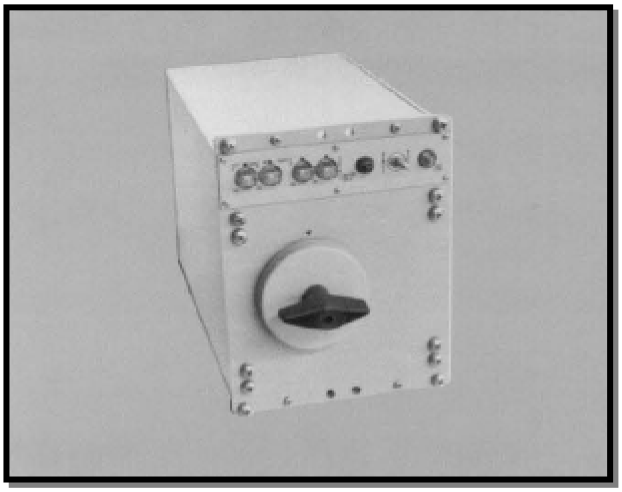


Figure 3-13.—Type KLS Linear Switch.

Figure 3-14.—Type DLS Linear Switch.



TYPE DLS. A unique linear movement switch because it is capable of switching functions required by digital data systems from shore sites and combatant ships. It provides casualty backup and select switching to Input/Output channels of digital data which are the sole communications link for data exchange between computers and their associated peripherals. The DLS is available in a number of versions, including two weatherproof versions, type R3DLSOS3A3 and type R3DLSO-S3A4, for exposed area usage. It has 160 available poles for wired-loaded switching which can be switched from three positions. It offers remote operation with manual override. Remote-operated versions have fuseholders. Its current handling capability is 2 amperes at 15 VDC.

3.2.3.2 Physical and Electrical Characteristics

Switchboards are generally made in two configurations. However, size is determined by the required number of switches and supporting panel assemblies.

SWITCHBOARDS	**LARGE SECTION**
Width	36" (91.44 cm)
Height	72" (182.88cm)
Depth	36.5"-38.5" (92.71-97.79cm)
Weight	Dependent on contents
Power Dissipation	from 50 watts

3.2.3.3 COMPUTER SWITCH CONTROL PANEL

Computer Switch Control Panel varies in size according to the Digital Switchboard it controls, and It draws its power from the Switchboard.

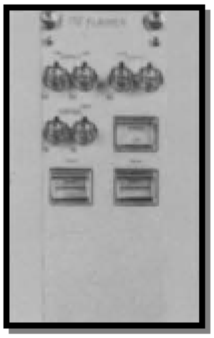
MILITARY SPECIFICATION	TYPE LS MIL-S-24187/1(SH)	TYPE BLS MIL-S-24187/2A(SH)	TYPE CLS MIL-S-24187/3A(SH)	TYPE KLS MIL-S-24187/7A(SH)	TYPE DLS MIL-S-24187/4A(SH)
DRAWING NUMBER (NAVSHIP) ELECTRICAL CHARACTERISTICS	815-1853048	803-1853221	803-4680150	803-5002990	803-4680149
Number of Poles	up to 56	98	up to 56	up to 28	up to 210
Wire Load Switching Poles	56	93	/	/	186
Number of Positions	up to 7	2 to 4	2 to 8	2 to 8	2 to 4
Break-before-make	Yes with variation	Yes	Yes with variation	Yes with variation	Yes
Make-before-break	/	No	/	/	No
ELECTRICAL RATING & ENDURANCE 10 Amp, 115V. 60 Hz. Unity p.f.	> 20,000 OP.	/	> 20,000 OP.	> 20,000 OP.	/
75 Amp, 115V 60 Hz. Unity p.f.	> 30,000 OP.	/	> 30,000 OP.	> 30,000 OP.	/
5 Amp, 50V, DC Resistive	>30,000 OP.	/	>30,000 OP.	>30,000 OP.	/
2 Amp, 115 DC Resistive	> 30,000 OP.	/	> 30,000 OP.	> 30,000 OP.	/
25 Micro Amp, 1.5V DC Resistive	>30,000 OP.	> 20,000 OP.	>30,000 OP.	>30,000 OP.	> 20,000 OP.
4 Amp, 115 VAC, Resistive	/	> 20,000 OP.	/	/	/
3 Amp, 115 VAC, 60 Hz, (0.3 p.f.)	/	> 20,000 OP.	/	/	/
3 Amp, 115 VAC, 400 Hz, (0.1 p.f.)	/	> 20,000 OP.	/	/	/
4 Amp, 28 VDC, Resistive	/	> 20,000 OP.	/	/	/
2 Amp. 15 VDC, Resistive	/	/	/	/	> 20,000 OP.
REMOTE OPERATION Transfer Time					
Minimum	15 ms	0.030 sec.			0.010 sec.
Maximum	35 ms	0.125 sec.	/	/	0.035 sec.
Actuating Time					
1 Position	0.25 sec.	0.25 sec.			0.25 sec.
7 Position (One Direction)	1.85 sec.				/
3 Position (One Direction)		1.10 sec.			1.10 sec.
Current Drain at 115V, 35Ohm. 60 Hz	1 Amp Rms per Phase	1 Amp Rms per Phase			1 Amp Rms per Phase
CONTACT RESISTANCE					
At 10 Amperes	16 milliohms	/	16 milliohms	16 milliohms	/
25 Micro Amperes	50 milliohms	/	/	/	/
4 Amperes	/	0.025 ohms	/	/	/

MILITARY SPECIFICATION	TYPE LS MIL-S-24187/1(SH)	TYPE BLS MIL-S-24187/2A(SH)	TYPE CLS MIL-S-24187/3A(SH)	TYPE KLS MIL-S-24187/7A(SH)	TYPE DLS MIL-S-24187/4A(SH)
2.5 Micro Amperes	/	0.050 ohms	50 milliohms	50 milliohms	0.050 ohms
2 Amperes	/	/	/	/	0.025 ohms
TOTAL CIRCUIT RESISTANCE					
2 Amperes	/	/	/	/	0.065 ohms
25 Micro Amperes	/	0.115 ohms	/	/	0.100 ohms
4 Amperes	/	0.080 ophms	/	/	/
PHYSICAL CHARACTERISTICS					
Torque: Shaft Rotation	Remote 50 In.-Lbs. Manual 40 In.-Lbs.	Initial 40 In.-Lbs. After Shock 40 In.-Lbs.	40 In.-Lbs.	20 ln.-Lbs.	Initial 90 In.-Lbs. After Shock 100 In.-Lbs.
Stop Strength	100 In.-Lbs.	150 In.-Lbs.	100 In.-Lbs.	100 In.-Lbs.	250In.-Lbs.
Temperature and Humidity (for Rotational Torque and Endurance Tests)					
Minimum	-20Deg F (-29Deg C)	+40Deg F (+4Deg C)	-20Deg F (-29Deg C)	-20Deg F (-29Deg C)	+40Deg F (+4Deg C)
Maximum	+149Deg F (+65Deg C)(40-50 Pcnt RH)	+149Deg F (+65Deg C)(40-50 Pcnt RH)	+149Deg F (+65Deg C)(40-50 Pcnt RH)	+149Deg F (+65Deg C)(40-50 Pcnt RH)	+149Deg F (+65Deg C)(40-50 Pcnt RH)
Temperature Rise	30Deg C	30Deg C	30Deg C	30Deg C	30Deg C
DIMENSIONS: Width	4"	4"	4"	3.75"	7.060"
Height	10"	10"	CLS-6.6" CLSA 10.0"	4.38"	9.40"
Depth	12 7/8"	up to 14.0"	9.75"	7.25"	Short 21.25" long 25.25"
Weight	Manual 8 lbs.	With wiring module 20lbs.	CLS-5 lbs.	3.25 lbs	Encl w/wiring module 40 lbs.
	Remote 14 Ibs.	w/o encl. & wiring module 14 Ibs.	CLSA-l0 Ibs.		w/o RMCL and Wiring module 30 Ibs.

Table 3-1.—Plug-In Modularized Linear Movement Switches.

3.2.3.4 Switchboard Components

BUS SELECTOR. There are two types-AC and DC. They select and route AC and DC bus voltages to their respective meter panels for measurement.



FLASHER ASSEMBLY. Used to flash system indicators when a warning or an emergency condition occurs.

Figure 3-15.

FUSE DISPENSER. Contains a series of drawers, each marked with an appropriate fuse size. The drawers are stocked with a supply of fuses of each current rating in the switchboards. The assembly is provided with a hinged access cover.

FUSE PANEL. These panels utilize the FHL 57G fuseholder, designed for circuit loads from 1 to 16 amperes and voltages up to 125VAC. A blown-fuse indicator lamp is provided for each fuse. The fuses protect all switchboard circuits that distribute power and excitation to peripheral equipment and components within the switchboard.

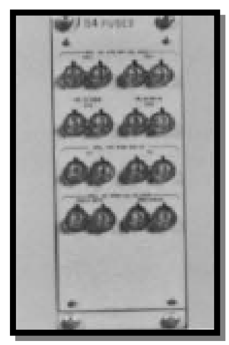
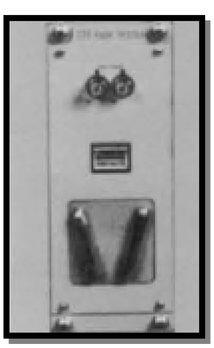
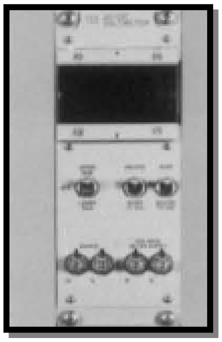


Figure 3-16.



FUSE TESTER. Used to test fuses that have current ratings above 0.05 amperes.

Figure 3-17.



METER ASSEMBLY. Contains AC and DC meters to monitor bus voltages and ground potentials within the switchboards.

Figure 3-18.

MISCELLANEOUS PANEL. Used in Digital Fire Control Switchboards. Contains the potential transformers and latching-type relays used to control the DLS switches in the switchboard. Also includes fusing for power supplied to the transformers and for the 28-volt D.C. relay supply.

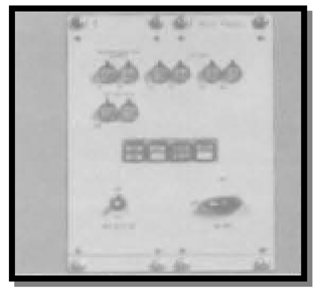
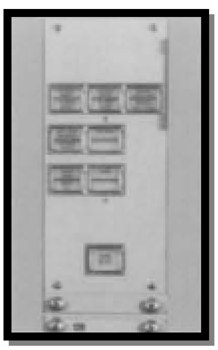


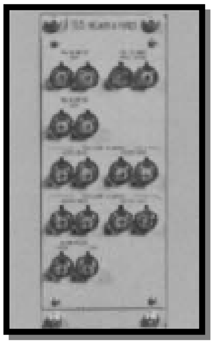
Figure 3-19.



POWER AVAILABLE INDICATOR. This unit provides a visual indication of power
supplied to the switchboard.

Figure 3-20.

RELAY PANEL. This assembly provides the switchboard with the capability to respond to external commands in order to automatically transfer data.



RELAY AND FUSE ASSEMBLY. It allows the switchboard to respond to external commands to transfer data automatically.

Figure 3-21.

RELAY TESTER. This unit permits the testing of 8- and 16-pin relays in the switchboard.

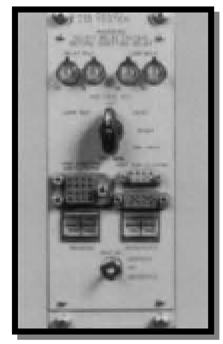
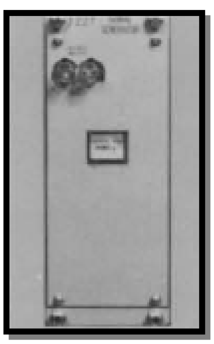


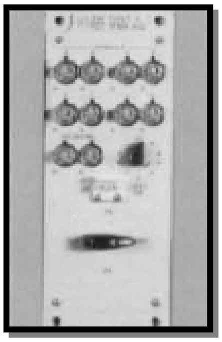
Figure 3-22.



SIGNAL GENERATOR. Used in Gun Fire Control switchboards, this unit produces audible tones at 600-Hz and 1500-Hz.and a warble frequency combing 600 and 1500 Hz. for distribution to various weapon system stations.

Figure 3-23.

SNAP SWITCH ASSEMBLY. Provides normal control of switchboard firing supply signals to the launching systems.



SWITCH CONTROL ACO AND POTENTIAL TRANSFORMER ASSEMBLY. Provides the control voltages and produces the potentials for remote control of the remote-operated switches.

Figure 3-24.

SYSTEM SETUP INDICATOR ASSEMBLY. Provides a visual indication of launcher assignment to a specific fire control system.

SYNCHRO ANGLE METER ASSEMBLY. Measures the inputs and outputs of the synchro signal converter assemblies.

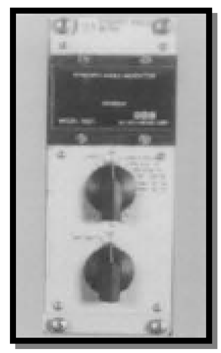


Figure 3-25.

SYNCHRO SIGNAL CONVERTER ASSEMBLY. Converts and amplifies pertinent weapon parameters for interfacing weapons systems. In navigation control switchboards, this unit amplifies pitch, roll, heading, and various velocity signals from the IC Switchboard and Data Converters.

Each switchboard panel assembly is legibly marked as to its function for rapid and positive identification.

BUS FAILURE ALARM UNIT.— The type IC/E1D1 electronic signal unit (fig. 3-26) is designed as a bus failure alarm. The unit contains an electronic solid-state oscillator, which drives a 2-inch howler unit that provides an audible signal upon loss of power on the supervised bus. A red drop flag installed on the unit provides a visual signal upon loss of power.

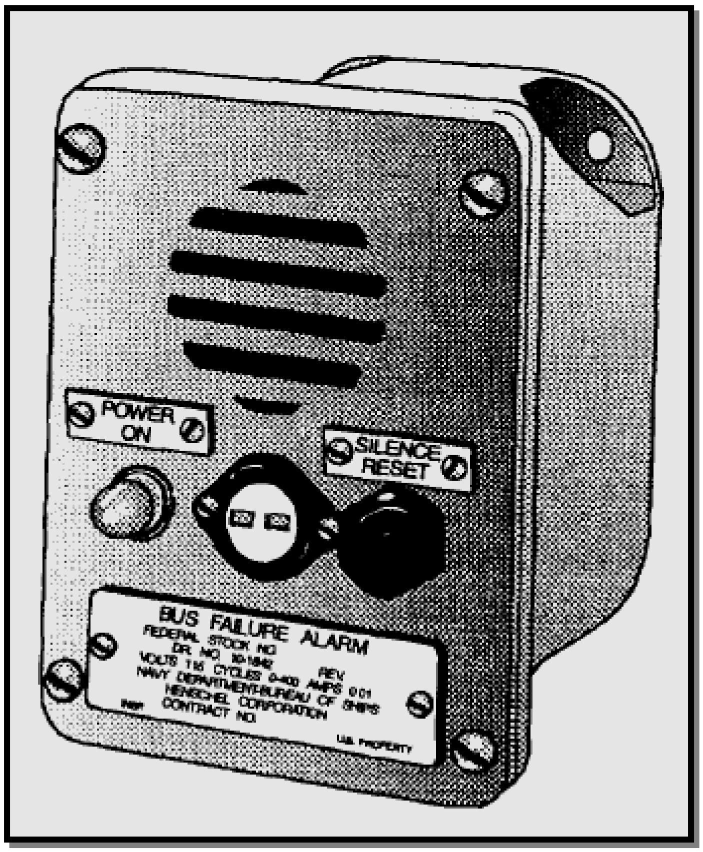


Figure 3-26.—Type IC/E1D1 electronic signal unit.

A small nickel-cadmium battery provides power for the oscillator. The battery is maintained on a low charge when the supervised bus is energized. The unit will operate on 115 volts, dc or ac, and 60 or 400 hertz without modification.

The POWER ON light, a back-lighted push button, tests the audible signal of the unit. The SILENCE RESET push button silences the alarm (the red flag will not reset until power is restored to the bus) and resets the unit when power is restored to the bus.

There is usually a bus failure alarm unit for each bus associated with the switchboard.

FUSES AND FUSE HOLDERS.— The basic type of fuse used in the IC switchboard is designated F03 plastic or ceramic with silver-plated ferrules.

The fuse holders used in IC switchboards are the dead-front blown fuse indicating type. The two basic types of fuse holders used with the F03 fuses are the FHL10U and the FHL11U.

LAMPS AND LAMP HOLDERS.— Both neon and incandescent lamps are used in the IC switchboard. Neon lamps are used as synchro overload and blown fuse indicators, and incandescent lamps are used for power indication.

Incandescent lamp holders are normally rated at 120 volts. These lamp holders use step-down transformers for ac applications or resistors for dc applications to permit use of a lower voltage rated lamp, Lamps that are rated at 120 volts are not suitable for the vibration and shock conditions encountered aboard ship.

SYNCHRO OVERLOAD TRANSFORMERS AND INDICATORS.— Synchro overload transformers and indicators are used in the ACO section of the IC switchboard to alert operating personnel of a casualty or overload in the associated circuit.

The transformers are wired in series with the secondary connections of selected synchro torque instruments. Type B and C transformers are used for 60-Hz and 400-Hz circuits, respectfully.

When the angular displacement of the synchro receiver is in excess of 17 ±3 degrees from the position of its associated transmitter, the indicator lamp connected to the transformer will glow. This displacement may be caused by an open or shorted rotor circuit, an open or shorted stator circuit, or lack of synchronism between transmitter and receiver caused by excessive bearing friction in the receiver.

When an overload indicator lamp is glowing, the cause of the malfunction should be investigated immediately and corrected as soon as possible. The switchboard operator can isolate the affected instrument from the circuit by operating the associated ACO switch. If the circuit malfunction cannot be determined, check the transformer setting. The indication may be the result of the overload transformer being set too low.

NOTE: Operation of an ACO transfer switch normally causes the associated overload indicator light to flash. This is due to a momentary displacement between the transmitter and receiver. The flash is normal and shows the system is operating properly.

POWER MONITORING INSTRUMENTS.— The power monitoring instrumentation consists of voltmeters, ammeters, and frequency meters. There are also phase selector switches for the voltmeters and the ammeters. These various meters are used to check the voltage, current, and frequency of each input power bus and the presence of grounds.

3.2.4 Watch Standing

When a ship is underway, the main IC switchboard should be manned 24 hours a day. On ships where there are two main IC switchboards, the forward main IC switchboard is usually the only one required to be manned. The IC Electrician on watch is responsible for recording hourly voltage, current, frequency, and ground readings of the various buses associated with the IC switchboard.

When checking for grounds, the watch stander should compare the readings being taken with previous readings. Unusual deviations should be investigated and the cause determined. Low voltage between any phase and ground, with high voltage between the other phases and ground, normally indicates a ground on the phase with the low-voltage reading.

The watch stander is also responsible for investigating all blown fuse indications, synchro overload indications, and bus failure alarms.

3.3.0 LOCAL IC SWITCHBOARDS

Local IC switchboards are type II, bulkhead-mounted, front-service, enclosed units. Terminal boards and an ABT are mounted inside the switchboard. Switches, fuse holders, and lamp holders are mounted on the door.

The number of local IC switchboards installed on a ship depends on the type and class of that ship. As stated earlier, local IC switchboards provide local control of circuits vital to the operation of a space. The local IC switchboards that will be discussed in this chapter are (1) engine room, (2) central control station, and (3) steering gear room. There may be other local IC switchboards installed aboard ships, depending on individual ship requirements.

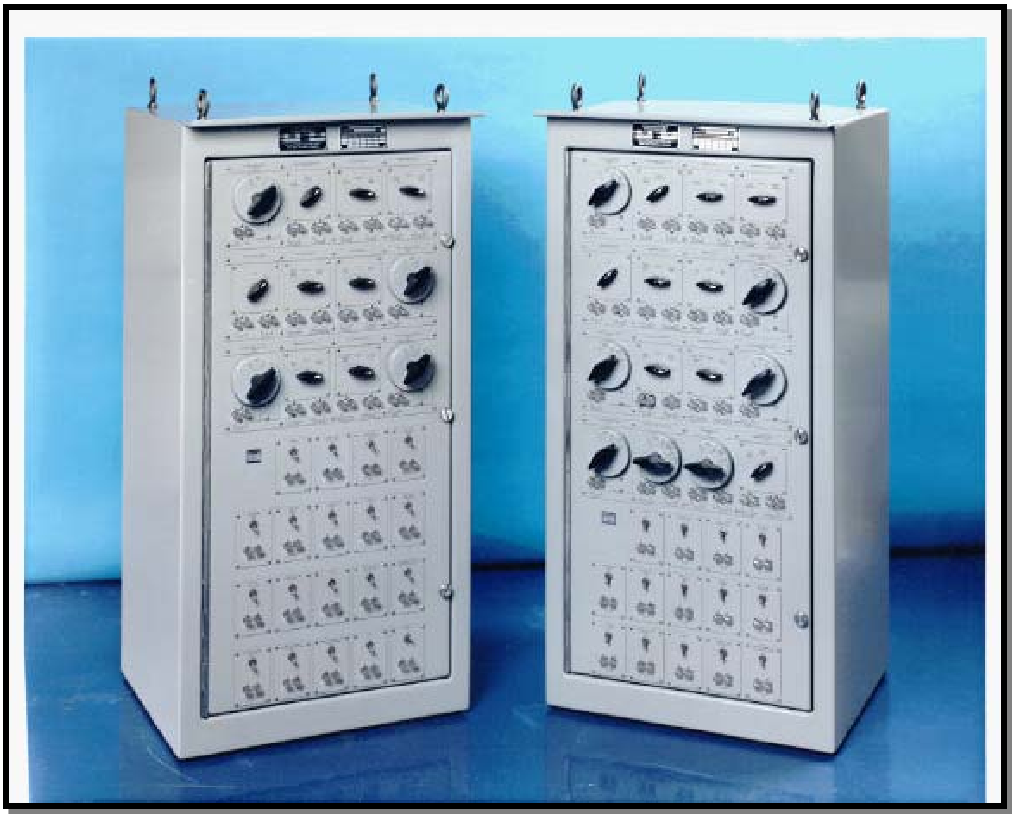


Figure 3-27.—Local IC Switchboards.

3.3.1 Engine-room Local IC Switchboard

On some ships, a local IC switchboard is provided in each engine room to energize local IC alarm, warning, and indicating systems.

The engine-room switchboard operates on 120-volt, 60-Hz, single- or 3-phase ac power, There are two sources of power available: normal and emergency. The nearest main IC switchboard provides the normal power supply, The emergency power supply comes from a local emergency lighting circuit. The emergency power supply provides the switchboard with power if the normal supply is lost. The engine-room switchboard includes supply switches, an ABT device, and power available indicator lights.

3.3.2 Central Control Station Local IC Switchboard

On ships with a central control station, a local IC switchboard is provided to energize the machinery control IC systems.

The central control station switchboard receives its normal power supply (120-volt, 60-Hz, 3-phase) from one of the ship's power panels. One of the ship's lighting panels provides the emergency supply. The switchboard also includes an ABT device, power available indicator lights, and supply switches for the various machinery control systems.

3.3.3 Steering Gear Room Local IC Switchboard

A local IC switchboard is usually installed in each steering gear room to energize all circuits associated with steering-order and rudder-angle indicator systems.

The switchboard receives its 120-volt, 60-Hz, single- or 3-phase normal input from the steering-power transfer switchboard or one of the ship's power panels located in the steering gear room. A local emergency lighting circuit provides emergency power. This switchboard includes an ABT device, power available indicator lights, supply switches, and ACO switches.

3.4.0 IC TEST SWITCHBOARDS

Dead-front IC test switchboards are installed in the IC shops on most ships to provide a means of performing operational tests and for troubleshooting IC components.

The test switchboards are normally set up to provide the following test outputs:

- 120 volts, 60 Hz, single phase
- 0 to 230 volts, 60 Hz, single phase
- 120 volts, 400 Hz, single phase
- 80 volts, 20 Hz, single phase
- 120 volts dc
- 0 to 120 volts dc

The test switchboard may also contain ac and dc voltmeters, ammeters, test jacks, test leads, lamp test sockets, a multimeter, and a fuse tester. These capabilities permit comprehensive bench testing of all types of IC equipment.

3.5.0 SWITCHBOARD MAINTENANCE

Another of your duties as an IC Electrician is the maintenance of the power distribution systems assigned to your division. Normally, the required inspections and cleaning are outlined on maintenance requirement cards (MRCs). When the inspection and cleaning is due, you often think only of the main IC switchboard. The small local IC switchboards located in the engineering spaces and the remote sections of the ship are often forgotten. Auxiliary IC panels may have their own MRCs.

Switchboard preventive maintenance will be accomplished according to the applicable MRCs. Corrective maintenance and troubleshooting will usually consist of clearing grounds, repairing open circuits, tightening loose connections, and finding the cause for blown fuses and overloads.

3.6.0 INSPECTION AND CLEANING

Loose electrical connections or mechanical fastenings have caused numerous derangements of electrical equipment. Loose connections can be readily tightened, but it requires thorough inspection to detect them. Consequently, at least once a year and during each overhaul, each switchboard, propulsion control cubicle, distribution panel, and motor controller should be de-energized for a thorough inspection and cleaning of all bus equipment. Inspection of de-energized equipment should not be limited to visual examination but should include touching and shaking electrical connections and mechanical parts to make sure that the connections are tight and mechanical parts are free to function. Where space permits, a torque wrench should be used when tightening bolts. Over-tightening can be detrimental as under-tightening. Refer to *NSTM*, chapter 075, “Fasteners,” for torquing procedures and precautions. Table 3-2 contains torque values for the more common bolt sizes used in switchboard construction. Torque values are minimum and should not be exceeded by more than 10 percent.

	Torque Requirements (ft/lb)		
Bolt Size (in)	**Steel**	**Silicone Bronze**	**Copper**
Bus Bar Bolts			
3/8	14	10	-
1/2	30	15	-
5/8	50	35	-
Circuit Breaker Studs			
3/8	-	-	7
1/2	-	-	15
5/8	50	-	-
3/4	-	-	25
1	130	-	-
1-1/8	-	-	40

Table 3-2.—Common Bolt Size Torque Values

Be certain that no loose tools or other extraneous articles are left in or around switchboards and distribution panels. Check the supports of bus work to be certain the supports will prevent contact of bus bars of opposite polarity, or contact between bus bars and grounded parts during periods of mechanical shock.

Clean the bus work and the creepage surfaces of insulating materials, and be certain that creepage distances are ample. If damaged, taped switchboard bus bars should be re-taped as necessary *NSTM*, chapter 320, "Electric Power according to Distribution Systems," Check the condition of control wiring and replace if necessary.

Bus bars and insulating materials can be cleaned with dry wiping cloths and a vacuum cleaner. Make sure the switchboard or distribution panel is completely de-energized and tagged out and remains so until the work is completed. Cleaning energized parts should be avoided because of the danger to personnel and equipment. Always observe electrical safety precautions when cleaning or working around switchboards.

Soap and water should not be used on the front panels of live front switchboards or on other panels of insulating material. Use a dry cloth.

The front panels of dead front switchboards may be cleaned without de-energizing the switchboard. These panels can usually be cleaned by wiping with a dry cloth. However, a damp, soapy cloth may be used to remove grease and fingerprints. Then, wipe the surface with a cloth dampened in clear water to remove all soap, and dry with a clean, dry cloth. The cloths used in cleaning must be wrung out thoroughly so that no water is left to squeeze out and run down the panel. Clean a small area at a time and wipe dry.

3.6.1 Rheostats and Resistors

Be certain that ventilation of rheostats and resistors is not obstructed. Replace broken or burned out resistors. Temporary repairs of rheostats can be made by bridging burned out sections when replacements are not available. Apply a light coat of petrolatum to the faceplate contacts of rheostats to reduce friction and wear. Make sure that no petrolatum is left in the spaces between the contact buttons as this may cause burning and arcing. Check all electrical connections for tightness, and wiring for frayed or broken leads. Service commutators and brushes for potentiometer-type rheostats according to instructions for the dc machines.

3.6.2 Instruments

The pointer of each should read zero (except switchboard instrument synchroscopes) when the instrument is disconnected from the circuit. The pointer may be brought to zero by external screwdriver adjustment.

CAUTION: This should not be done unless proper authorization is given.

The pointer should not stick at any point along the scale. Check instruments for accuracy whenever they have been subjected to severe shock. Repairs to switchboard instruments should be made only by the manufacturers, shore repair activities, or tenders. For detailed instructions on instruments, refer to *NSTM,* chapter 491, "Electrical Measuring and Test Instruments."

3.6.3 Fuses

Make sure that fuses are the right size and that they make firm contact with fuse clips. Ensure that lock-in devices (if provided) are properly fitted and that all fuse wiring connections are tight.

3.6.4 Control Circuits

Control circuits should be checked to ensure circuit continuity and proper relay, contactor, and indication lamp operation. Because of the many types of control circuits installed in naval ships, it is impractical to list any definite operating test procedures in this manual. In general, certain control circuits, such as those for the starting of motors or motor generator sets, or voltmeter switching circuits, are best tested by using the circuits as they are intended to operate. When testing such circuits, the precautions listed in *NSTM,* chapter 300, should be observed to guard against damage to the associated equipment.

Protective circuits, such as over-current or reverse current circuits usually cannot be tested by actual operation because of the danger to the equipment involved. These circuits should be visually checked and, when possible, relays should be operated manually to make sure that the rest of the protective circuit performs its desired functions. Exercise extreme care not to disrupt vital power service or damage electrical equipment. Reverse power relays should be checked under actual operating conditions. With two generators operating in parallel, the generator whose reverse power relay is to be checked should be made to take power from the other generator. The reverse power relay should trip the generator circuit breaker in 10 seconds or less after the reverse power relay starts to operate. If the relay fails to function, the generator circuit breaker should be tripped manually to prevent damage to the prime mover. To make a generator act as a load, it is necessary to restrict the flow of steam or fuel. This can be accomplished by reducing the speed control setting slowly until the generator begins to absorb power and act as a motor.

3.6.5 Bus Transfer Equipment

Bus transfer equipment should be tested weekly. For manual bus transfer equipment, manually transfer a load from one power source to another, and check the mechanical operation and mechanical interlocks. For semiautomatic equipment, the test should also include operation by the control push buttons. For automatic equipment, check the operation with the control switches.

The test should include operation initiated by cutting off power (opening a feeder circuit breaker) to see if an automatic transfer takes place. When testing bus transfer equipment, you should follow the same precautions given for testing circuit breakers. The tests and inspections are normally outlined on MRCs.

3.6.6 Overload Relays

During periodic inspections of motor controllers, or at least once a year, overload relays should be examined to determine that they are in good mechanical condition and that there are no loose or missing parts. The size of overload heaters installed should be checked to determine that they are of proper size as indicated by the motor nameplate current and heater rating table. Any questionable relays should be checked for proper tripping at the next availability and replaced. If necessary a description of the various types of overload relays can be found in *NSTM*, chapter 302, “Electric Motors and Controllers.”

3.6.7 Circuit Breakers, Contractors, and Relays

Circuit breakers should be carefully inspected and cleaned at least once a year and more frequently if subjected to unusually severe service conditions; that is, during ships overhaul period. A special inspection should be made after a circuit breaker has opened a heavy short circuit.

To test normally operated circuit breakers, simply open and close the breaker to check mechanical operation. For electrically operated circuit breakers, the test should be made with the operating switch or control to check both mechanical operation and control wiring. Care must be exercised during these operating tests not to disrupt any electric power supply vital to the operation of the ship, nor to endanger ship’s personnel by inadvertently starting or energizing equipment being repaired.

POWER REMOVAL.— Before working on a circuit breaker, control circuits to which it is connected should be de-energized. Drawout circuit breakers should be switched to the open position and removed before any work is done on them. Disconnecting switches ahead of fixed-mounted circuit breakers should be opened before any work is done on the circuit breaker. Where disconnecting switches are not provided to isolate fixed-mounted circuit breakers, the supply bus to the circuit breaker should be de-energized, if practical, before inspecting, adjusting, or replacing parts or doing any work on the circuit breaker. If the bus cannot be de-energized, observe the safety precautions of working on an energized circuit. These precautions can be found in *NSTM*, chapter 300.

CONTACT CLEANING.— Contacts in circuit breakers, contractors relays, and other switching equipment should be clean, free from severe pitting or burning, and properly aligned, Occasional opening and closing of contacts will aid cleaning and sealing. Remove surface dirt, dust, or grease with a clean cloth.

Silver alloy contacts should not be filed or dressed unless sharp projections extend beyond the contact surface. Such projections should be filed or dressed only to the contact surface. When cleaning and dressing contacts, maintain the original shape of the contact surface and remove as little material as possible.

CONTACT SURFACE INSPECTION.— Inspect the silver alloy contact surface for heavy burning, erosion, or overheating. If any discrepancies are found, replace the contact. Slight burning, pitting, or erosion is acceptable. Carbon deposits should be removed using a dry, lint-free cloth. Loosen deposits according to the MRC. Do not use emery cloth, a file, or sandpaper. If the contacts have deep pitting that penetrates through the contact surface or 50 percent of the contact surface, replace the contact.

CLEANING BREAKER MECHANISM SURFACES.— Clean all circuit breaker mechanism surfaces, particularly insulation surfaces, with a dry cloth or air hose. Be sure that water is blown out of the air hose, that the air is dry, and that the pressure is not over 30 lb/in2 before directing it on the breaker.

INSPECTION OF MOVING PARTS.— Inspect pins, bearings, latches, and contact and mechanism springs for excessive wear or corrosion and current carrying parts for evidence of overheating. Bolt-on parts/attachments and subassemblies may be replaced by ship's force personnel. Replacement of parts that require major disassembly or subassembly teardown must be accomplished by an overhaul facility or shipyard with circuit breaker repair capability.

OPERATIONAL CHECK.— Slowly open and close circuit breakers a few times manually, See that trip shafts, toggle linkages, latches, and all other mechanical parts operate freely and without binding. Make sure that the arcing contacts meet before and break after the main contacts. If poor alignment, sluggishness, or other abnormal condition is noted, adjust according to the technical manual for the circuit breaker.

LUBRICATION.— Lubricate bearing points and bearing surfaces, including latches, with a drop or two of light machine oil. Wipe off excess oil.

FINAL INSPECTION AND INSULATION RESISTANCE CHECK..— Before returning a circuit breaker to service, inspect all mechanical and electrical connections, including mounting bolts and screws, drawout disconnect devices, and control wiring. Tighten where necessary. Give final cleaning with a cloth or compressed air. Operate manually to make sure that all moving parts function freely. Check insulation resistance.

SEALING SURFACE.— Sealing surfaces of circuit breaker, contactor, and relay magnets should be kept clean, and relay magnets should be kept clean and free from rust. Rust on the sealing surfaces decreases the contact force and may result in overheating of the contact tips. Loud humming or chattering will frequently warn of this condition. Light machine oil wiped sparingly on the sealing surfaces of the contactor magnet will aid in preventing rest.

USE OF OIL.— Oil should always be used sparingly on circuit breakers, contractors, motor controllers, relays, and other equipment, and should not be used at all unless there are specific instructions to do so or oil holes are provided. If working surfaces or bearings show signs of rust, the device should be disassembled and the rusted surface carefully cleaned. Light oil may be wiped on sparingly to prevent further rusting. Oil has a tendency to accumulate dust and grit, which may cause unsatisfactory operation of the device, particularly if the device is delicately balanced.

ARC CHUTE MAINTENANCE.— Arc chutes should be cleaned by scraping with a file if wiping with a cloth is not sufficient. Replace or provide new linings when they are broken or burned too deeply. See that arc chutes are securely fastened and that there is sufficient clearance to ensure that no interference occurs when the switch or contactor is opened or closed.

FLEXIBLE PARTS.— Shunts and flexible connectors that are flexed by the motion of moving parts should be replaced when worn, broken, or frayed.

3.6.8 Adjacent Installations

Inspections should not be confined to switchboard and distribution panels, but should also include adjacent installations, which may cause serious casualties. Rubber matting, located near switchboards, should be inspected for signs of deterioration, such as cracks in the material and separation at the seams. Ventilation opening located to permit water to discharge onto electrical equipment, insufficient insulation overhead to prevent sweating, need for drip-proof covers and spray shields, and location of water piping and flanges where leakage could spray onto switchboards and other gear are examples of installations that could cause casualties. Action should be initiated to have unsatisfactory conditions corrected.

3.6.9 Distribution Boxes

Wiring distribution boxes (fused), with and without switches that feed vital circuits should be checked annually. Tighten fuse clip barrel nuts and terminal connections. On anew ship and after a major overhaul, tighten and prick punch loose bus bar nuts on the backs of insulating bases.

The phosphor-bronze fuse clip and supplementary bent-wire fuse retainer have been superseded by a steel copper-clad silver-plated fuse clip. The steel fuse clips do not require fuse retainers to prevent dislodgement of fuses under shock and vibration. The wire fuse retainers impose a hazard of possible accidental dislodgement and falling into bus work to cause short circuits. To eliminate this hazard on both vital and nonvital circuits that require frequent removal of fuses, and where difficulties occur with loosening of existing phosphor-bronze fuse clips and wire fuse retainers, steel copper-clad silver-plated fuse clips should be used. Do not remove the wire retainers until the new steel fuse clips are on board for substitution. Tighten the fuse-clip barrel nut until the arch in bottom of the steel fuse clip is drawn flat.

3.6.10 Emergency Switchboards

Emergency switchboards should be tested regularly, according to the instructions on the switchboard, to check the operation of the ABT equipment and the automatic starting of the emergency generator.

All other preventive maintenance should be performed according to the applicable PMS card. Remember, when you are conducting tests or troubleshooting equipment, the first thing you should do is consult your PMS schedule. By doing this, you will find information to assist you.

3.7.0 MOTOR CONTROLLERS

By definition, a motor controller is a device (or set of devices) that serves to govern, in some predetermined manner, the operation of the dc or ac motor to which it is connected. Preventive maintenance of motor controllers should be accomplished while consulting the applicable PMS card. Troubleshooting and corrective maintenance of motor controllers is discussed in depth in *Interior Communications Electrician*, volume 2, NAVEDTRA 14121A.

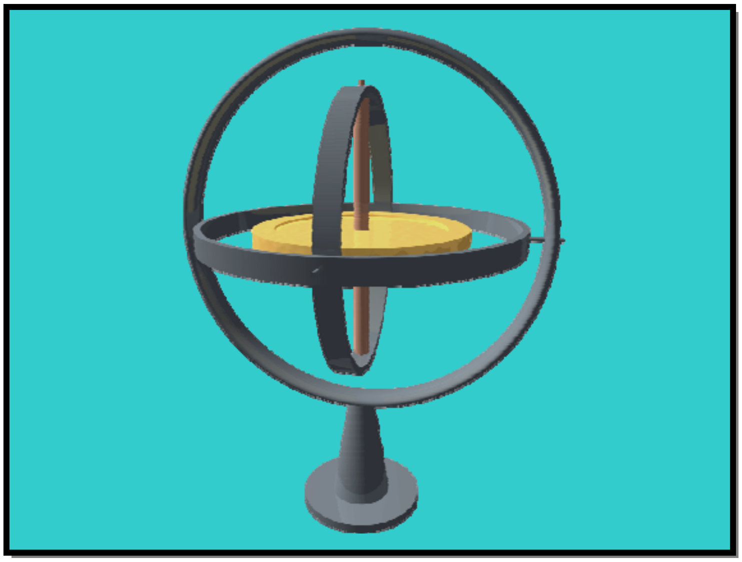
3.8.0 SUMMARY

In this chapter, we have discussed the ship’s service, emergency, and casualty Power distribution systems found on board Navy ships and their importance in supplying power to the IC switchboards and various IC systems.

We have discussed the main and local IC switchboards used to supply power to IC systems, the components associated with the switchboards, and switchboard maintenance. We have identified IC systems by their classification and described a typical IC test switchboard installed in IC shops for bench testing IC equipment.

The information covered in this chapter does not include the necessary specifications or the specific procedures for repair and maintenance of each piece of equipment you will encounter. This information can only be obtained from the appropriate *NSTM* and the manufacturers' technical manuals.

4 GYROCOMPASS SYSTEMS



Upon completion of this chapter, you will be able to do the following:

- Discuss basic gyroscopic and gyrocompass theory.
- Identify the major components of the Mk 23 gyrocompass systems, and explain the procedures for starting, standing watch on, and securing the Mk 23 gyrocompasses.
- Identify the major components of the Mk 27 gyrocompass system, and explain the procedures for starting, standing watch on, and securing the Mk 27 gyrocompass.
- Identify the major components of the AN/WSN-2 stabilized gyrocompass set, and explain the procedures for starting, standing watch on, and securing the AN/WSN-2 stabilized gyrocompass set.
- Explain the purpose of the synchro signal amplifier used with the various gyrocompass systems.
- Explain the purpose of the ship's course indicators used with the various gyrocompass systems.
- Describe the entries to be made in the engineering logs, and the deck and watch logs to be kept when standing watch on gyrocompass systems.

4.0.0 INTRODUCTION

The ship's gyrocompass and its associated equipment is an important part of an IC Electrician's responsibility. Gyrocompass systems provide information that is used for remote indicators and various navigational, radar, sonar, and fire control systems throughout a ship. As an IC3, you will be responsible for starting, standing watch on, and securing the ship's gyrocompass.

To understand how a gyrocompass operates, you should be familiar with gyroscopic and gyrocompass theory. A variety of gyrocompasses are presently in use throughout the Navy. In this chapter, we will discuss basic gyroscopic principles, and then we will develop the basic gyroscope into a basic gyrocompass. We will then discuss the operation of some of the more common gyrocompass systems installed on board Navy ships today.

We will also discuss the associated equipment used in conjunction with the gyrocompass systems. The topics include descriptions of the components and functions of the master compass, gyro control systems, follow-up systems, alarm systems, and starting control systems. In addition, we will also point out the significant differences among the various modifications and provide procedures for operating the gyrocompass in normal and auxiliary modes.

4.1.0 THE FREE GYROSCOPE

A free gyroscope is a universal-mounted, spinning mass. In its simplest form, the universal mounting is a system that allows three degrees of freedom of movement. The spinning mass is provided by a heavy rotor. Figure 4-1 illustrates a free gyroscope. As you can see in the figure, the rotor axle is supported by two bearings in the horizontal ring. This ring is supported by two studs mounted in two bearings in the larger vertical ring. These two rings are called the inner gimbal and outer gimbal, respectively. The outer gimbal is then mounted with two studs and bearings to a larger frame called the case.

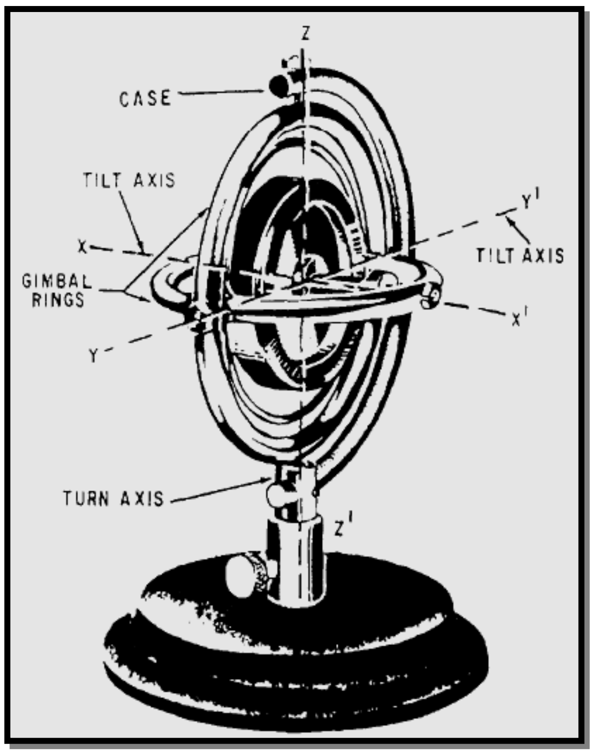


Figure 4-1.—The gyroscope.

The rotor and both gimbals are pivoted and balanced about their axes. The axes (marked X, Y, and Z) are perpendicular to each other, and they intersect at the center of gravity of the rotor. The bearings of the rotor and two gimbals are essentially frictionless and have negligible effect on the operation of the gyroscope.

4.2.0 THREE DEGREES OF FREEDOM

As you can see in figure 4-1, the mounting of the gimbals allows movement in three separate directions, or three degrees of freedom: (1) freedom to spin, (2) freedom to tilt, and (3) freedom to turn. The three degrees of freedom allow the rotor to assume any position within the case. The rotor is free to spin on its own axis, or the X axis, the first degree of freedom. The inner gimbal is free to tilt about the horizontal or Y axle, the second degree of freedom. The outer gimbal ring is free to turn about the vertical or Z axis, the third degree of freedom.

4.3.0 GYROSCOPIC PROPERTIES

When a gyroscope rotor is spinning, it develops two characteristics, or properties, that it does not possess when at rest: rigidity of plane and precession. These two properties make it possible to convert a free gyroscope into a gyrocompass.

4.3.1 Rigidity of Plane

When the rotor of the gyroscope is set spinning with its axle pointed in one direction (fig. 4-2, view A), it will continue to spin with its axle pointed in that direction, no matter how the case of the gyroscope is positioned (fig. 4-2, view B). As long as the bearings are frictionless and the rotor is spinning, the rotor axle will maintain its plane of spin with respect to a point in space. This property of a free gyroscope is termed *rigidity of plane.*

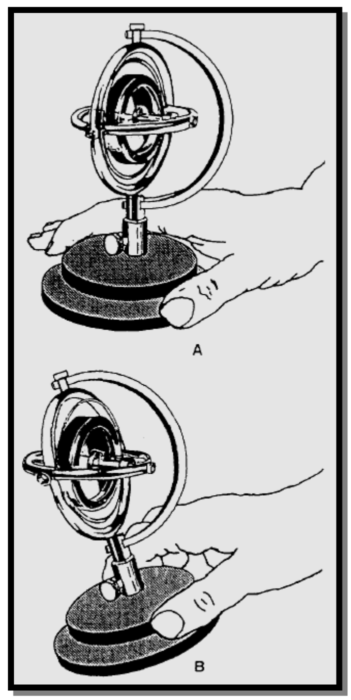


Figure 4-2.—Rigidity of plane of a spinning gyroscope.

Newton’s first law of motion states that a body in motion continues to move in a straight line at a constant speed unless acted on by an outside force. Any point in a spinning wheel tries to move in a straight line but, being a part of the wheel, must travel in an orbit around its axle. Although each part of the wheel is forced to travel in a circle, it still resists change. Any attempt to change the alignment or angle of the wheel is resisted by both the mass of the wheel and the velocity of that mass. This combination of mass and velocity is the kinetic energy of the wheel, and kinetic energy gives the rotor rigidity of plane. *Gyroscopic inertia* is another term that is frequently used interchangeably with rigidity of plane.

A gyroscope can be made more rigid by making its rotor heavier, by causing the rotor to spin faster, and by concentrating most of the rotor weight near its circumference. If two rotors with cross sections like those shown in figure 4-3, are of equal weight and rotate at the same speed, the rotor in figure 4-3, view B, will have more rigidity than the rotor in figure 4-3, view A. This condition exists because the weight of the rotor in figure 4-3, view B, is concentrated near the circumference. Both gyroscope and gyrocompass rotors are shaped like the rotors shown in figure 4-3, view B.

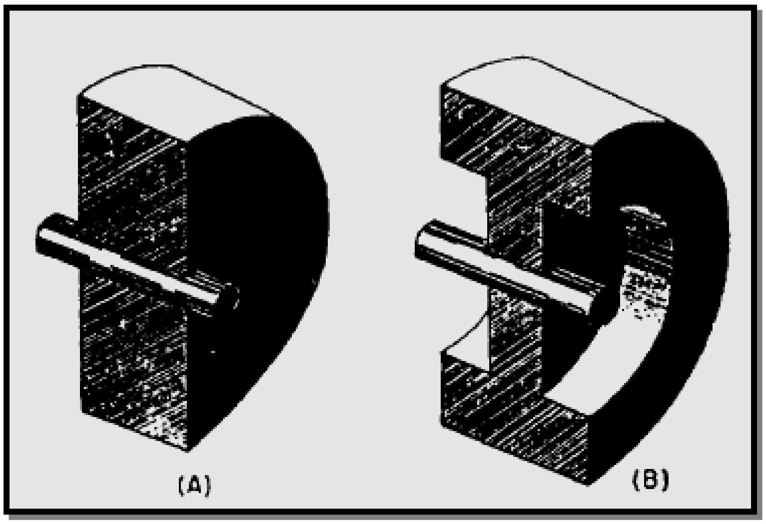


Figure 4-3.—Weight distribution in rotors.

4.3.2 Precession

Precession describes how a gyro reacts to any force that attempts to tilt or turn it. Though vector diagrams can help explain why precession occurs, it is more important to know how precession affects gyro performance.

The rotor of a gyro has one plane of rotation as long as its axle is aligned with, or pointed at, one point in space. When the axle tilts, turns, or wobbles, the plane of rotation of the rotor changes. Plane of rotation means the direction that the axle is aligned or pointed.

Torque is a force that tends to produce rotation. Force acts in a straight line, at or on a point. Torque occurs within a plane and about an axle or axis of rotation. If the force acts directly on the point of an axis, no torque is produced.

Because of precession, a gyro will react to the application of torque by moving at right angles to the direction of the torque. If the torque is applied downward against the end of the axle of a gyro that is horizontal, the gyro will swing to the right or left in response. The direction in which it will swing depends on the direction the rotor is turning.

A simple way to predict the direction of precession is shown in figure 4-4. The force that tends to change the plane of rotation of the rotor is applied to point A at the top of the wheel. This point does not move in the direction of the applied force, but a point displaced 90° in the direction of rotation moves in the direction of the applied force. This results in the rotor turning left about the Z axis and is the direction of precession.

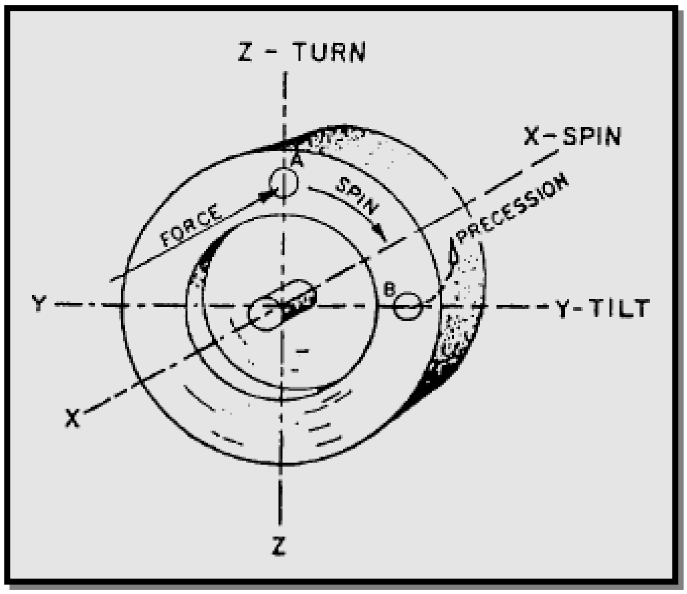


Figure 4-4.—Direction of precession.

Any force that tends to change the plane of rotation causes a gyroscope to precess. Precession continues as long as there is a force acting to change the plane of rotation, and precession ceases immediately when the force is removed. When a force (torque) is applied, the gyroscope precesses until it is in the plane of the force. When this position is reached, the force is about the spinning axis and can cause no further precession.

If the plane in which the force acts moves at the same rate and in the same direction as the precession it causes, the precession will be continuous. This is illustrated by figure 4-5, in which the force attempting to change the plane of rotation is provided by a weight, W, suspended from the end of the spin axle, X. Although the weight is exerting a downward force, the torque is felt 90° away in the direction of rotation. If the wheel rotates clockwise, as seen from the weighted end, precession will occur in the direction of arrow P.

As the gyroscope precesses, it carries the weight around with it so that forces F and F1 continuously act at right angles to the plane of rotation, and precession continues indefinitely. In other words, the rotor will turn to the right and continue turning until the weight is removed.

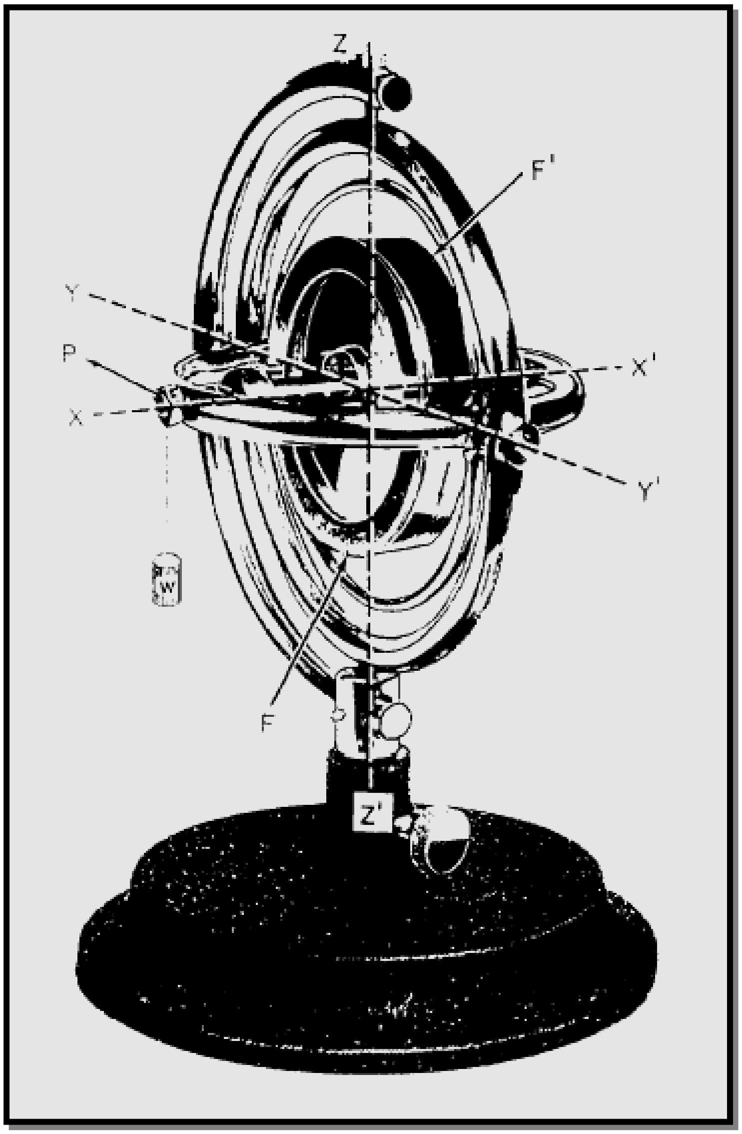


Figure 4-5.—Continuous precession.

4.4.0 FORCE OF TRANSLATION
Any force operating through the center of gravity of the gyroscope does not change the angle of the plane of rotation but moves the gyroscope as a unit without changing its position in space. Such a force operating through the center of gravity is known as a force of translation. Thus, the spinning gyroscope may be moved freely in space by means of its supporting frame, or case, without disturbing the plane of rotation of the rotor. This condition exists because the force that is applied through the supporting frame acts through the center of gravity of the rotor and is a force of translation. It produces no torque on the gyro rotor.

4.5.0 EFFECT OF EARTH'S ROTATION
As just explained, a free-spinning gyroscope can be moved in any direction without altering the angle of its plane of rotation. If this free-spinning gyroscope is placed on the earth's surface at the equator, with its spinning axis horizontal and aligned east and west, an observer in space below the South Pole would note that the earth rotates clockwise from west to east and carries the gyroscope along. As the earth rotates, rigidity of plane keeps the gyroscope wheel fixed in space and rotating in the same plane at all times. Figure 4-6 shows how this gyroscope would appear. Assume that the gyroscope is set spinning at 0000 hours with its spinning axis aligned east and west and parallel to the earth's surface. At 0600, 6 hours after the gyroscope was started, the earth has rotated 90° and the axle of the gyroscope is aligned with the original starting position. At 1200 the earth has rotated 180°, while the gyroscope returns to its original position. The figure shows how the gyro completes a full cycle in a 24-hour period.

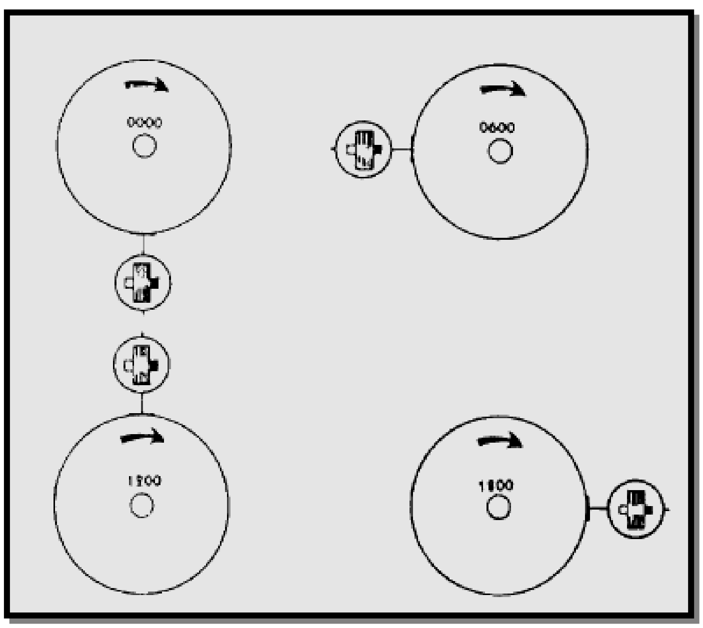


Figure 4-6.—Free gyroscope at the equator viewed from space.

4.6.0 APPARENT ROTATION OF THE GYROSCOPE

An observer on the earth's surface does not see the operation of the gyro in the same way as an observer in space does. On the earth, the gyro appears to rotate, while the earth appears to stand still. As the earth rotates, the observer moves with it, so the gyroscope seems to rotate around its horizontal axis. The effect the observer sees on the earth is called apparent rotation and also is referred to as the horizontal earth rate effect. If the gyro were started with its axle vertical at one of the earth's poles, it would remain in that position and produce no apparent rotation around its horizontal axis. Figure 4-7 illustrates the effect of apparent rotation at the equator, as seen over a 24-hour period.

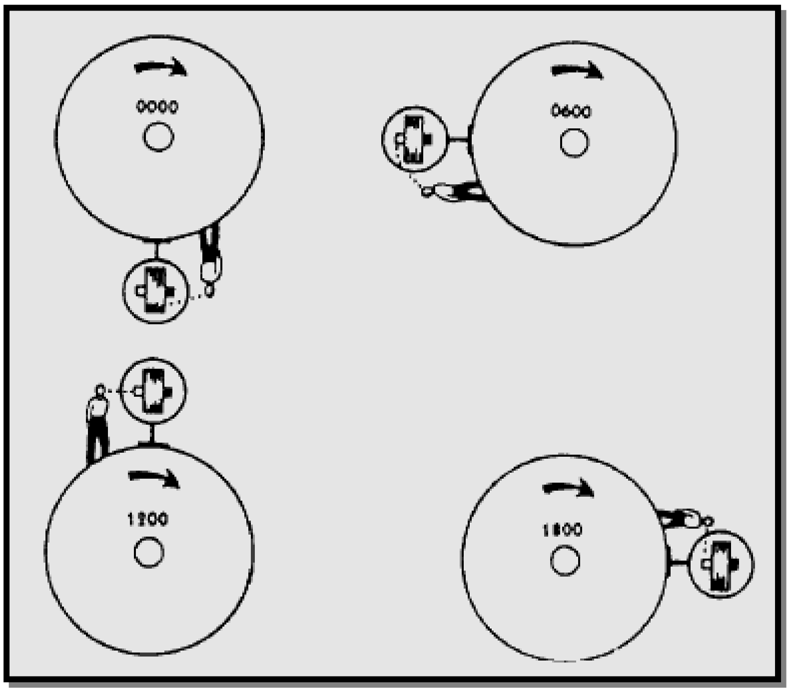


Figure 4-7.—Free gyroscope at the equator viewed from the earth's surface.

Now assume that the spinning gyroscope, with its spinning axis horizontal, is moved to the North Pole (fig. 4-8). To an observer on the earth's surface, the gyroscope appears to rotate about its vertical axis. To an observer in space, the gyroscope axle appears to remain fixed, and the earth appears to rotate under it. This apparent rotation about the vertical axis is referred to as vertical earth rate effect. It is maximum at the poles and zero at the equator.

When the gyroscope axle is placed parallel to the earth's axis at any location on the earth's surface, the apparent rotation is about the axle of the gyroscope and cannot be observed. At any point between the equator and either pole, a gyroscope whose spinning axis is not parallel to the earth's spinning axis has an apparent rotation that is a combination of horizontal earth rate and vertical earth rate.

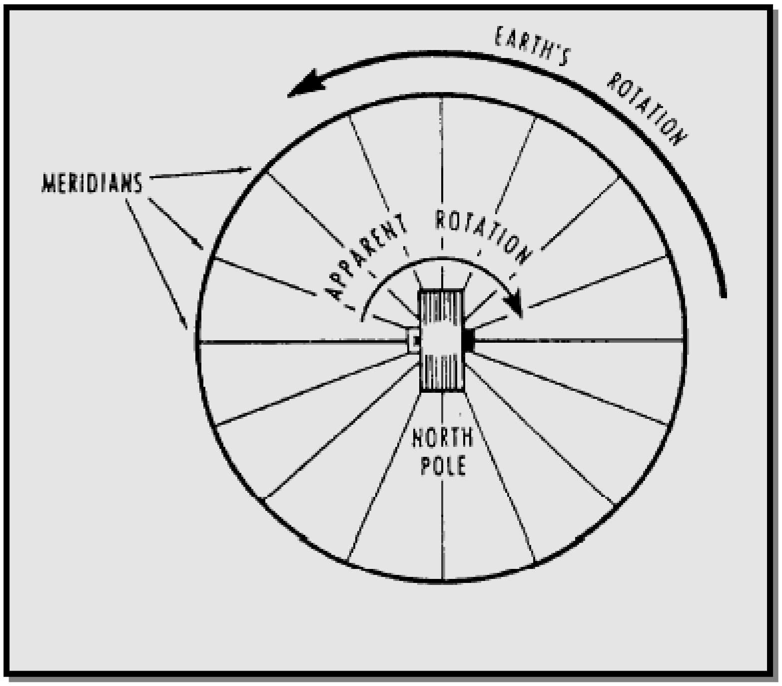


Figure 4-8.—Apparent rotation of a gyroscope at the North Pole.

The combined earth rate effects at this point make the gyro appear to rotate partly about the horizontal axis and partly about the vertical axis. The horizontal earth rate causes the gyro to tilt, whereas the vertical earth rate causes it to turn in azimuth with respect to the earth. The magnitude of rotation depends on the latitude of the gyro.

Apparent rotation is illustrated by placing a spinning gyroscope with its axle on the meridian (aligned north-south) and parallel to the earth's surface at 45° north latitude and 0° longitude (fig. 4-9).

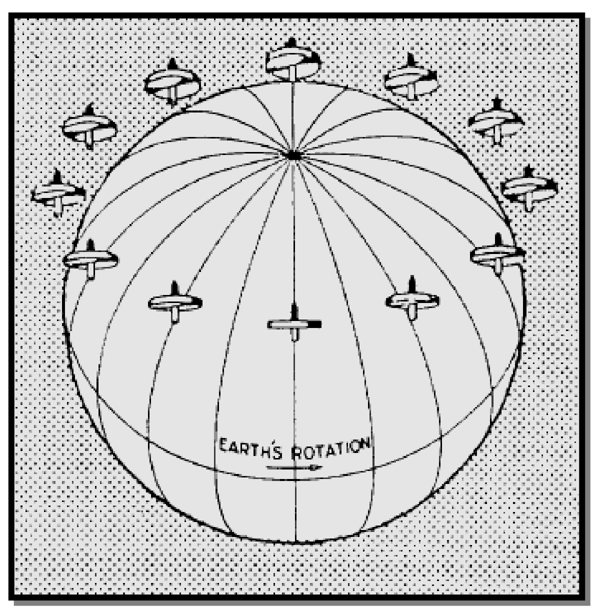


Figure 4-9.—Apparent rotation of a gyroscope at 45°N latitude.

A gyroscope, if set on any part of the earth's surface with the spinning axle not parallel to the earth's polar axis, appears to rotate, over a 24-hour period, about a line passing through the center of the gyroscope and parallel to the earth's axis. This apparent rotation is in a counterclockwise direction when viewed from south to north. The path that the north axle describes in space is indicated by the line EAWB back to E (fig. 4-10).

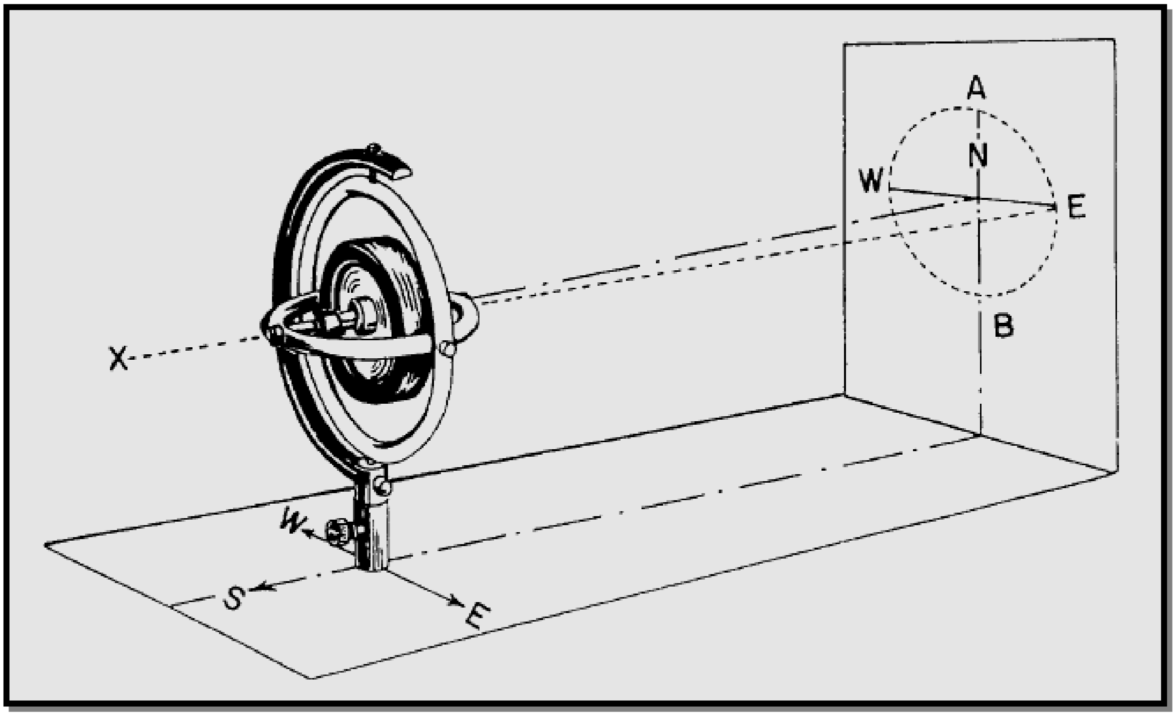


Figure 4-10.—Path of the spinning axis of a free gyroscope.

The effect of the earth's rotation causes the north end of the gyroscope axle to rise when east of the meridian and to fall when west of the meridian in any latitude. This tilling effect provides the means by which the gyroscope can be made into a north-seeking instrument.

4.7.0 MAKING THE GYROSCOPE INTO A GYROCOMPASS

Up to this point, we have discussed the basic properties of a free gyroscope. Now, we will discuss how we use these properties, rigidity of plane and precession, to make a gyroscope into a gyrocompass. The first step in changing the gyroscope to a gyrocompass is to make a change in the suspension system. The inner gimbal that holds the gyro rotor is modified by replacing it within a sphere or case (fig. 4-11, view A), a necessary feature that protects the rotor. A vacuum is formed inside the sphere to reduce air friction on the spinning rotor. The next step is to replace the simple gyroscopic hose with what is called a phantom ring (fig. 4-11, view A). The difference between the simple base and the phantom is that the phantom is turned by a servomechanism to follow the horizontal plane of the rotor's axle, while the simple base remains fixed in its position. The phantom ring allows the outer gimbal (vertical ring) (fig. 4-11, view A) the freedom to turn and to tilt. These modifications enable the gyroscope to maintain its plane of rotation as long as it spins and nothing touches it. We have modified the basic suspension system to enable us to convert the gyroscope to a gyrocompass. Now, we must make it seek out and point to true north. For the purposes of this explanation, true north is the direction along the meridian from the point of observation to the North Pole.

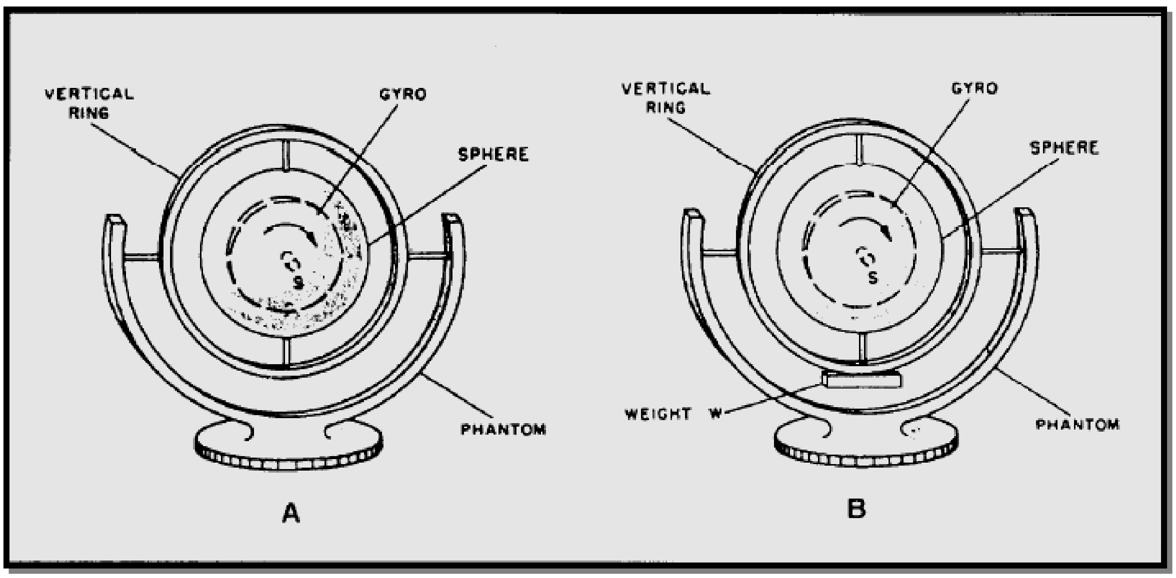


Figure 4-11.—A. Simple gyroscope. B. Modified gyroscope.

To become a gyrocompass, a gyro must be modified so it can:

1. align its axis on the meridian plane,

2. align its axis nearly horizontal, and

3. maintain its alignment both horizontally and on the meridian, once it is attained.

In figure 4-11, view B, a weight (pendulous weight) has been added to the bottom of the vertical ring, which makes it bottom heavy, or pendulous. The weight exerts a force on the gyro whenever the rotor is not level with the earth's surface.

In previous discussion, we talked about precession and vertical and horizontal earth rates. Now, we will see how we use the apparent rotation of the gyro rotor to make the modified gyroscope north-seeking. In figure 4-12, point A, the gyro axle is parallel to the earth's surface; however, as the earth rotates, the earth rate effect causes the gyro rotor axle to tilt in relation to the earth's surface, and the weight that we attached to the bottom of the vertical ring now applies a force to the bottom of the gyro. As we discussed earlier, precession occurs in the direction of rotation, but 90° away from the point of application; therefore, the weight applies a force to the bottom of the gyro but is felt about its horizontal axis, which causes the gyro to turn. As the gyro turns, the phantom follows the rotor axle. As you follow the gyro through one rotation on the earth's surface, you can see that the gyro rotor follows an elliptical path around the meridian. It actually points north twice in the ellipse; in other words, it has become north-seeking. The period of oscillation is actually much less than the 24 hours required of an unmodified gyro; the actual time is determined by the speed and weight of the rotor and the size of the pendulous weight. The next step, logically, is to make the north-seeking gyroscope north-indicating.

As you have seen, we made the gyroscope north-seeking by adding a pendulous weight, which caused the gyroscope to oscillate about north. To make it north-indicating, we must somehow dampen these oscillations. To do this, we must add another smaller weight, Wz, on the cast side of the rotor. Both weights, W and W1, influence the gyro when it is not aligned with the meridian (fig. 4-13).

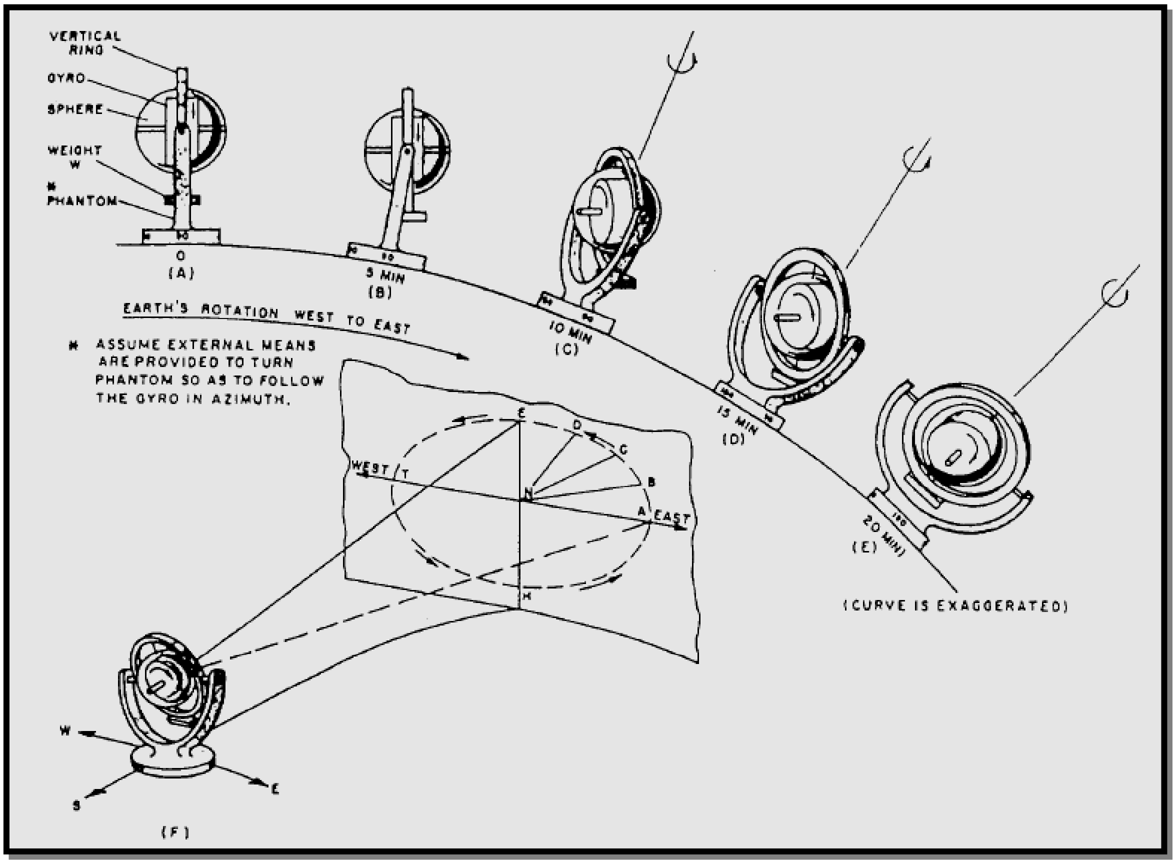


Figure 4-12.—Effect of weight and earth's rotation on the gyroscope.

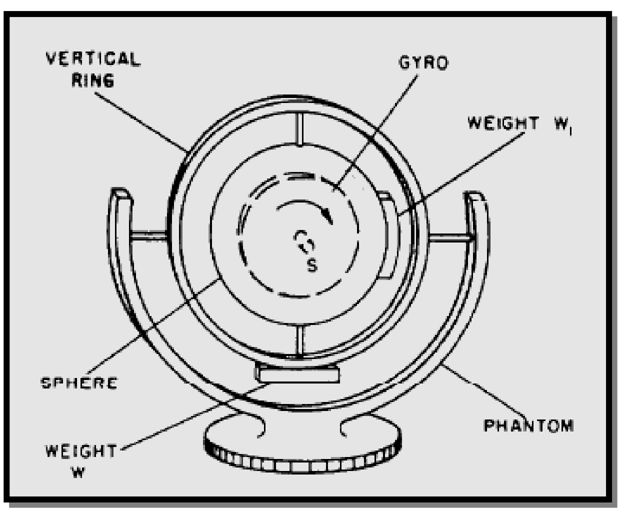


Figure 4-13.—Gyroscope with weights on the vertical ring and sphere.

When the gyro is started while pointed away from the meridian, the effect of earth rate causes it to tilt. As soon as it tilts, weight W causes precession; however, now the smaller weight, W1, also causes the gyro to precess towards a more level position, which limits the effect of precession caused by weight W. The excursions from level continue, but the dampening effect of weight W1 causes each successive oscillation to be reduced; the path of the rotor axle then will be spiral shaped (fig. 4-14).

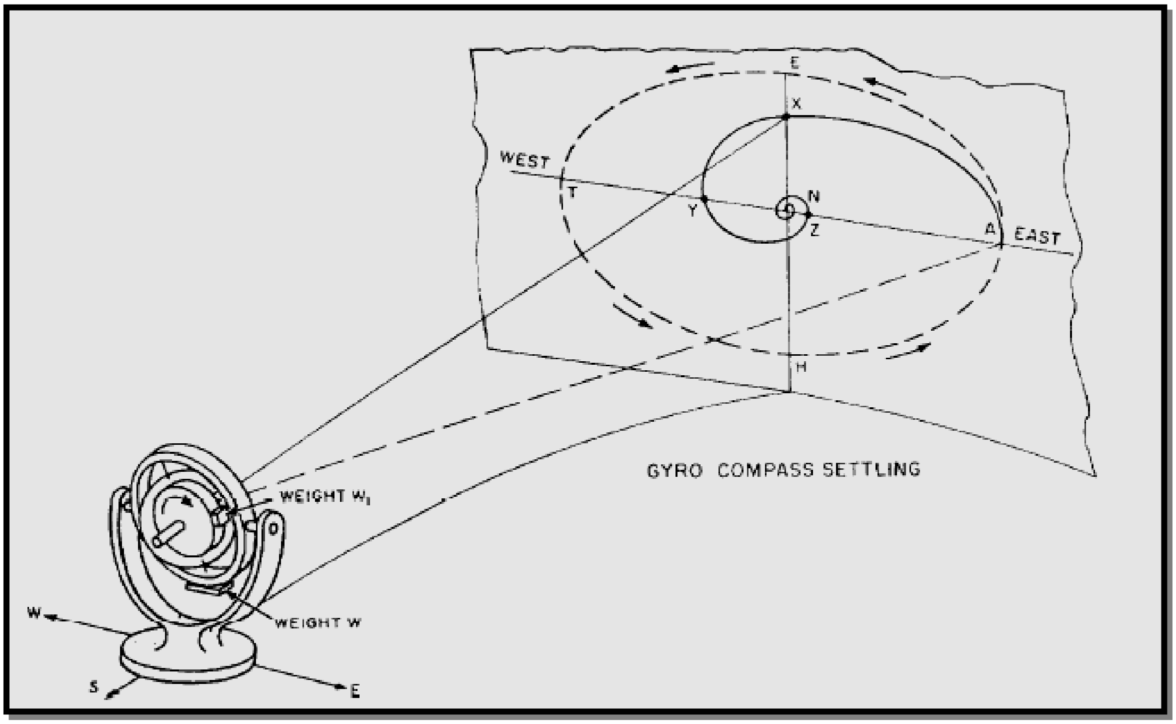


Figure 4-14.—Effect of weights on the gyroscope.

As you can see, the only position of rest for the gyro axle is level and on the meridian. The free gyroscope has now become a gyrocompass, able to settle only on the meridian (pointing north) and level.

This is a very basic gyrocompass, and it really operates satisfactorily only on the equator and when mounted on a stable platform; however, the principles and basic concepts are the same for all gyrocompasses.

To make a basic gyrocompass function properly over a wide range of latitudes, we must stabilize it with respect to the earth's surface instead of with the earth's axis, and we must damp out the effects of the ship's acceleration and deceleration. There are several methods used to do this. The method used depends on the type of gyrocompass. For further information on the method of damping used in the gyrocompasses installed on your ship, refer to the applicable manufacturer's technical manual.

4.8.0 DIGITAL FLUX GATE MAGNETIC COMPASS SYSTEM (DFGMC)

The MV103AC, MV103ACS and MV103DG Digital Flux Gate Magnetic Compass (DFGMC) Systems constitute an integral part of the ship's navigation system. These systems were designed as a replacement for the wet globe magnetic compasses found on many older vessels. DFMGC systems are electronic compass systems, which use digital processing techniques to determine the heading of a vessel referenced to magnetic North. Magnetic heading data is displayed to the operator in numerical format on a liquid crystal display at the helm and may be sent to other equipment in the form of RS-232 or RS-422 serial data.

4.8.1 Equipment Description

The basic DFGMC System consists of the (1A3) Sensor / Processor Unit, (1A2) Junction Box, (1A1) Main Display, (PS1) Uninterruptible Power Supply, plus associated power and signal cabling. System specific equipment may include the (1A6) Degaussing Interface Unit, (1A4) RS232/422 Display Driver, and (1A5) RS232/422 Remote Displays. All system components are shown in figure 4-15.

Figure 4-15.—DFGMC System.

Figure 4-16 shows the interrelationship of units in AC and ACS systems, including the optional (1A4) RS232/422 Display Driver and optional (1A5) RS232/422 Remote Displays.

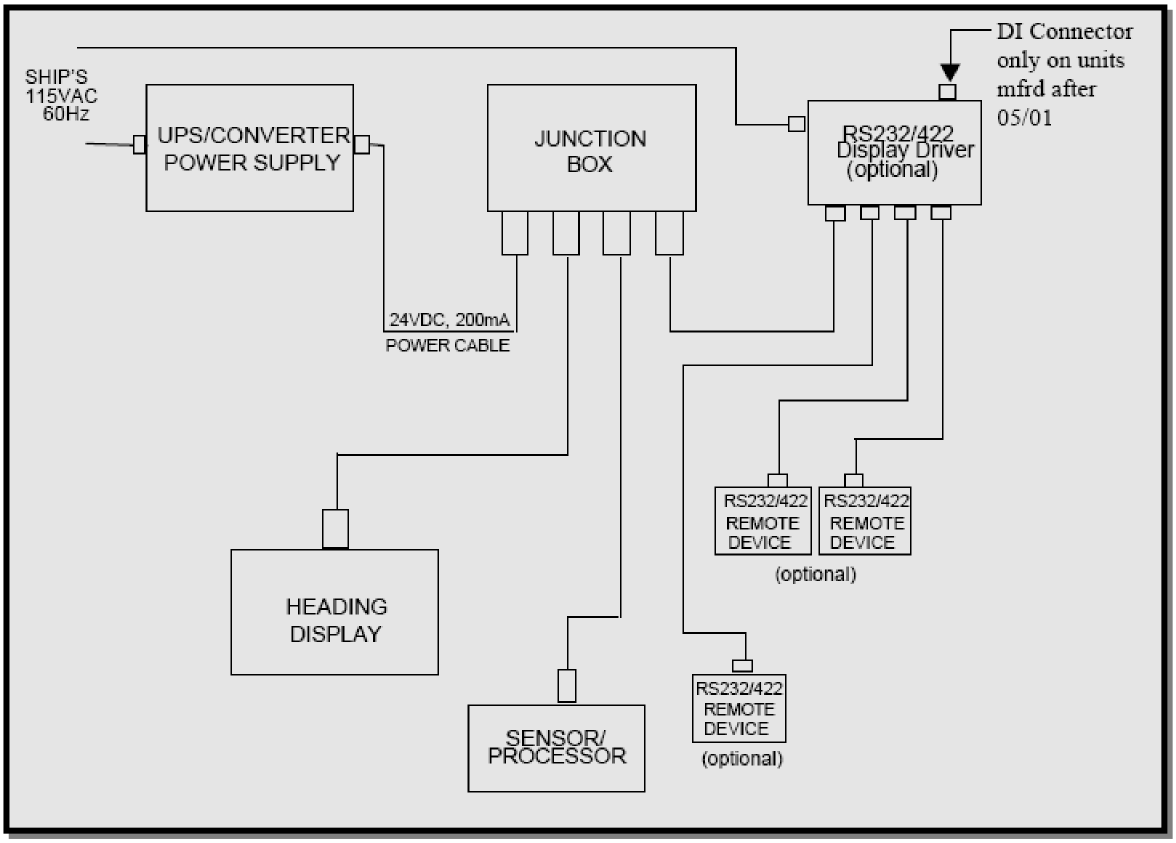


Figure 4-16.— MV103AC and MV103ACS DFGMC System Block Diagram.

Figure 4-17 shows the interrelationship for the units in the DG systems.

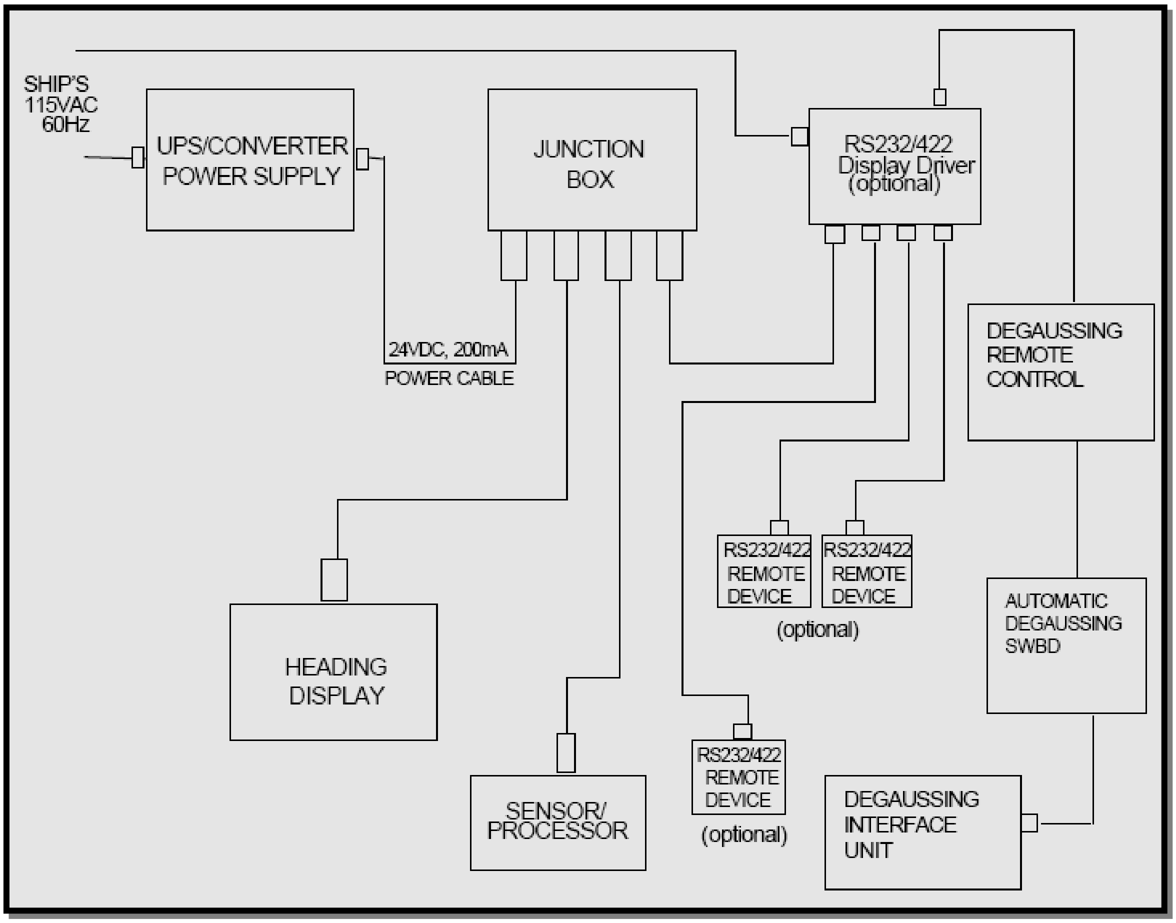


Figure 4-17.— MV103DG DFGMC System Block Diagram.

4.8.2 Reference Data

PERFORMANCE:

Accuracy:	1.0^{o} RMS error after calibration in free field
Repeatability:	1.0^{o}
Resolution:	1.0^{o} display; 0.1^{o} digital output
Field Strength Sensitivity:	6.5 to 65 Tesla
Magnetic Dip Angles:	80^{o} magnetic inclination

ENVIRONMENTAL:

Operating Temperature:	-40^{o} C to $+85^{o}$ C (-20^{o} C to $+70^{o}$ C for (1A5) RS232/422 Remote Display)
Storage Temperature:	-62^{o} C to $+74^{o}$ C (-40^{o} C to $+125^{o}$ C for (1A5) RS232/422 Remote Display)
Humidity:	0% to 100% ((1A3) Sensor / Processor only)

SERIAL DATA INTERFACE:

(1A2) Junction Box	RS232 or RS422 (depot selectable) using NMEA 0183 sentence structure
(1A4) RS232/422 Display Driver	RS232 using NMEA 0183 sentence structure

POWER REQUIREMENTS:

Input Power - Compass:	+24VDC 6VDC at 200 mA ((1A1) Main Display lighting at full brightness)
Input Power – (PS1) KH-1000B:	115VAC 60Hz, 2.2A startup, 1.8 A running
Input Power – (PS1) BH-2000:	115VAC 60Hz, 4.6A startup, 2.2 A running
Input Power – (1A4) RS232/422 Display Driver	115VAC, 60 Hz at 300mA (with 3 (1A5) Remote Displays attached at full brightness
Fuse Rating – (1A2) Junction Box:	3/10A, 250 VAC, slow-blow
Fuse Rating – (PS1) Power Supply:	KH100B 2.5A, 250VAC (in); 3/10A, 250VDC, slow-blow (out)
Fuse Rating – (PS1) Power Supply:	BH2000 5A, 250VAC (in); 3/10A, 250VDC, slow-blow (out)

Fuse Rating – (1A4) RS232/422 Display Driver 1/2 A, 250VAC

DIMENSIONS AND WEIGHTS

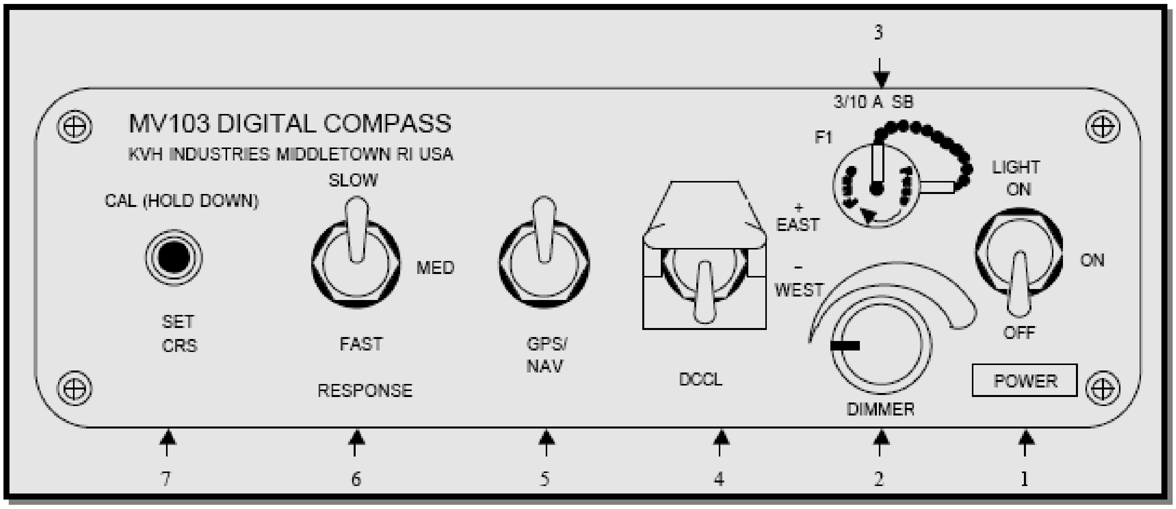
(1A1) KVH Main Display:	4.8"L x 3.6"W x 1.8"H / 1lb.
(1A1) AMSEC LLC Main Display	4.5" L x 3.5" W x 2.8" D / 1.1 lbs.
(1A2) Junction Box:	9.9"L x 4.0"W x 3.4"H/2.7 lbs.
(1A3) Sensor / Processor Unit:	6.3"L x 6.6"W x 3.6"H/3.8 lbs.
(1A4) AMSEC LLC RS232/422 Display Driver	8.9" L x 4.7" W x 2.5" D / 2.5 lbs.
(1A5) AMSEC LLC RS232/422 Remote Display	5.5" L x 3.5" W x 2" D / 1.1 lbs.
(1A6) Degaussing Interface	6.3"L x 6.6"W x 3.6"H/4.0 lbs
(PS1) Power Supply:	KH-1000B: 11"L x 7"W x 5.5"H/15 lbs. BH-2000: 11 1/2"Lx 7 1/2"Wx 4 5/8"H/10.3 lbs.

4.8.3 DFGMC Operation

The DFGMC is an "output only" type system and does not require any operator input for normal operation. When power is applied, the system automatically enters the Compass Heading mode. The Digital Display shows the present compass heading relative to magnetic north using the last calibration data stored by the system.

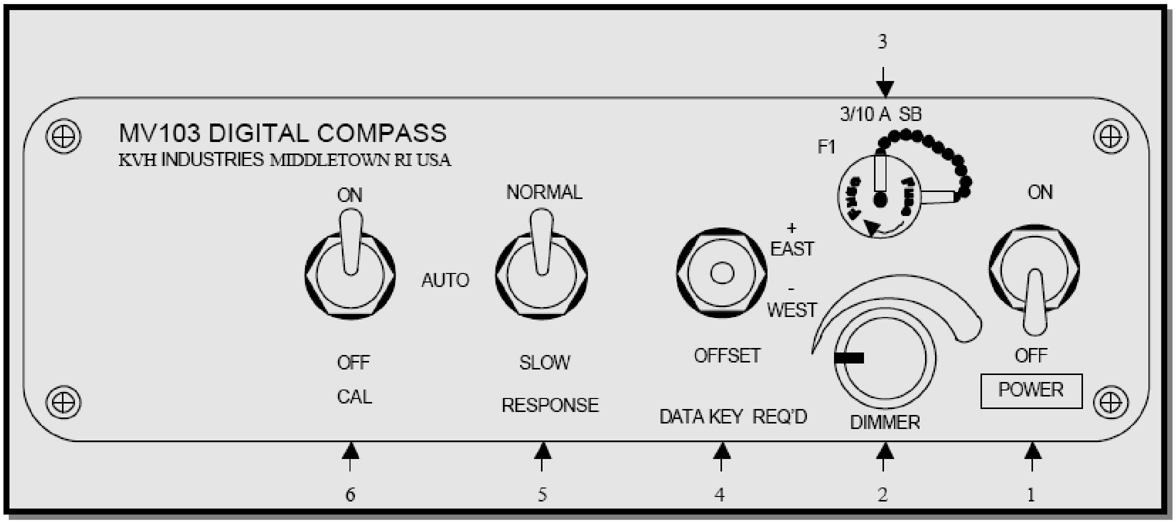
4.8.4 Controls

Figure 4-18 illustrates MV103AC (1A2) Junction Box controls. Figure 4-19 illustrates MV103ACS and MV103DG (1A2) Junction Box controls. Use of these controls is further described in Section 2, Compass System Operation. The Main Power Switch located on the KH1000B Power Supply and the Alarm Override Switch on the BH2000 Power Supply are the only other controls on this system.



Key	Nomenclature	Function
1	POWER	Controls power to the DFGMC OFF: no power applied. ON: applies power to the DFGMC (no display lighting). LIGHT ON: applies power to the DFGMC and lighting to (1A1) Main Display.
2	DIMMER	Controls (1A1) Main Display lighting when POWER switch is at LIGHT ON.
3	F1 3/10A	Fuse under screw-off cap; protects the DFGMC from short circuits and overloads.
4	DECL	Used to enter variation or declination to convert magnetic to true North. Also used to enter (1A3) Sensor / Processor alignment correction factor.
5	GPS/NAV	Used to toggle between compass heading and GPS input display modes. GPS Input not used at this time.
6	RESPONSE	Adjusts display response time (damping factor). SLOW: displayed value averaged over a 17-second period. MED: displayed value averaged over a 9-second period. FAST: displayed value averaged over a 3-second period.
7	SET CRS	Used to enter a reference course or to enter and exit the calibration mode.

Figure 4-18.— MV103AC (1A2) Junction Box Controls.



Key	Nomenclature	Function
1	POWER	Controls power to the DFGMC. OFF: no power applied. ON: applies power to the DFGMC.
2	DIMMER	Controls (1A1) Main Display lighting.
3	F1 3/10A	Fuse under screw-off cap; protects the DFGMC from short circuits and overloads.
4	OFFSET	Used to enter (1A3) Sensor / Processor alignment correction fact
5	RESPONSE	Adjusts display response time (damping factor). SLOW: displayed value averaged over a 9-second period. NORMAL: displayed value averaged over a 3-second period.
6	CAL	Used to select the type of calibration for the DFGMC. ON: Calibration is on. The display cycles “CAL” “CAL score” “heading”. AUTO: Calibration is monitored and adjusted by the DFGMC as required. The (1A2) Junction Box will beep 4 times indicating a new calibration has been accepted by the DFGMC.

Figure 4-19.— MV103ACS and MV103DG (1A2) Junction Box Controls.

4.8.5 Operating Procedures

Compass Heading Mode - MV103AC

When the DFGMC is powered up, the present declination value is displayed for two seconds, and then automatically enters the Compass Heading mode. The LCD area shows the present compass heading relative to magnetic North; no other symbols are activated. Figure 4-20 shows the LCD display at initial power-up in Compass Heading mode. The factory default declination value is 00^{o} and the present heading is 270^{o}.

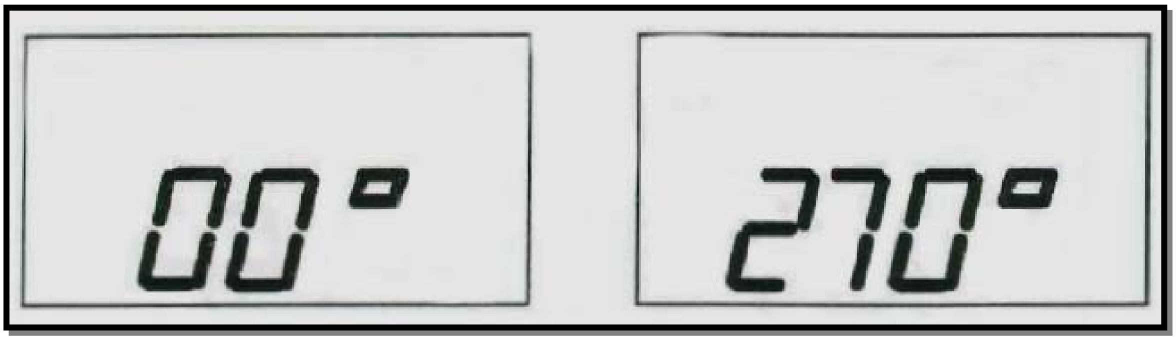


Figure 4-20.— Compass Heading MV103AC.

Adjusting Display Response Damping - MV103AC

The RESPONSE toggle switch (Fig. 4-18) selects any of three fixed values of display damping. The function of display damping is to average a number of headings over time to present a stable display to the operator. This function has no effect on the response time of the (1A3) Sensor / Processor electronics. When a damping time is selected, the LCD shows “d-1” (FAST position), “d-2” (MED position), or “d-3” (SLOW position) for two seconds. Selection of the response damping value is largely a matter of operator preference and the vessel’s operating condition. For example, when operating in rough seas or at high speeds where heading is apt to change rapidly, the operator may select SLOW which causes the display data to be averaged over a 17- second period. The heading continues to update at one-second intervals, but the display is the average of the most recent 17 seconds. Conversely, when operating in calm seas or slow speeds where heading changes slowly, the operator may select FAST, which causes the display data to be averaged over a 3- second period. MED averages the heading data at a 9-second interval. Response damping time may be selected at any time in the Compass Heading or Set Course operating modes. RESPONSE has no effect in the GPS mode.

Compass Heading Mode - MV103ACS and MV103DG
When the DFGMC is powered up, the system automatically enters the Compass Heading mode. The LCD area shows the present compass heading relative to magnetic North. No other symbols are activated. Figure 4-21 shows the LCD display in Compass Heading mode. The illustrated heading is 270°.

Figure 4-21.— Compass Heading MV103ACS and MV103DG.

Adjusting Display Response Damping - MV103ACS and MV103DG
The RESPONSE toggle switch selects any of two fixed values of display damping. The function of display damping is to average a number of headings over time to present a stable display to the operator. This function has no effect on the response time of the (1A3) Sensor / Processor electronics. Selection of the response damping value is largely a matter of operator preference and the vessel's operating condition. For example, when operating in rough seas or at high speeds, where heading is apt to change rapidly, the operator may select SLOW, which causes the display data to be averaged over a 9-second period. The heading continues to update at one-second intervals, but the display is the average of the most recent 9 seconds. Conversely, when operating in calm seas or slow speeds, where heading changes slowly, the operator may select NORMAL, which causes the display data to be averaged over a 3- second period. Response damping time may be selected at any time in the Compass Heading mode.

Calibration
All magnetic heading sensors operate on the principle that a magnetized needle or card aligns itself with the Earth's magnetic flux field. These devices are also influenced by nearby distortions or disturbances caused by magnetized or magnetizable materials or electrically generated flux fields. The DFGMC has the ability to compensate itself for these disturbances by executing on-demand or continuous self-compensation routines. "Auto-compensation", or calibration, refers to a process in which the DFGMC assesses the local magnetic environment and applies correction factors through embedded software routines.

The DFGMC is calibrated at the factory during assembly. However, every vessel has its own magnetic characteristics, which require that the DFGMC be compensated after installation. In addition, auto-compensation should be done whenever the Processor Unit is replaced, if it is moved to a new location on the vessel, or whenever the vessel goes to an area where the magnetic environment differs. The MV103DG system also has the capability of maintaining correct compensation regardless of the status of the ships Degaussing System.

4.9.0 GYROCOMPASS SYSTEMS

There are a wide variety of gyrocompass installed on Navy ships in the fleet systems today. Gyrocompasses are identified by the mark (Mk)–modification (Mod) system. The Mk number designates a major development of a compass. The Mod number indicates a change to the major development. The most common type of gyrocompasses found in the fleet today are the electrical gyrocompass systems, such as the Sperry Mk 23 and the Sperry Mk 27.

There are also other gyrocompass systems currently being installed on Navy ships today. These are the Stabilized Gyrocompass Set AN/WSN-2, Inertial Navigation Set AN/WSN-5, Ring Laser Gyrocompass (RLG) Inertial Navigation System AN/WSN-7B, and AN/WSN-7 RLG. Operation of the AN/WSN-5 is classified; therefore, only the AN/WSN-2, WSN-7 and 7B will be discussed in this training manual.

4.9.1 SPERRY MK 23 GYROCOMPASS SYSTEMS

The Sperry Mk 23 gyrocompass is a small electrical compass that is used aboard many naval vessels to furnish heading data. On many of the small combatant vessels and larger auxiliary vessels, it is used as the master compass. On some of the larger combatant vessels, it is used as a backup compass. The compass is capable of indicating true north accurately in latitudes up to 75°N or S. The compass also can be used as a directional gyro when nearer the poles.

Unlike the mechanical gyrocompass, which uses weights that are affected by gravity to cause the desired period of damping, the Sperry Mk 23 gyrocompass uses a special type of electrolytic bubble level (gravity reference), which generates a signal proportional to the tilt of the gyro axle. This signal is then amplified and applied to an electromagnet which applies torque about the vertical and/or horizontal axes to give the compass the desired period and damping. The gyrocompass is compensated for speed error, latitude error, unbalance, and supply voltage fluctuations. An electronic follow-up system furnishes accurate transmission of heading data to remote indicators.

The original Sperry Mk 23 gyrocompass (Mod O) has had several minor modifications and one major modification (Mod C-3). Only the Mk 23 Mod O and the Mk 23 Mod C-3 will be discussed in this training manual.

4.9.2 MK 23 MOD 0 GYROCOMPASS SYSTEM

The Mk 23 Mod 0 gyrocompass system (fig. 4-22) consists of the master unit, control cabinet, speed unit, alarm control unit, a compass failure annunciator, and an alarm belt.

Figure 4-22.—Mk 23 Mod 0 gyrocompass equipment.

Master Unit
The master unit consists of a shock-mounted, oil-filled binnacle and the gyrocompass element. The master unit is designed for deck mounting and weighs approximately 100 pounds. The compass element is the principle unit of the compass system and is gimballed in the binnacle to allow ±45° of freedom about the pitch and roll axes. Drain plugs are located in the lower bowl for draining the oil.

Control Cabinet
The control cabinet contains all the equipment required for operating and indicating the condition of the master compass except the visual alarm indicator and the alarm bell. The control cabinet houses the control panel, control amplifier, follow-up amplifier, and power supply.

Speed Unit
The speed unit contains the necessary components to produce an electrical signal proportional to ship's speed. Speed information is received from the ship's underwater log equipment or is set in manually by the ship's dummy log system. The speed range of the unit is 0 to 40 knots.

Alarm Control Unit
The alarm control unit contains the necessary relays and components to actuate the lamp on the visual alarm indicator or the bell alarm when certain portions of the system become inoperative.

Compass Failure Annunciator
The compass failure annunciator is a visual alarm indicator. It provides a visual indication of problems within the gyrocompass system. Under normal conditions, the lamp on the indicator is lighted continuously. When a failure occurs within the system, the lamp flashes or goes out. A test push button is provided on the annunciator. In some installations a type B-51 or B-52 alarm panel is used in place of the annunciator.

Alarm Bell
The alarm bell is used with the annunciator to provide an audible indication of problems within the gyrocompass system.

4.9.3 OPERATING THE MK 23 MOD 0 GYROCOMPASS

Instructions for starting and stopping (securing) the compass under normal conditions are on an instruction plate (fig. 4-23). This plate is located on the front of the control cabinet. There are two modes of operation, normal and directional gyro (DG). The normal mode of operation is used for latitudes up to 75°. The DG mode of operation is used for latitudes above 75°. Normally, the compass should be started at least 2 hours before it is needed for service. For additional information on starting the compass, refer to the manufacturer's technical manual.

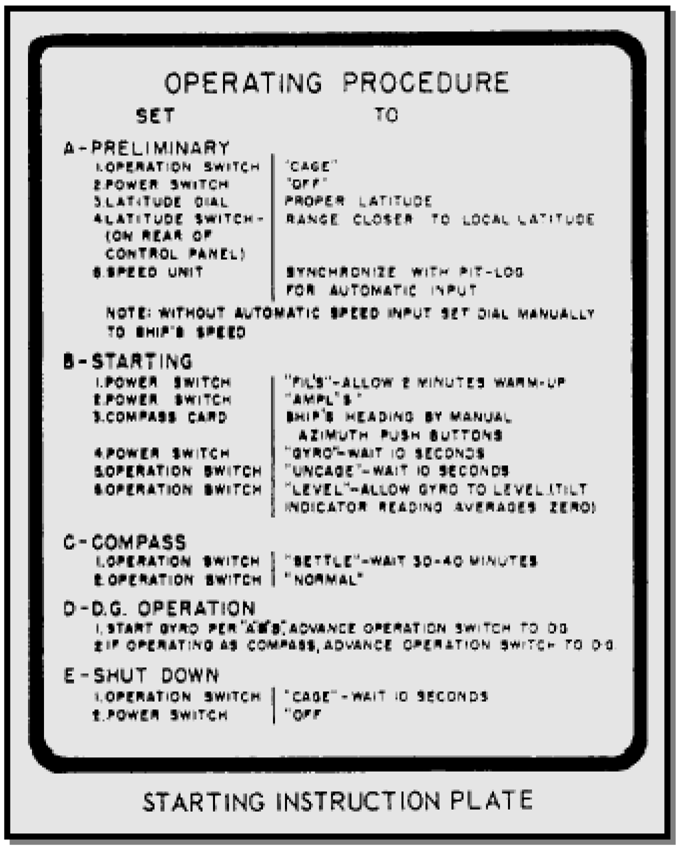


Figure 4-16.—0perating procedures for the Sperry Mk 23 Mod 0 gyrocompass.

If it becomes necessary to stop the compass in a heavy sea for any reason other than failure of the follow-up system, the following procedure should be used:

1. Place the power switch in the AMPL'S position.

2. 7 Wait 30 minutes, and then place the operation switch in the CAGE position.

3. Place the power switch in the OFF position.

In case of follow-up system failure, place the operation switch in the CAGE position immediately and the power switch in the OFF position.

If power to the compass fails, place the power switch in the FIL'S position and the operation switch in the CAGE position. When the power is restored, restart the compass in the usual manner.

Setting Correction Devices
Correction device settings for the Mk 23 gyrocompass include the manual speed setting on the speed unit, the latitude control knob setting on the control panel, and the latitude switch setting on the rear of the control panel.

When you operate the speed unit manually, adjust the speed settings to correspond to the average ship's speed. Change the latitude control knob setting on the control panel when the ship's latitude changes as much as 2°, or as ordered by the ship's navigator. Throw the latitude switch on the rear of the control panel to the 65° position for normal operation when the ship's latitude is above 60°. The position of the latitude switch is immaterial for directional gyro operation.

Indications of Normal Operation
Normal operating conditions for the compass are indicated by the following:

1. The follow-up failure and corrector failure lamps on the control panel should be dark.

2. The master unit should be lukewarm.

3. The speed dial should indicate the ship's speed for normal operation or zero for directional gyro operation.

4. The tilt indicator pointer should be oscillating evenly about the zero position.

Watch Standing
When you are assigned the gyrocompass watch, you will be required to maintain the gyrocompass log and to respond to any alarms associated with the gyrocompass system. The gyrocompass log contains hourly readings showing the conditions of the gyrocompass and the power sources available. During an alarm condition, the compass is no longer considered reliable.

4.9.4 MK 23 MOD C-3 GYROCOMPASS SYSTEM
The Mk 23 Mod C-3 gyrocompass system is identical to the Mk 23 Mod 0 system with the exception that the Mk 23 Mod C-3 system uses solid-state devices in place of vacuum tubes in the control cabinet. In addition, two more units are used in the C-3 system. These two additional units arc the power supply unit and the power supply control unit.

The power supply unit and the power supply control unit, together with a 120-volt dc battery, are used to form a standby power supply for the compass. This standby power supply provides uninterrupted 120-volt, 400-Hz, 3-phase power to the compass for a limited period of time if the normal ship's supply fails. If the normal ship's supply fails, a red light located on the power supply control unit will come on. When the compass is being supplied power from the standby power supply, power will be cut off to some of the remote repeaters.

The starting and stopping procedures for the compass are basically the same as for the Mk 23. Instructions for starting and stopping the compass under normal conditions are given on the instruction plate (fig. 4-24) located on the front of the control panel. Make sure the ON-OFF switch located in the power supply control unit is in the ON position before starting the compass. For additional information on starting and stopping the compass, refer to the manufacturer's technical manual.

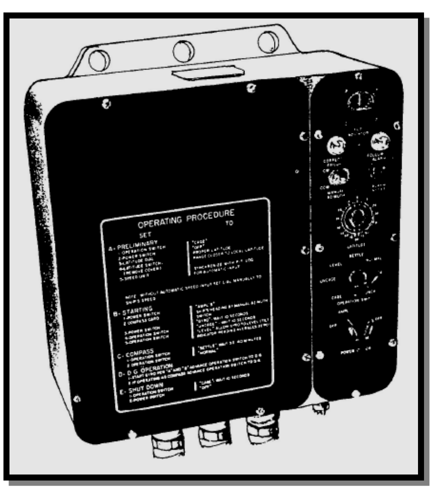


Figure 4-24.—Mk 23 Mod C-3 control cabinet.

Watch-standing procedures are basically the same as for the Mk 23 Mod 0 gyrocompass system.

4.9.5 SPERRY MK 27 GYROCOMPASS SYSTEM

The Sperry Mk 27 gyrocompass is a rugged, low-voltage electrical compass used as the master compass on small craft and as the auxiliary compass on larger ships. The Mk 27 gyrocompass is designed to operate on 24-volt dc or 115-volt, 60- or 400-Hz, single-phase power.

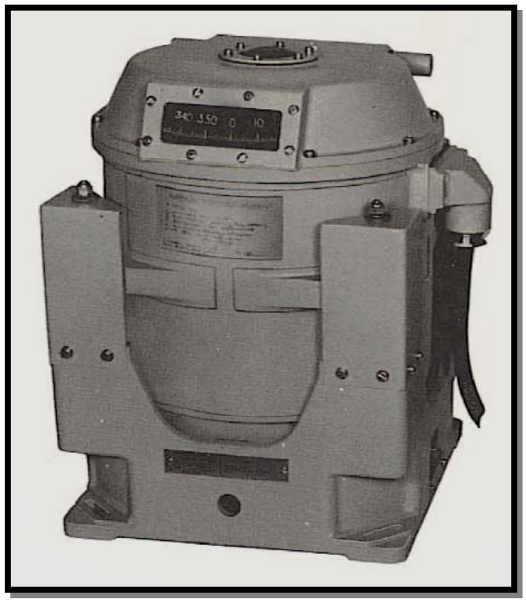


Figure 4-25.— Mark 27 Master Unit.

The Mark 27 Mod 0 Gyrocompass Equipment, shown in figure 4-26 and described in this manual, is small, compact, has a low power demand, and is capable of furnishing an accurate heading indication under the severe operating conditions encountered in small boats, amphibious vehicles and craft, submarines, and larger combatant vessels. The compass can be read directly or heading data can be transmitted to remote systems and indicators.

4.9.5.1 Design Features

The Mark 27 Gyrocompass contains a gyroscope controlled in a manner to make it seek and continuously align itself with the meridian and thereby point to true north. The properties of the gyroscope in combination with the rotation of the earth and the effect of gravity produce this result. The Mark 27 Gyrocompass differs from previous gyrocompasses in that a gimbal system is used which reduces the complexity of the equipment.

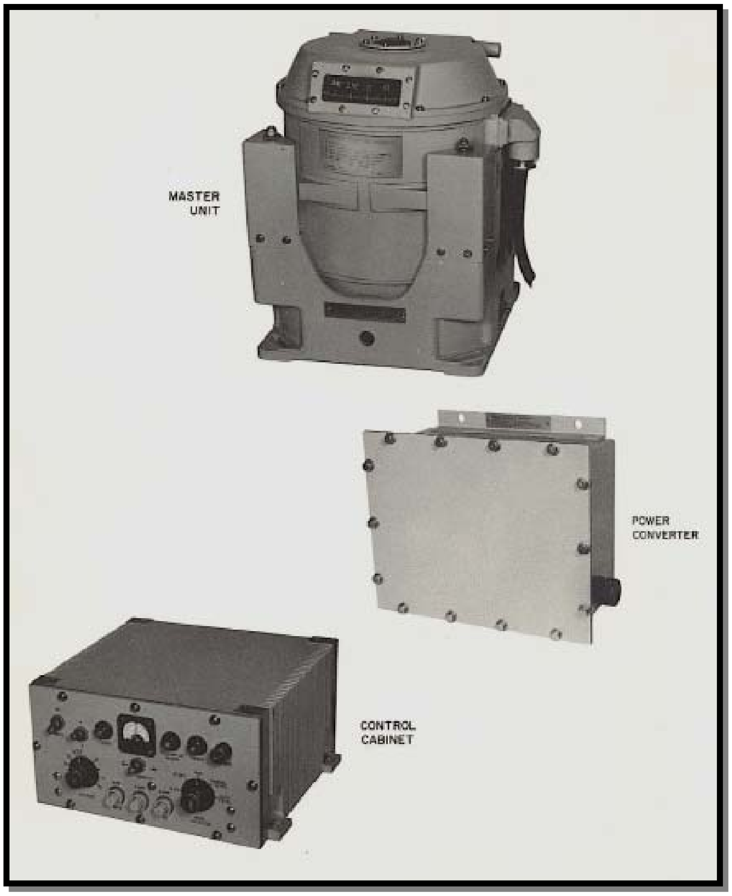


Figure 4-26.— Mark 27 Mod 0 Gyrocompass Equipment.

The gyrosphere containing the gyroscope rotor is immersed in silicone fluid, and is designed and adjusted to have neutral buoyancy. The weight of the gyrosphere in the fluid is canceled by the buoyant force of the displaced fluid. This feature is a distinct advantage in that (1) the weight of the gyrosphere is removed from the sensitive-axis bearings, (2) the gyrosphere and bearings are protected from excessive shock loads, (3) sensitivity to shifts of the center of mass of the gyrosphere relative to the sensitive axis are eliminated providing improved accuracy, and (4) the effects of accelerations are minimized because the center of mass of the gyrosphere and the center of buoyancy are made coincident.

The compass is compensated for the effects of varying latitude. In addition, a servo follow-up system is provided in the azimuth axis to keep the phantom yoke support aligned with the gyrosphere as the vessel turns; it also drives the compass card and any data transmission system that may be included. Provision is made so that the gyrocompass may be equipped with a step transmitter, a I-speed synchro transmitter, a 36-speed synchro transmitter, or any combination of these units. Either 60 or 400 cps heading data synchros can be supplied. The compass card is visible for direct reading, and has the normal sense of relative rotation for direct steering purposes. A built-in alarm is utilized to give a direct indication of failure in power supply or follow-up amplifier. Because of the low viscosity of the suspension and ballistic fluids, no heaters are required in the Mark 27 Gyrocompass.

4.9.5.2 General Description

The Mark 27 Gyrocompass consists of three major assemblies: Master Unit, Electronic Control Assembly and Power Converter.

Master Unit

The Master Unit consists of a shock-mounted, fluid-filled binnacle which houses the sensitive element. The unit is sealed and designed for deck mounting. To prevent damage when not in use, the sensitive element can be caged by depressing a button on the top of the unit. The viewing window for the compass card is oriented on the after side of the compass. The dial has dark-adapted illumination and its brightness is adjustable at the Electronic Control Assembly. This will be discussed in further detail later in the chapter.

Electronic Control Assembly

The Electronic Control Assembly is a watertight, deck-mounted unit which houses the control panel, power supply, servo amplifier, latitude compensation circuit, and alarm circuit. The servo amplifier printed circuit board and the power supply section (except for the power amplifier transistors) are easily removable for maintenance. The power amplifier transistors are attached to the cabinet frame for adequate heat dissipation. The Master Unit and Electronic Control Assembly will operate directly from an external 24-volt d-c power source or from the Power Converter described below. The Electronic Control Assembly may be mounted directly under the Master Unit or remotely, although the assembly should not be separated from the Master Unit by more than an arm’s length to permit ease of operation during starting or adjustment of dial illumination. This will be discussed in further detail later in the chapter.

Power Converter

The Power Converter is used for applications where the gyrocompass equipment must operate from a single phase 115-volt, a-c, 60 or 400 cps power source. The converter is housed in a watertight enclosure and its purpose is to convert a-c input power to 24-volt d-c for operation of the compass equipment. This will be discussed in further detail later in the chapter.

4.9.5.3 Operation

These instructions will enable operating personnel to start and settle the compass in azimuth in a minimum of time under all sea conditions. Although operation of the Mark 27 Gyrocompass does not require continuous attention to the controls and adjustments, operating personnel should have a full knowledge of the meaning and purpose of the various indicating lamps, meters, switches, and alarms.

STARTING THE COMPASS

Where practical, starting procedures should begin at least 2 hours before the gyrocompass is required for service.

- **NORMAL SEA STARTING**

For use where roll and pitch are less than 10 degrees and compass has been stopped for at least 1 hour.

(1) Insure that the RPTR switch and the MODE SELECTOR switch are in the OFF position.

(2) Place MODE SELECTOR to SLEW

(3) CAGED lamp should be lighted. If lamp is off, push the cager button on the top of the binnacle to cage gyro and wait 5 minutes to allow ballistic fluid to stabilize.

NOTE: Compass will slew rapidly if gyro is uncaged.

(4) Use the TILT/AZIMUTH switch to slew the compass as close as possible to ship's heading. Pushing the switch in the + direction will make the compass card rotate counterclockwise; pushing in the - direction will make the card rotate clockwise. (Wait 5 to 10 seconds between reversals of the switch to allow the follow-up servo amplifier to stabilize.)

(5) Turn MODE SELECTOR to START. Wait 10 minutes for gyro to come up to speed. Then firmly push cager button on top of the binnacle to encage the gyro. CAGED lamp must go out or gyro has not been uncaged.

(6) Switch MODE SELECTOR to MANUAL LEVEL immediately after uncaging.

(7) Operate the TILT/AZIMUTH switch to bring the gyro to a level position as indicated by the LEVEL meter. Push the switch in the direction of desired pointer movement and hold it until the meter pointer has reached its center position. If it overshoots, reverse direction as needed until the pointer has been centered.

(8) Place MODE SELECTOR to RUN.

(9) Set N -S switch for north or south latitude.

(10) Set LATITUDE corrector control to ship's latitude.

(11) To operate repeater, place RPTR switch to ON.

NOTE: When step repeaters are used they should be synchronized to the compass card reading prior to turning RPTR switch ON.

(12) Adjust DIMMER control for satisfactory dial brightness.

- **HEAVY SEA STARTING**

During the starting period when the gyro is caged, the eager mechanism will apply torques to the gyro if any rolling or pitching is taking place. When these motions are 10 degrees or more, they will cause the gyro to move away from the desired heading. This can increase the time required to settle the compass. The following procedure uncages the gyro before this movement in azimuth takes place and enables operating personnel to get the compass settled in a minimum of time.

(1) Insure that the RPTR switch and the MODE SELECTOR switch are in the OFF position.

(2) Place MODE SELECTOR to SLEW.

(3) CAGED lamp should be lighted. If lamp is off, push the eager button on top of the binnacle and wait 5 minutes for the ballistic fluid to stabilize.

NOTE: Compass will slew rapidly if it is uncaged.

(4) Use the TILT/AZIMUTH switch to slew the compass as close as possible to ship's heading. Pushing the switch in the + direction will make the card rotate counterclockwise; pushing the switch in the - direction will make the card rotate clockwise. (Wait 5 to 10 seconds between reversals of the switch to allow the follow-up servo amplifier to stabilize.)

(5) Place MODE SELECTOR to START

(6) Wait from 30 to 35 seconds only and then uncage the gyro by depressing the eager button. CAGED lamp must go out.

NOTE: The compass will move away from heading rapidly if a longer period is allowed between starting and uncaging. The compass should be uncaged if possible when the ship is at the center of its roll and pitch motions so the gyro will be released near a level position.

(7) Note the average position of the swings of the pointer of the LEVEL meter. If they average around zero, proceed to step 10. If they do not, operate the TILT/AZIMUTH switch to reverse the polarity of the average position and to make it about one-half of what is was. Push the switch in the direction of desired pointer movement.

(8) Watch the compass card for about 1 minute to determine in which direction it is moving with respect to the desired heading.

(9) If the card is moving toward heading, allow it to continue until it is within 2 degrees of the desired heading and then operate the TILT/AZIMUTH switch to level the gyro and make the average position of the LEVEL meter pointer zero.

(10) If the card is moving away from heading, reverse the polarity of the average pointer position by operating the TILT/AZIMUTH switch. Wait until the direction of the card movement changes and when it is within 2 degrees of the desired heading, operate the TILT/AZIMUTH switch to level the gyro and make the average position of the LEVEL meter pointer zero.

(11) Place MODE SELECTOR to RUN.

(12) Set N-S switch for north or south latitude.

(13) Set LATITUDE corrector control to ship's latitude.

(14) Wait 10 minutes from the time the compass was uncaged before placing RPTR switch to ON.

NOTE: When step repeaters are used they should be synchronized to the compass card reading prior to turning RPTR switch ON.

(15) Adjust DIMMER control for desired dial brightness.

- **ROUTINE OPERATION**

Because operation of the compass is almost completely automatic, the only routine operating procedures that need to be performed are the following checks for each watch:

(1) Check setting of LATITUDE corrector control and reset to local latitude, if required.

(2) Check setting of N-S switch and reset to proper hemisphere, if required.

(3) Make normal azimuth checks on compass to determine accuracy of heading indication.

(4) Record LEVEL meter reading when compass is settled for reference.

- **STOPPING THE COMPASS**

To stop the compass:

(1) Place RPTR switch to OFF.

(2) Place MODE SELECTOR to SLEW.

NOTE: When seas are rough, turn MODE SELECTOR to OFF. Wait 30 minutes and then cage the gyro.

(3) Push cager button on top of binnacle to cage the gyro. CAGED lamp should light.

(4) Place MODE SELECTOR to OFF.

- **OTHER PROCEDURES**

The procedure to be used if the compass is dumped or must be started with the wheel running is as follows:

(1) If the compass should become dumped after the wheel has come up to speed, as indicated by a full scale LEVEL meter reading and a rapidly slewing compass, place the MODE SELECTOR in AUTO LEVEL. This will stop the slew and level the gyro, but will leave the compass at some heading other than the desired heading.
To restore the compass to heading, perform steps (1) through (8).

(1) Place MODE SELECTOR to MANUAL LEVEL.

(2) Push cager button on top of binnacle to cage the gyro. CAGED lamp should light.

(3) Push the TILT/AZIMUTH switch in the same direction as that in which the card should rotate to return to the desired heading. Release the switch when the LEVEL meter indicates its maximum.

(4) Compass card will slowly rotate toward desired heading.

(5) Allow compass to rotate past desired heading by 2 or 3 degrees and immediately uncage the gyro by depressing the cager button on the binnacle. C AGED lamp should go out.

(6) Move MODE SELECTOR to AUTO LEVEL. This will approximately level the gyro.

(7) Move MODE SELECTOR to MANUAL LEVEL and operate TILT/AZIMUTH switch to center the pointer of the LEVEL meter.

(8) Place MODE SELECTOR to RUN.

- **LATITUDE CORRECTION**

The tilt of the ballistic causes horizontal torques which precess the gyro in azimuth. Horizontal earth rate affects a gyro when located anywhere except at the poles. Horizontal earth rate likewise causes the gyro to tilt. The torque developed by the tilted ballistic will be just enough to keep the gyro precessing at a rate equal and opposite to the vertical component of earth rate. The higher the latitude, the greater must be the tilt of the spin axis to keep up with the higher vertical earth rate.

As a result of this tilt, the damping weight produces a vertical torque which causes the north end of the gyro axle to settle eastward from the true meridian in north latitudes, westward in south latitudes. This displacement from the true meridian, increasing with latitude, is called latitude error. In the Mark 27 Gyrocompass, latitude error is corrected by applying an opposing vertical torque to the gyrosphere of a magnitude to just cancel out the steady torque produced by the damping weight. The gyro settles with a tilt, but with no latitude error.

The E-core pickoff is used to produce this torque. A d-c current is introduced in one output winding of the E-core pickoff on the vertical ring. The magnetic field produced attracts the armature on the gyrosphere and a counteracting vertical torque is created.

Because the latitude error reverses sign between north and south latitudes, the d-c current is introduced in one output winding of the pickoff for north latitudes and in the other output winding for south latitudes. This reverses the direction of the corrective torque. The switching function is manually performed as an equipment control function. Magnitude of the torque is varied to agree with the latitude of operation.

4.9.5.4 Gyrocompass Equipment Detailed Description

Master Unit

The Master Unit, shown in figure 4-27 contains the compass element. The two basic parts of the Master Unit are the binnacle and the base. The binnacle is shock-mounted in the base and the shock mounts are positioned to act through the center of gravity of the binnacle. The base is a casting which is fixed to the deck by four bolts with plus or minus 5 degrees of freedom in azimuth to permit accurate alignment with the ship.

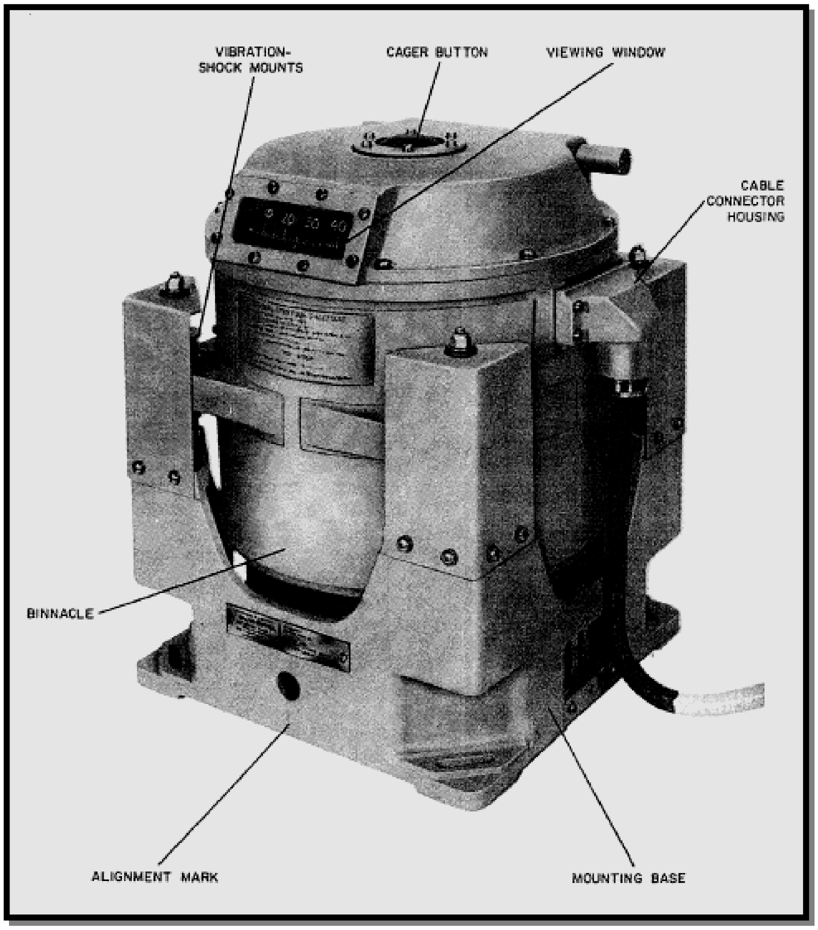


Figure 4-27.— Mark 27 Master Unit.

Binnacle

The binnacle contains the compass element and is completely filled with flotation fluid. In addition to the sensitive element, it contains a bellows located inside the bottom cover, which accommodates the contraction and expansion of the fluid with temperature changes. Also on the binnacle are the card viewing window, the cager diaphragm, the binnacle electrical connector, and the evacuating and filling nozzles.

Compass Element

The heart of the compass is the compass element and it is shown in figure 4-28 as removed from the binnacle. It consists of the support plate, follow-up system components, compass card, phantom fork, vertical ring and gyrosphere.

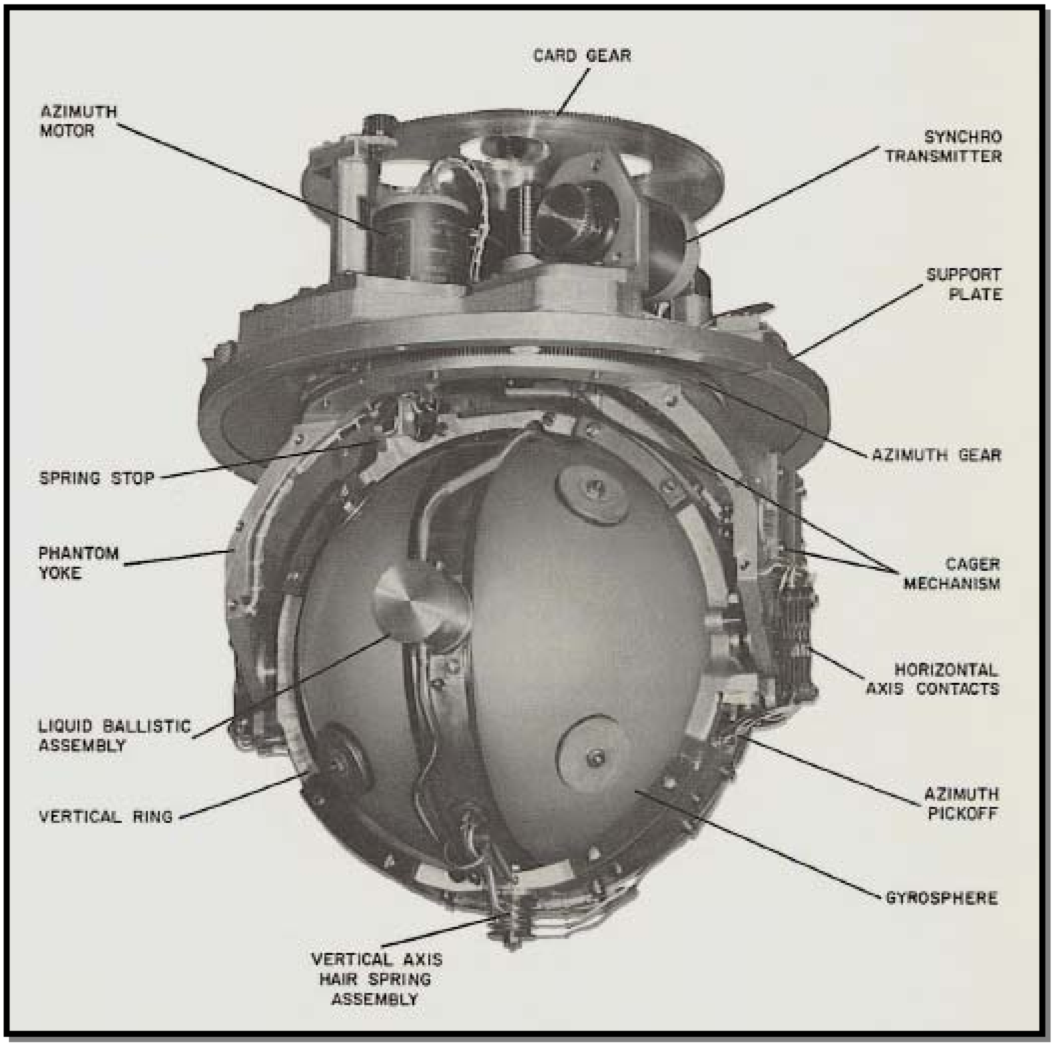


Figure 4-28.— Compass Element.

Gyrosphere - The gyrosphere, shown in figure 4-29, is the north seeking part of the gyrocompass. It derives its name from the fact that the gyro wheel is mounted within a spherical enclosure. The sphere is 6.5 inches in diameter; at running temperature, the specific gravity of the sphere is the same as that of the fluid in which it is immersed. Because the sphere is in neutral buoyancy, it exerts no load on the vertical bearings which, therefore, serve only as guides for the sphere. Flotation of the gyro in this manner not only reduces pivot friction, but serves to protect the gyro pivots from destructive shocks. The sphere has been evacuated and partially filled with helium gas. This gas serves to transfer the heat generated by the gyro motor windings to the surface of the sphere.

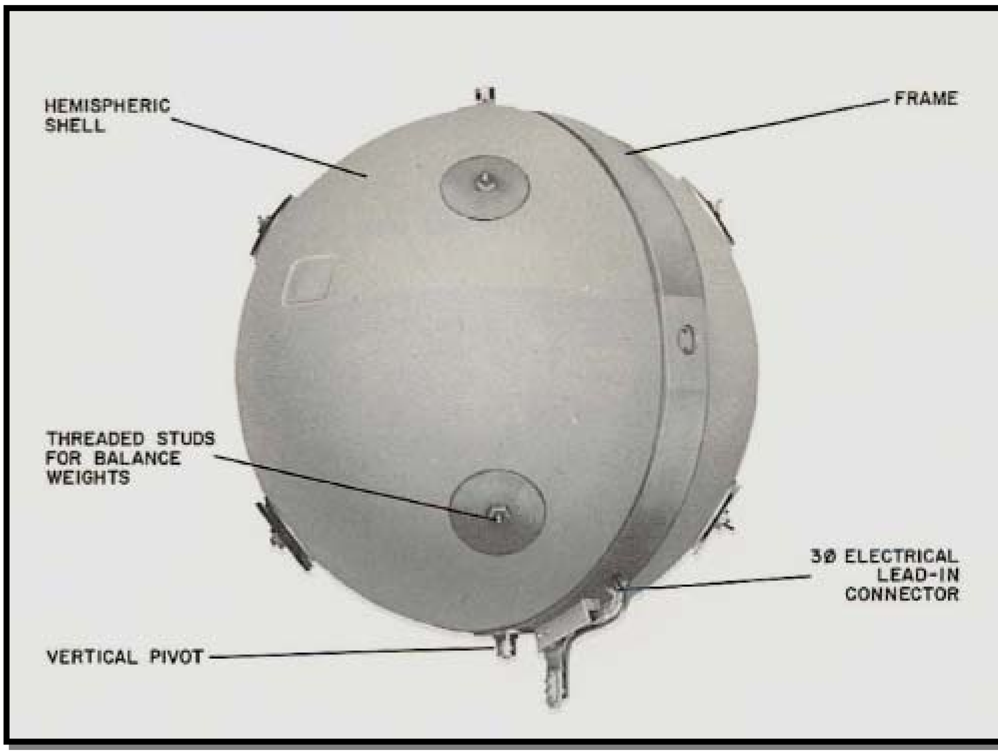


Figure 4-29.— Gyrosphere.

Gyro Motor - Gyro motor B1101 is of symmetrical design to minimize weight shifts. It consists of an outer cylindrical aluminum flywheel into which is pressed the aluminum bar squirrel cage of the induction motor. This assembly is then secured to the two aluminum endbells, and the entire unit rotates on the outer bearing races fitted into the gyro endbells. This aluminum rotor is designed for maximum angular momentum, consistent with the flotation requirements. The ball bearings and inner races of this separable bearing are fitted on a fixed aluminum shaft which also carries the stator winding of the gyro motor. The stator winding is placed at the center, and the leads are brought out through a hole bored in one end of the shaft.

The preload is maintained by two threaded clamps, one on each end of the gyro rotor. In addition, the clamp presses a wick (held in a retainer ring) against the inner race of each bearing. The wick feeds oil to the bearings from a felt reservoir in the lower part of the gyrosphere. The outer race rotation results in a flow of oil from the inner race to the outer race where the excess oil is centrifugally thrown off. The excess oil collects on the inner surface of the sphere and runs down the inside of the sphere to the oil reservoir. By this means the required oil lubrication is achieved.

The gyro is a complete subassembly and is statically balanced as a unit. The stator winding on the shaft and squirrel cage on the gyro wheel constitute a 4-pole, 3-phase induction motor. The speed is about 11,800 rpm counterclockwise from the south end, and the motor uses 7 watts of electrical power.

Gyro Shaft Pillow Blocks - The gyro shaft is secured to the frame by two pillow blocks, as shown in figure 4-30. A pin, driven through a hole in one of the pillow blocks into a keyway in the end of the stator shaft, prevents rotation of the shaft. The pin does not go all the way through the shaft. After the gyro and pillow blocks are assembled in the frame, nuts are screwed on the threaded gyro shaft to position the shaft. These nuts hold the shaft stationary along the pillow block axis of the frame and provide a means of positioning the entire gyro and shaft to establish mechanical balance of the frame and motor assembly. The pillow blocks and holding screws are individually fitted to the frame and are not interchangeable.

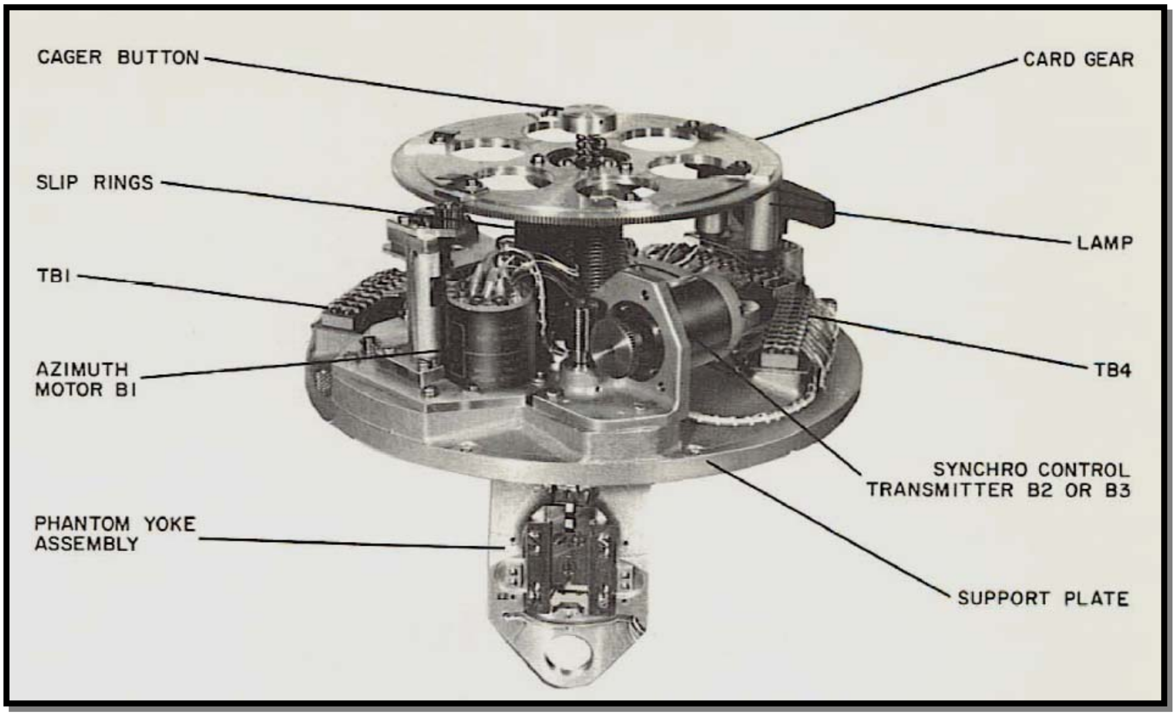


Figure 4-30.— Support Plate Assembly.

Electronic Control Assembly

The electronic control assembly shown in figure 4-31, houses the operating controls, follow-up servo amplifier, alarm circuitry, power supply, latitude control circuitry, and gyrocompass control functions. It can be mounted directly under the gyrocompass to form a compact arrangement or conveniently nearby for easy access to both units. All internal components are easily accessible by removal of the chassis and panel combination through the front.

A plug-in connector on the rear cabinet frame connects external cables to the chassis and permits removal of the chassis from the cabinet. Cables to the Electronic Control Assembly are routed through three stuffing tubes on the rear of the cabinet.

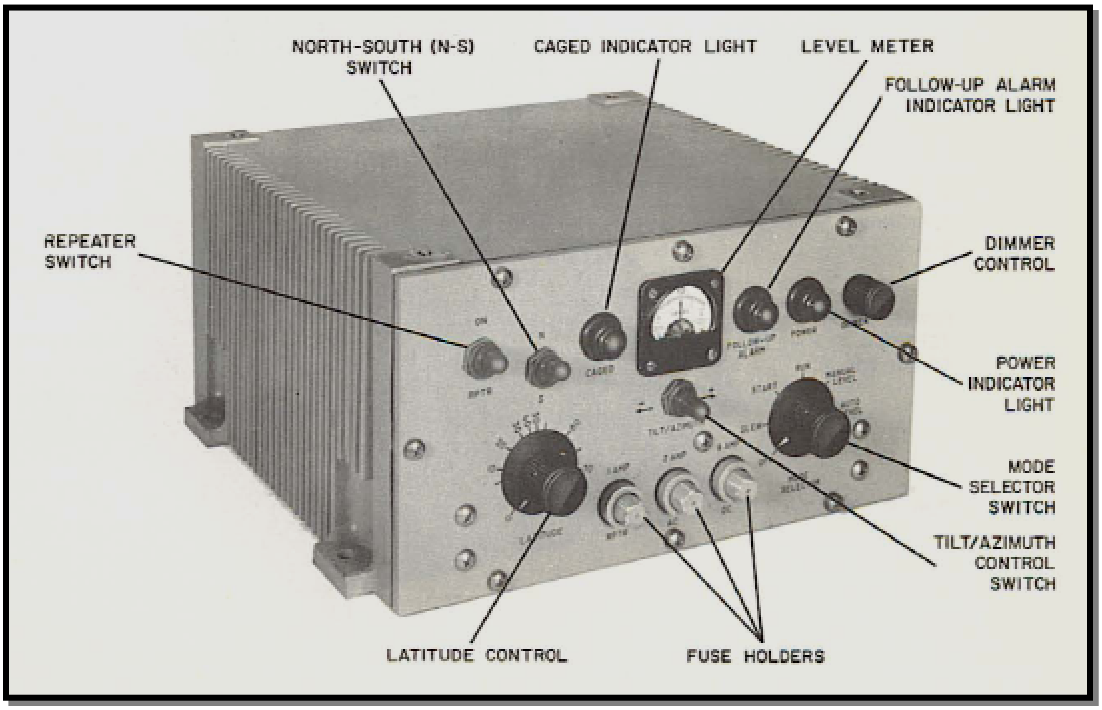


Figure 4-31.— Control Cabinet.

Servo Amplifier - The servo amplifier is an integral part of the follow-up system used for the Mark 27 Gyrocompass. The amplifier has the necessary voltage and the power amplification of the follow-up pickoff signal to drive the azimuth n1otor and n1aintain alignn1ent of the phanton1 yoke with the sensitive element. It also provides stabilization and quick response to the overall follow-up system. It uses other sources of signals to aid in leveling the gyrocompass or to slew it in azimuth during starting.

The servo amplifier is located in the electronic control assembly where necessary interconnections are made between the amplifier, signal source, and power supply. With the exception of the power output transistors, the amplifier components are mounted on a plug-in, subassembly board on the right side of the electronic control assembly as shown in figure 4-32 and easy access to all circuit points is possible by removal of the chassis from the front of the cabinet. The power output transistors are physically mounted on the rear of the cabinet frame which affords heat dissipation.

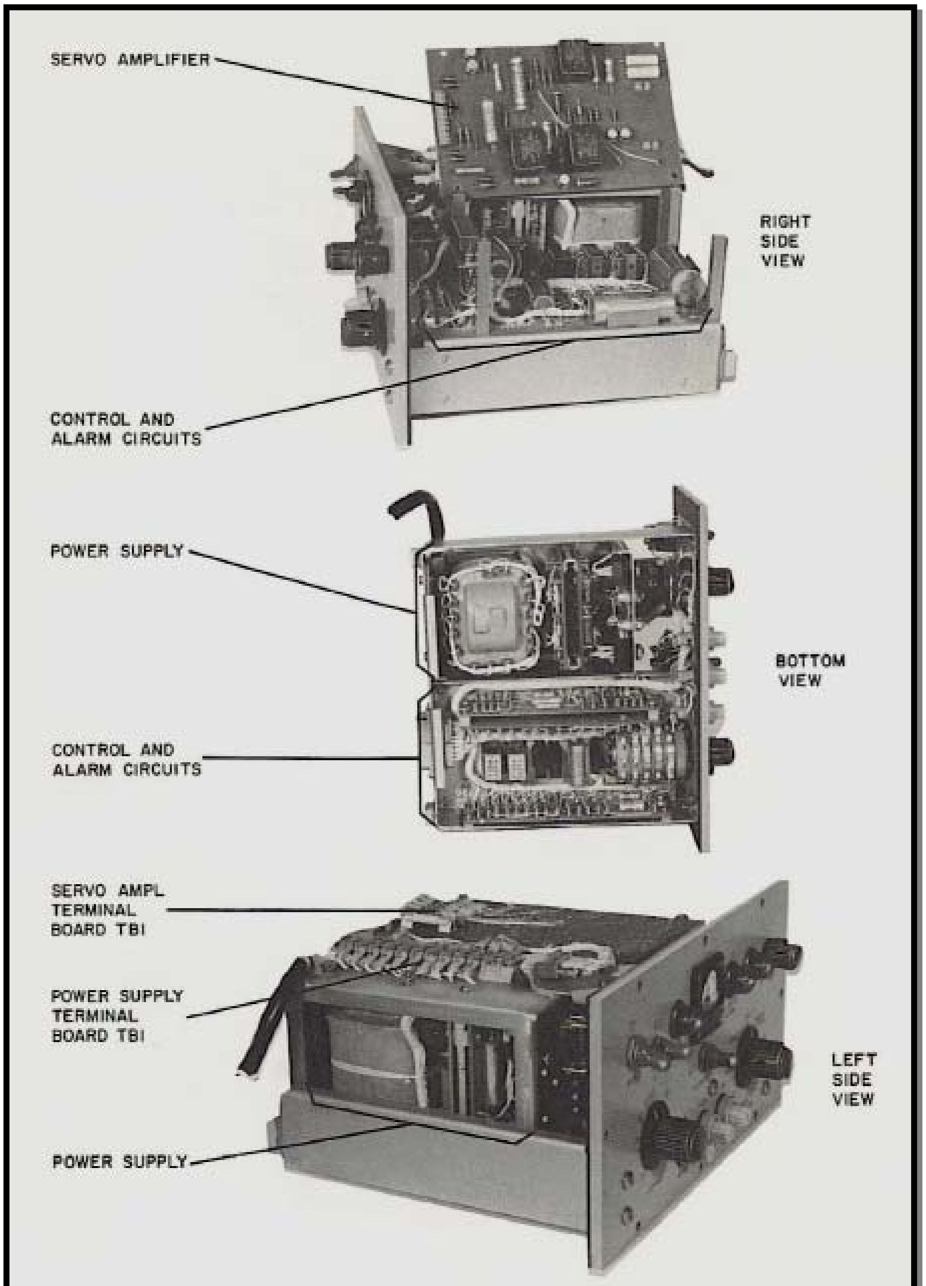


Figure 4-32.— Electronic Control Chassis.

The amplifier is the heart of the gyrocompass follow-up system. From the block diagram of figure 4-33 it can be seen that the amplifier consists of three basic circuits: a single-needed input stage, a driver stage, and a power output stage. Additional stages of demodulation and modulation are used to accomplish feedback.

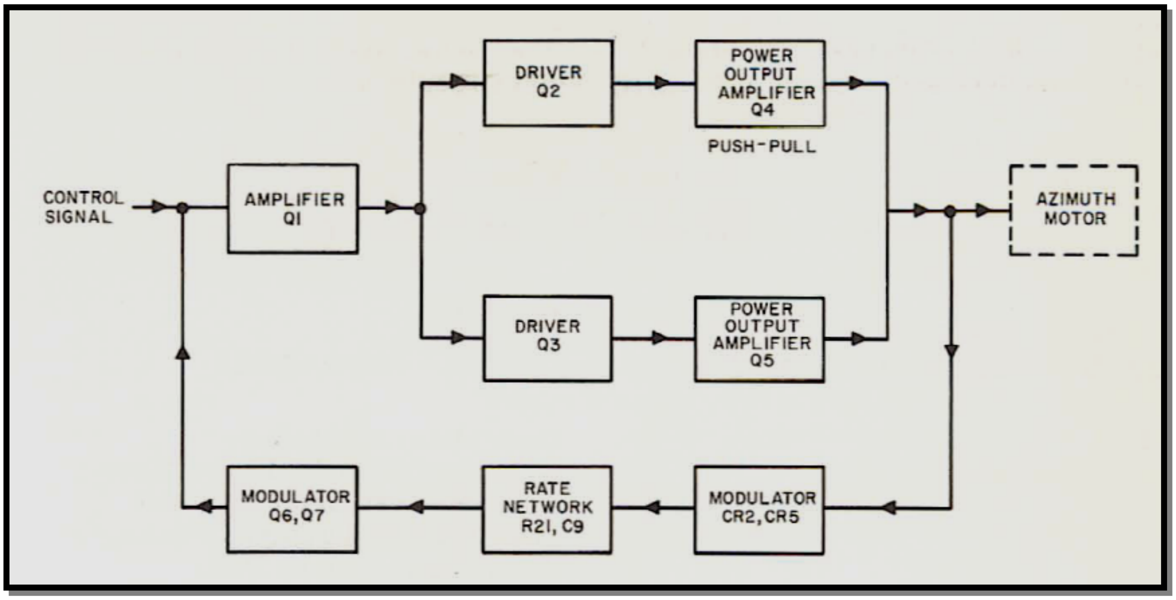


Figure 4-33.— Servo Amplifier, Block Diagram.

The input stage provides amplification of the pickoff signal to control the push-pull driver stage. A driver is utilized for each half of the signal to provide sufficient voltage and power amplification for operation of the push-pull power amplifier stage. Stabilization of the follow-up system is derived from the feedback of a portion of the output signal. To provide rapid response, free from oscillation, this feedback voltage is demodulated and developed into a rate signal. The rate signal is then modulated and mixed with the pickoff signal to give the amplifier the required dynamic characteristics.

Power Supply - The power supply converts the normal 24-volt d-c shipboard power to voltages which meet the power requirements of the Mark 27 Gyrocompass. Where the shipboard power source is a-c power, the Mark 27 Power Converter is used to produce the 24 volts d-c for the input to the power supply.

The power supply chassis is mounted on the left of the electronic control chassis in the Electronic Control Assembly cabinet as shown in figure 4-32 and is accessible without removing the chassis from the control cabinet. The power output and regulator transistors and zener diodes are mounted separately on the frame member at the rear of the cabinet and the cabinet is used as a heat sink. The chassis contains two circuit boards, three transformers, and other directly-mounted components. A terminal board on top provides connection points for the cable coupling the power supply to the transistors located on the rear frame member. A connector is provided to permit easy removal or replacement of the power supply.

4.9.6 AN/WSN-2 STABALIZED GYROCOMPASS SET

The AN/WSN-2 stabilized gyrocompass set provides precision analog dual-speed roll, pitch, and heading signals to the ship's navigation and fire control systems. The set uses an accelerometer controlled, three-axis, gyro-stabilized platform to produce vital heading synchro data and reference, nonvital heading synchro data, and both roll and pitch angle synchro data.

4.9.6.1 Equipment Description

The AN/WSN-2 stabilized gyrocompass set (fig. 4-34) consists of an electrical equipment cabinet and five major assemblies. The five major assemblies are contained within the cabinet. These assemblies are the control indicator, control power supply, battery set, synchro signal amplifier, and inertial measuring unit (IMU).

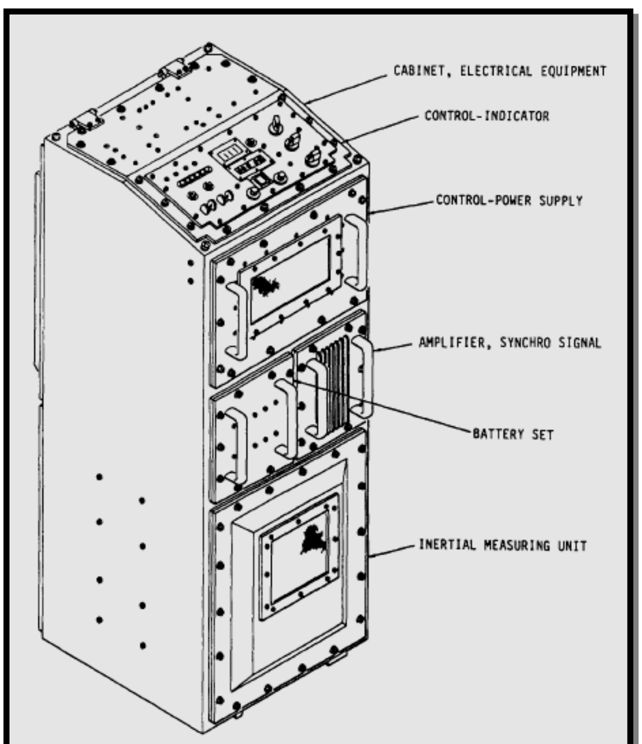


Figure 4-34.—Stabilized gyrocompass set, AN/WSN-2.

4.9.6.2 Electrical Equipment Cabinet

The electrical equipment cabinet (fig. 4-34) provides the mechanical and electrical interface for the five major assemblies. The cabinet also provides forced air cooling for the IMU.

The cabinet contains a wiring harness, alarm relays, power relays, electromagnetic interference (EMI) filters, an elapsed time meter, capacitor assemblies, and a blower for IMU cooling, and the IMU rack. A connector panel located on the rear of the cabinet provides the electrical cable interconnections for cabling to external equipment, including primary power.

Control Indicator

The control indicator (fig. 4-35) is a hinged assembly located in the top of the electrical equipment cabinet. It is secured to the cabinet with quick-release fasteners. The control indicator contains all the operator controls and indicators for the gyrocompass set. The control indicator also contains built-in test equipment (BITE) for the major assemblies and subassemblies. BITE circuits identify equipment faults and provide visual indications of the faulty assembly or subassembly.

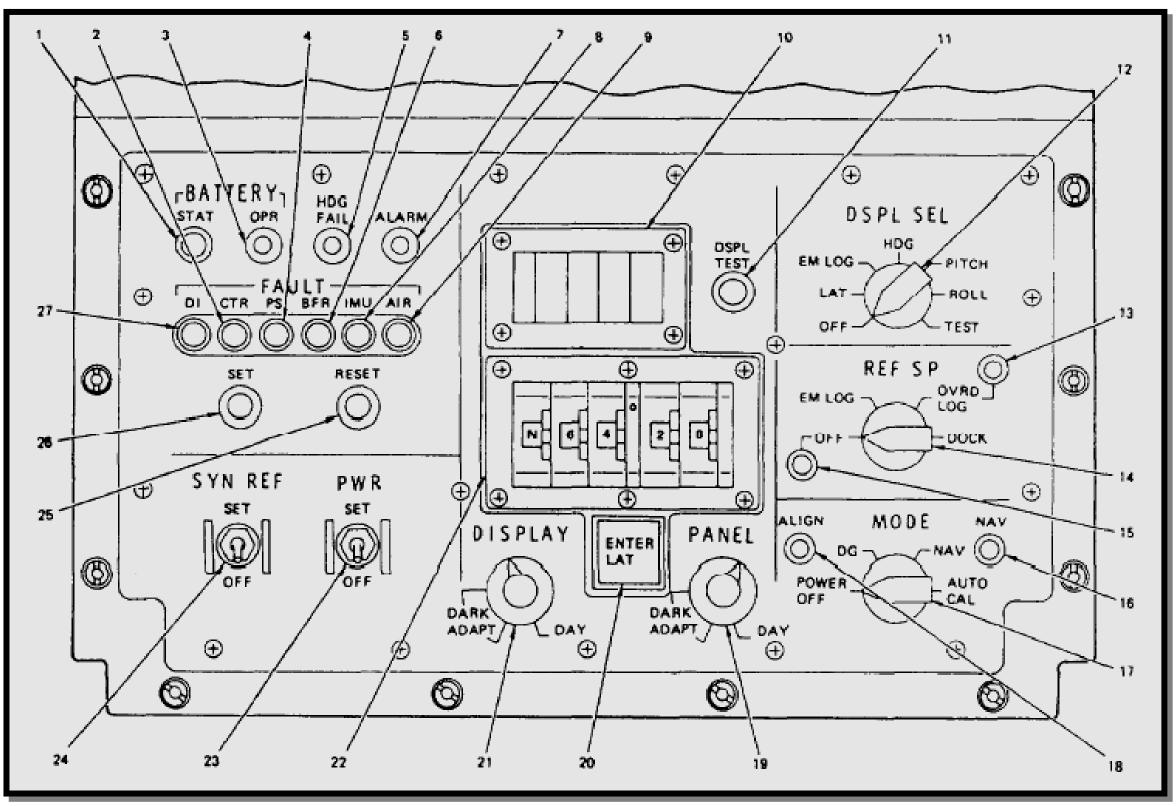


Figure 4-35.—Controls and indicators.

1.	BATTERY, STAT indicator	15.	REF SP, OFF indicator
2.	FAULTY, CTR indicator	16.	MODE, NAV indicator
3.	BATTERY, OPR indicator	17.	MODE switch
4.	FAULT, PS indicator	18.	MODE, ALIGN switch
5.	HDG FAIL indicator	19.	PANEL potentiometer
6.	FAULT, BFR indicator	20.	ENTER LAT switch-indicator
7.	ALARM indicator	21.	DISPLAY potentiometer
8.	FAULT, IMU indicator	22.	Latitude thumbwheel switch
9.	FAULT, AIR indicator	23.	PWR circuit breaker
10.	Display	24.	SYN REF circuit breaker
11.	DSPL Test push-button switch	25.	FAULT, RESET push-button switch
12.	DSPL SEL switch	26.	FAULT, SET push-button switch
13.	REF SP, OVRD LOG indicator	27.	FAULT, DI indicator
14.	REF SP switch		

Figure 4-35 (Cont'd).—Controls and indicators.

CONTROL POWER SUPPLY

The control power supply (fig. 4-36) contains the control, computing, processing, analog/digital conversion, input/output interface, and power supply electronics for the gyrocompass set. The control power supply also contains capacitor assemblies, cooling blowers, BITE, and the battery charging electronics for charging the battery set.

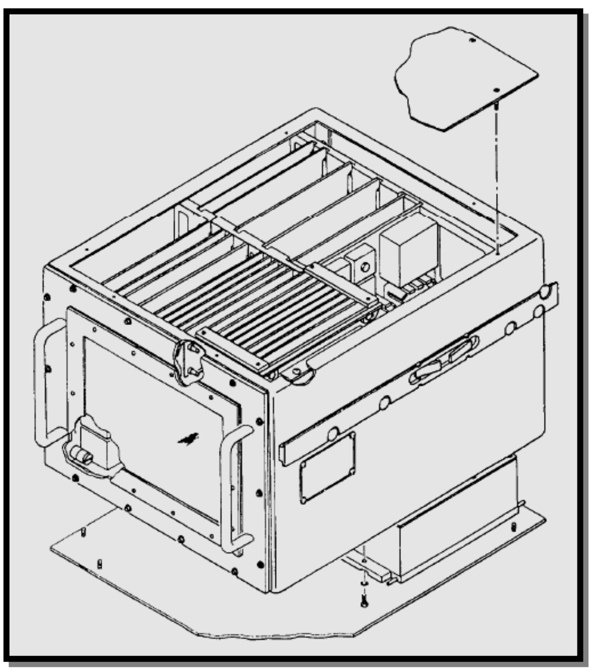


Figure 4-36.—Control power supply.

BATTERY SET

The battery set is installed in the electrical equipment cabinet (fig. 4-34). It is secured in the cabinet by quick-release fasteners. The battery set consists of a battery, isolation diodes, fuses, and sensing circuits. The battery consists of 60 sealed lead-acid storage cells. They are connected in series-parallel, five parallel branches, consisting of 12 cells per branch, to provide a nominal 24-volt output for approximately 30 minutes during normal power failure. The battery set weighs 70 lbs and requires careful handling by two persons when moved. The battery is under a continuous charge, provided by electronics in the control power supply. The fuses provide overload protection in the battery charger input circuit and the battery output. The sensing circuits consist of a high-voltage sensing circuit, a low-voltage sensing circuit, and a temperature sensing circuit. The output of these sensing circuits go to BITE circuits in the control power supply and are routed to BITE indicators on the control indicator.

SYNCHRO SIGNAL AMPLIFIER

The synchro signal amplifier (fig. 4-37) is installed in the electrical equipment cabinet. It is held in the cabinet by quick-release fasteners. The synchro signal amplifier contains four synchro buffer amplifiers, an inverter power supply, cooling blower, and BITE.

The synchro buffer amplifiers provide the voltage and power levels for the gyrocompass heading, pitch, and roll synchro output signals. The inverter power supply converts the battery output to 115-volt, 400-Hz power and converts this to the proper dc levels for the synchro signal amplifier. The inverter power supply also produces ac power for the equipment cooling fans and a vital heading reference output for the gyrocompass set when normal single-phase, 400-Hz power is lost. The inverter power supply also contains BITE summary logic for the synchro signal amplifier.

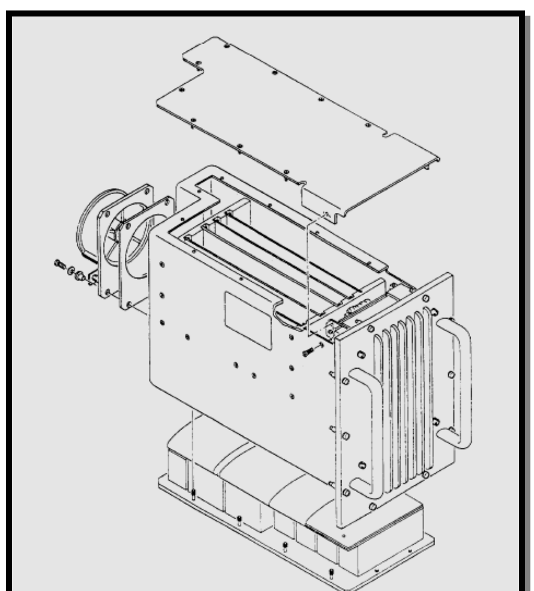


Figure 4-37.—Synchro signal amplifier, exploded view.

INERTIAL MEASURING UNIT

The IMU (fig. 4-38) is installed in a special precision IMU alignment rack located in the bottom of the electrical equipment cabinet, behind an access cover. Access to the IMU is gained by removing the access cover. The IMU contains the gimbal assembly, the electronics necessary to maintain the gimbal assembly, and associated electronics necessary to interface with the control, computing, and processing functions of the control power supply. The IMU also contains BITE circuitry and indicators and houses temperature controlling electronics.

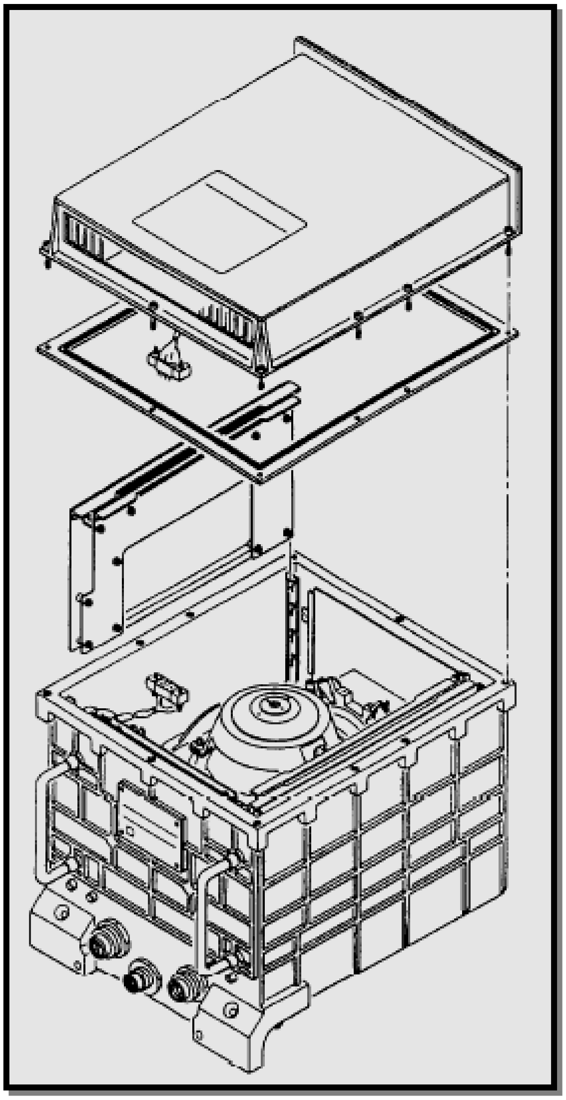


Figure 4-38.—Inertial measuring unit exploded view.

4.9.6.3 FUNCTIONAL DESCRIPTION

The primary function of the stabilized gyrocompass set is to produce precision analog dual-speed roll, pitch, and heading signals for use by the ship's equipment. The outputs are available in all modes during normal operation and battery backup. When operating on inverter produced single-phase power, only vital heading and its synchro reference are available. For the stabilized gyrocompass to operate, it requires certain electrical inputs from the ship. These inputs are 115-volt ac, 400-Hz, single-phase synchro excitation; 115-volt ac, 400-Hz, 3-phase primary power; underwater log data with reference voltage; and 24-volts dc provided internally by the battery set and used during the loss of 3-phase input power.

4.9.6.4 SIGNAL DEVELOPMENT

The roll, pitch, and heading (in some publications referred to as azimuth) located in the IMU gimbal are excited by 26 volts, 4.8 kHz when the gimbal is caged, or by 26 volts, 400 Hz during normal operation. Both resolver excitation levels are provided by the servoamplifier. Each resolver has two outputs, which represent the sine and cosine of the angular displacement of its respective rotor shaft. These outputs are sent back to the servoamplifier when the gimbal is caged. When the gimbal is uncaged, during normal operation, the outputs are sent to the resolver preamplifier.

The roll and pitch sine and cosine signals from the resolver preamplifier are amplified, buffered, and converted to standard three-wire format by the synchro signal amplifier. The data leaves the synchro signal amplifier as S1, S2, and S3 synchro data.

The heading sine and cosine signals from the resolver preamplifier are converted to true heading sine and cosine signals in the 1X and 36X true heading converters before being sent to the synchro signal amplifier and the analog/digital (A/D) multiplexer. The true heading sine and cosine data, like the roll and pitch data, are amplified, buffered, and converted to standard three-wire synchro data in the synchro signal amplifier. True heading data is subsequently sent out as S1, S2, and S3 synchro data.

The roll, pitch, and heading sine and cosine signals from the resolver preamplifier and the true heading sine and cosine signals from the true heading converter are also sent to the A/D multiplexer. The A/D multiplexer sends these analog signals to the A/D converter, where each sine/cosine part is converted to the tangent of the respective angle, in digital format. The tangent values of the roll, pitch, and heading angles are sent to the processor for use in program computations and data updates.

4.9.6.5 MODES OF OPERATION

The stabilized gyrocompass set has three modes of operation: automatic calibration (AUTO CAL), navigate (NAV), and directional gyro (DG). At equipment turn-on, there is a leveling sequence that provides for equipment leveling and initial calibration.

Leveling Sequence

The stable element leveling sequence is initiated upon application of power to the equipment. This is accomplished by moving the MODE switch out of the POWER OFF position. The major elements of the leveling sequence are stable element caging, digital course leveling, tine leveling, gyrocompassing, and calibration.

STABLE ELEMENT CAGING.— Upon energizing and for 10 seconds thereafter, gyro spin power is inhibited by the software program and the stable element is caged. At the end of the delay, the gyros are energized with high spin power. The software program allows 60 seconds for the gyros to gain speed and then perform the gyro synchronization test. If the synchronization test is passed, the program examines the output of the X accelerometer (fig. 4-39) for minimum output, which indicates the platform is level. The software program then checks for proper temperature of the IMU. When the synchronization test, level check and temperature check are successfully completed, the stable element is uncaged and placed under gyro control. Gyro spin power is then set to normal low spin value.

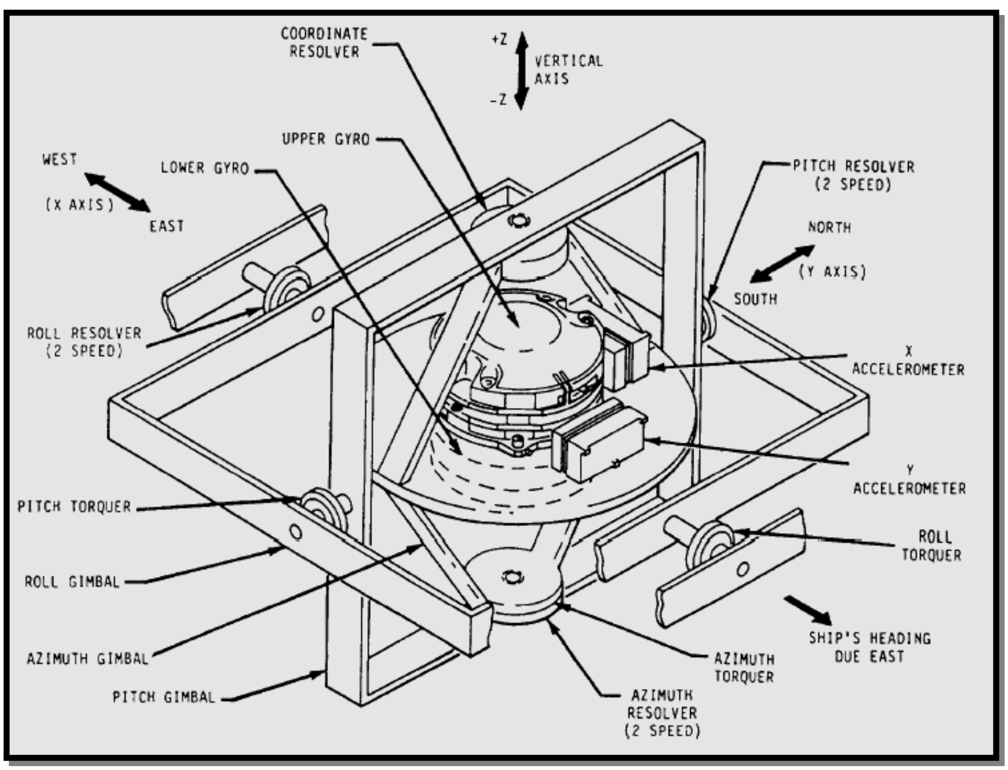


Figure 4-39.—Inertial measuring unit.

DIGITAL COARSE LEVELING.— Upon completion of the caging sequence, all integrators and biases and the alpha (OC) angle (the alpha angle is the angular difference between the stable element's [north-south] axis and true north) are set to zero, and digital course leveling is initiated. Normally, digital coarse leveling requires 1 minute. This time, however, may be lengthened by loop settling delays. Completion of digital coarse leveling is determined by the velocity error signal. When the absolute values of the velocity error signal represent less than 1/2 ft/sec, and 60 seconds have elapsed, digital coarse leveling is complete, and fine leveling is started.

FINE LEVELING.— At the start of fine leveling, as in digital coarse leveling, all integrators, biases, and the alpha angle signal are set to zero. Again, completion of the sequence is determined by the velocity error signals. When the absolute values of these signals represent less than 1/4 ft/sec and 6 minutes have elapsed, fine leveling is completed.

LEVELING COMPLETION.— At the end of the leveling sequence, the software program calculates the alpha angle, establishes an initial value for latitude, and initializes the two direction cosines (pitch and roll angles). If a latitude entry was made at the start or during the leveling sequence, that value will be the initial latitude; otherwise, latitude is set to zero degrees.

GYROCOMPASSING AND CALIBRATION.— A four-step, timed procedure accomplishes the gyrocompassing and calibration sequence. This sequence takes approximately 4 hours and must be completed before the gyrocompass is capable of providing full accuracy outputs. The software program estimates latitude if none was entered by the operator. In either case, latitude information will be updated at the end of the gyrocompassing and calibration sequence. At the completion of the sequence, the MODE NAV indicator light will come on, and the MODE ALIGN indicator light will go out, indicating the gyrocompassing and calibration sequence is completed. Table 4-1 details this sequence.

Step Name	Mechanization Functions	Calibration Functions	Time
East Gyrocompass	Slew Y-axis to -90 degrees	None	0-6 minutes
	Settling Step	None	2 minutes
	Coarse Gyrocompass	Minibias X-axis	37 minutes
	Fine Gyrocompass	Minibias X- and Z-axis and estimate latitude if no entry	20 minutes
	Slew Y-axis to +90 degrees	Accelerometer bias data	6 minutes
	Slew Settle	Estimate Y-accelerometer bias and remove platform tilt	2 minutes
West Gyrocompass	Coarse Gyrocompass	Minibias X-axis	27 minutes
	Fine Gyrocompass	Minibias X-axis, minibias Z-axis, update latitude and compute X-axis bias	20 minutes
South Compass	Slew Y-axis to 180 degrees	None	3 minutes
	Slew Settle	None	2 minutes
	Coarse Gyrocompass	Minibias Y-axis	27 minutes
	Fine Gyrocompass	Minibias Y- and Z-axis	20 minutes
North Gyrocompass	Slew Y-axis to 0 degrees	Bias accelerometers	6 minutes
	Slew Settle	Remove platform tilt	2 minutes
	Coarse Gyrocompass	Minibias Y-axis	27 minutes
	Fine Gyrocompass	Minibias Y-axis, minibias Z-axis, update latitude and compute Y-axis bias	15 minutes

Table 4-1.—Gyrocompassing and Calibration Sequence

Auto Cal Mode

The AUTO CAL mode is used at latitudes below 85° north or south. The AUTO CAL mode is used at initial start-up and should be implemented at least every 90 days during continuous operation to ensure accuracy of outputs. Automatic calibration requires 24 hours to complete but will continue as long as the mode switch is in this position.

Setting the MODE switch to AUTO CAL at anytime after completion of the leveling sequence places the equipment in the AUTO CAL mode. This mode starts an automatic recalibration sequence to determine new gyro biases, accelerometer biases, and latitude corrections. These new values are automatically averaged with old values to accomplish equipment recalibration.

All gyro functions and outputs are maintained in the AUTO CAL mode. The outputs from the IMU resolvers, representing pitch and roll angles, are applied directly to the synchro signal amplifier. The synchro signal amplifier amplifies the resolver input information and transmits dual-speed synchro information to the ship's equipment. Roll and pitch angle information is also sent to the A/D multiplexer.

In the AUTO CAL mode, heading is continuously slewed, completing 360° every 24 hours. The IMU heading signals are sent to the true heading converters. Also applied to the true heading converters is the alpha angle. In AUTO CAL it is set to a value representing 15° per hour. These two signals are combined in the true heading converter to develop true heading information. The output of the true heading converter is sent to the synchro signal amplifier for amplification and distribution to the ship's equipment and is sent to the A/D multiplexer for use by the processor.

The digital display indicator provides for local display of the quantities shown in table 4-2. Data for display is selected by the DSPL SEL switch.

DSPL Sel switch position	Data displayed	Range	Resolution	Remarks
LAT	Latitude	0 to 90 degrees	1 minute	Sign of latitude is not displayed; degree and minute marks are displayed
EM LOG	LOG velocity	0 to 99.9 knots	0.1 knot	leftmost digit is not used
HDG	True heading	0 to 359.9 degrees	0.1 degrees	
PITCH	Pitch	0 to +/- 99.9 degrees	0.1 degrees	Positive (bow down) sign is blank
ROLL	Roll	0 to +/- 99.9 degrees	0.1 degrees	Positive (starboard up) sign is blank
TEST	Test Pattern.	The program shall display all 0000's, 1111's through all 9999's. The pattern shall change approximately each second.		

Table 4-2.—Data Display Parameters

Nav Mode

The NAV mode, the primary operating mode, is mechanized the same as the AUTO CAL mode. In the NAV mode, the heading is not slewed and the alpha angle is held at zero; thus, the equipment becomes a north-pointing gyrocompass.

The NAV mode is the normal mode of operation and is used between latitudes 85° north or south. If the NAV mode is initially selected as the mode of operation, the alignment sequence must be completed before the gyrocompass is capable of providing full accuracy outputs. This sequence takes approximately 4 hours. The alignment sequence is completed when the MODE ALIGN indicator goes off and the MODE NAV indicator comes on.

DG Mode

The DG mode is used at latitudes above 85° north or south. When the gyrocompass is operating in the DG mode, the stable element is dampened by velocity signals and allowed to wander in azimuth. Earth rate correction is made by torquing the stable element in azimuth. The alpha angle is held constant and grid heading, rather than true heading, is sent to the ship's equipment. Otherwise, the equipment's function is the same as for the AUTO CAL mode.

4.9.6.6 SUPPORTING FUNCTIONS

The major functions of the stabilized gyrocompass are supported by several supporting or subordinate functions. The supporting functions are described in the following paragraphs.

Latitude Set

The entry of latitude data maybe made during the leveling sequence (except during the north and south gyrocompassing phases) and at anytime the system is NAV ready. The gyrocompass is ready to receive a latitude entry when the ENTER LAT switch indicator (Fig. 4-35) is on. The software program commands the ENTER LAT switch indicator on when power is applied and when the position of the MODE switch is changed. If the ENTER LAT switch-indicator is not on, entry can be accomplished by pressing the ENTER LAT switch indicator ONCE. The gyro compass will then be able to receive a latitude entry for 1 minute.

With the DSPL SEL switch set to LAT and the ENTER LAT switch indicator on (fig. 4-35), latitude entry is made by setting the desired latitude (hemisphere, degrees, and minutes) with the thumbwheel switch, then pressing and releasing the ENTER LAT switch indicator. The ENTER LAT switch indicator will go off and the selected latitude will be displayed on the digital display.

Data Display

Several pieces of data are available for display on the control indicator panel. The data available for display is latitude, electromagnetic (EM) log, ship's heading, pitch, roll, and test (table 4-2). The desired data is displayed by setting the DSPL SEL switch to the appropriate position. Also, under software control, but not selectable, are the MODE, ALIGN indicator, and the MODE, NAV indicator. When the alignment sequence is complete, the software program turns the MODE, NAV indicator on, and the MODE, ALIGN indicator off.

Reference Speed Selection

The software program controls the reference speed selection function. The REF SP switch is positioned by the operator to define to the software program the operational mode required. In the OVRD LOG position, the REF SP switch provides a ground via the dimming control circuit card to energize the OVRD LOG indicator. The REF SP OFF indicator is controlled by the processor.

The ship's EM log input is changed from synchro format to sine and cosine values by the Scott "T" transformers in the A/D multiplexer transformer. The EM log sine and cosine signals are selected by the A/D multiplexer and converted to a tangent value, in digital format, by the A/D converter. The EM log tangent signal is then applied to the processor. When the REF SP switch is set to OFF, the processor ignores the EM log inputs and the gyro operates in the free inertial state. When the REF SP switch is set to EM LOG, the processor tells the software program to implement gyro operation, damped by the EM log velocity information.

The EM log velocity information is monitored for reasonableness by the software program. When it determines that the velocity information does not meet the reasonableness test, the processor will command the equipment to ignore the velocity data and operate in the free-inertial state. The processor will also initiate a reference speed off signal, causing the REF SP, OFF indicator to light. The operator can override the reasonableness test by setting the REF SP switch to OVRD LOG. In the OVRD LOG position, the processor disables the velocity monitor and commands the software program to use the EM log velocity information for damping purposes. The REF SP, OFF indicator will go off, and the OVRD LOG indicator will come on, indicating the equipment is operating in a damped state.

When the REF SP switch is set to DOCK, the processor tells the software program to use a zero reference velocity for damping instead of the EM log velocity input.

Illumination Control

Two circuits control the level of illumination of the control-indicator's panel lighting and indicators. These circuits are illustrated in block diagrams in figures 4-39 and 4-40.

PANEL LIGHTING.— The control indicator panel lighting is controlled by a potentiometer marked PANEL. The PANEL potentiometer is excited by ±15 volts dc. The potentiometer adjusts a biasing level applied to the illumination sensing circuit in the dimming control circuit card. The output of the sensing circuit drives the dimming control amplifier. The output of the dimming control amplifier is an aboveground variable voltage determined by the position of the PANEL potentiometer. Figure 4-39 identifies the lights controlled by the PANEL potentiometer.

STATUS INDICATOR AND DISPLAY LIGHTING.— The control indicator's status indicators and the digital display are controlled by the DISPLAY potentiometer. The potentiometer provides a triggering level input (0 volts to +5 volts) to a controlled-width blanking pulse circuit, located on the dimming control circuit card. The blanking pulse is applied to the indicator enabling logic, also on the dimming control circuit card. When the input to any indicator, controlled by the DISPLAY potentiometer, is determined to be correct by the display logic, the indicator is energized.

The period of the blanking pulse, established by the DISPLAY potentiometer, determines the illumination level. Indicators on the control indicator that are controlled by the DISPLAY potentiometer are shown in figure 4-40.

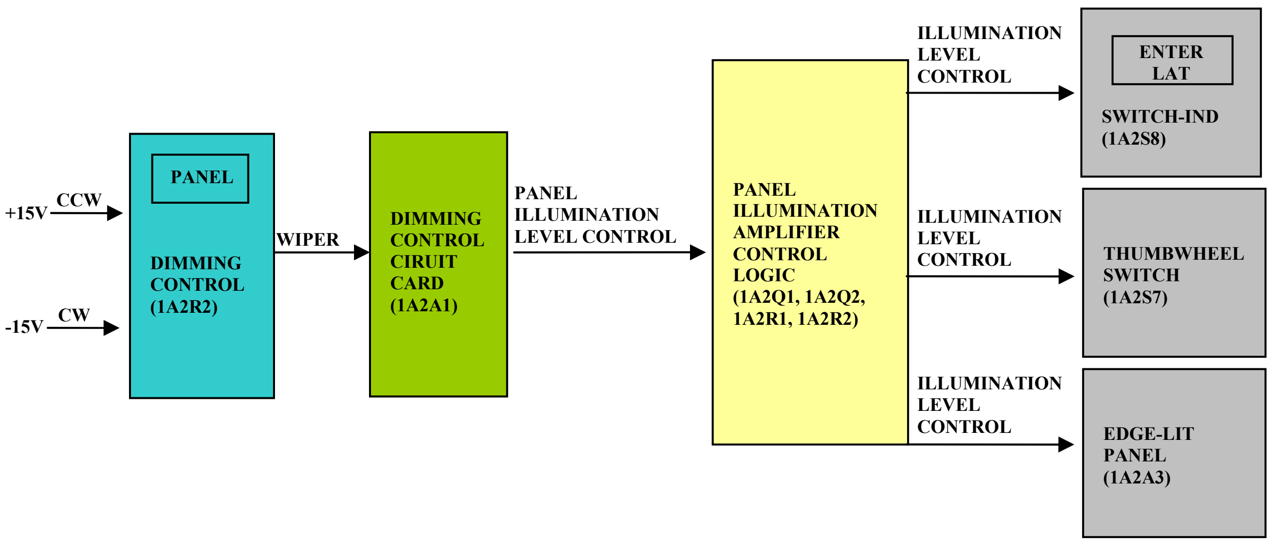


Figure 4-39.—Panel lighting dimming block diagram.

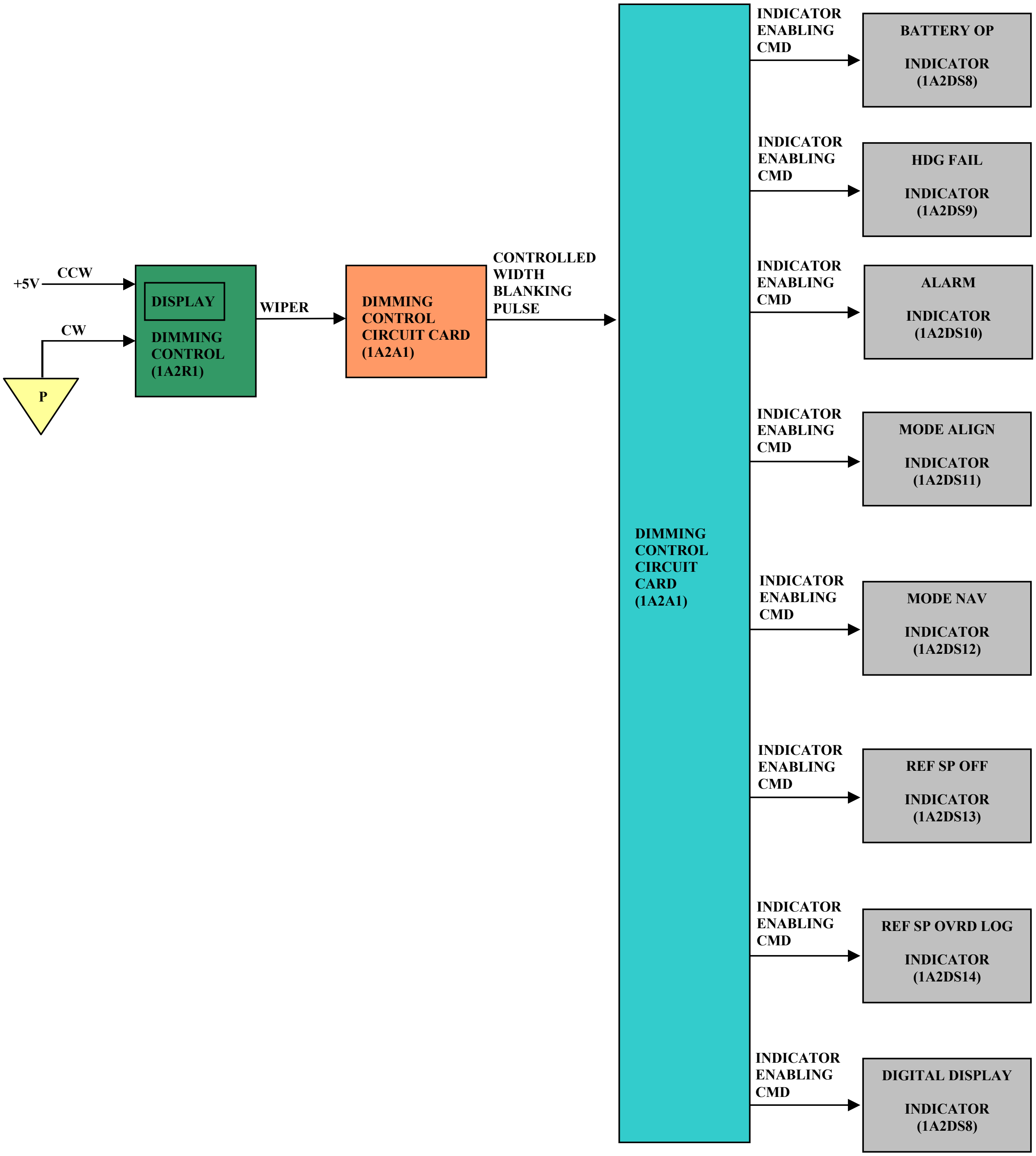


Figure 4-40.—Indicator and display lighting dimming block diagram.

Power Supplies
There are two power supplies to the AN/WSN-2 gyrocompass. These are the backup power supply and the normal power supply.

BACKUP POWER.— The backup power supply consists of the inverter and the inverter module, located in the synchro signal amplifier, for backup during loss of single-phase power, and the battery set and relays located on the transformer-rectifier assembly, for backup during loss of 3-phase power.

NORMAL POWER.— The normal power supply consists of the control monitor, battery charger, 5-volt regulator, 13-volt regulator, DC/DC module, and transformer rectifier. These are all located in the control power supply. Three-phase, 115-volt ac ship's power is routed through an EMI filter and power circuit breaker to the transformer rectifier for normal power. The transformer rectifier converts the 115 volts ac to 35 volts dc and unregulated 28 volts dc. The 35 volts dc goes to the battery charger and the unregulated 28 volts dc is sent to the 5-volt and 13-volt regulators.

The battery charger receives high- and low-voltage sensing signals and a temperature-sensing signal from the battery set. The battery charger uses the temperature-sensing signal to regulate the 35 volts dc to provide a charging voltage to the battery set. The charging voltage is present as long as the 3-phase, 115-volt ac ship's power is available and turned on.

The unregulated 28 volts dc is applied to the 5-volt and 13-volt regulators. The 5-volt regulator reduces the unregulated 28 volts dc to a regulated 5 volts dc, which is distributed to all using circuit cards and assemblies. The 13-volt regulator reduces the unregulated 28 volts dc to a regulated 13-volt dc level, which powers the DC/DC module. The 13-volt regulator is turned on before the 5-volt regulator to allow the DC/DC module and equipment to stabilize before the distribution of the 5 volts dc. The DC/DC module provides output voltages of +28 volts, -28 volts, +15 volts, -15 volts, +20 volts floating, +50 volts, and +50 volts floating. Floating indicates those voltages are isolated from power ground.

Single-phase, 115-volt ac ship's power is applied to the gyro by an EMI filter, a relay, and the SYN REF (synchro reference) circuit breaker. The single-phase, 115 volts ac provides power for the inverter magnetic module, internal resolver reference, and a vital heading reference output.

The gyrocompass will automatically switch to battery operation when the 3-phase or single-phase ship's power input is lost, loses a phase, or exceeds prescribed voltage or frequency tolerances. If the single-phase input is lost or exceeds tolerances, the system will shift to inverter backup.

The gyro is turned on and off by logic circuits in the control monitor, which is located in the control power supply.

Certain conditions will cause the control monitor to automatically turn the gyro off. These conditions are over-temperature, power supply fault, IMU fault, and battery under voltage when operating on the battery. When automatic shutdown occurs, the control monitor turns the gyro off as if the MODE switch were turned to the POWER OFF position, with one exception. Built-in test signals are applied to the control power supply to energize the proper fault indicators and alarms.

BITE circuits in the control monitor continuously check the 5-volt regulator, 13-volt regulator, DC/DC module, transformer rectifier, and inverter assembly outputs for over- and under-voltage conditions. They also monitor the frequency and voltage of the 3-phase and single-phase, 115 volts ac and the power supply temperature.

Built-in Test Equipment

The BITE provides four types of built-in tests. These are hard-wired, software, software-initiated, and software-monitored built-in tests. The hard-wired BITE consists of test logic that is wired directly to the fault circuits. Fault signals that start the automatic shutdown sequence are hard wired. The software built-in tests are tests that are controlled by the processor, rather than by hard-wired logic circuits. The software-initiated BITE consists of hard-wired logic circuits that are activated by the processor. The software-monitored BITE circuits are not wired directly to fault circuits. Instead, the monitored parameters are compared to predetermined parameters known to the software. If the monitored parameters are determined to be wrong, the appropriate fault indicator is energized; and if the fault warrants, the gyro is shut down. When any fault is detected by the BITE, the ALARM indicator on the control indicator and the appropriate fault indicator are energized.

The fault indicators are located on the control indicator. They are labeled FAULT AIR, FAULT DI, FAULT CTR, FAULTPS, BATIERY STAT, BATTERY OPR, FAULT BFR, HDG FAIL, FAULT IMU, and ALARM. These indicators serve to lead the operator to the failed area of the system.

FAULT INDICATORS.— The FAULT AIR indicator is energized when an over-temperature condition occurs in the power supply section of the control power supply, synchro signal amplifier, or the IMU. When this condition exists, an over-temperature no-go signal is sent to the control monitor, which starts the automatic power shutdown sequence.

The processor monitors the control signals from the control indicator. When erroneous control output signals are detected, the processor sends out signals that energize the FAULT DI indicator and the ALARM indicator.

The circuit cards, in the control section of the control power supply, are monitored and tested by the processor. When a circuit card fails, the FAULT CTR and ALARM indicators on the control indicator are energized. A combination of the six indicators, located inside the control power supply, will be energized, indicating which circuit card is faulty.

BITE logic circuits in the control monitor continuously monitor the 5-volt regulator, 13-volt regulator, DC/DC module, battery charger, and battery set for overvoltage and under-voltage conditions. If an under-voltage condition in the battery charger occurs, the control monitor sends a battery status signal to the control indicator, setting the BATTERY STAT indicator. If an overvoltage condition occurs in the battery charger, 5-volt regulator, 13-volt regulator, or DC/DC module, the fault indicator on the faulty card will set, and the control monitor will send a signal to the control indicator, energizing the FAULT PS indicator. The control monitor will also turn off the 5-volt regulator, 13-volt regulator, and DC/DC module when an overvoltage condition occurs. The fault indicators will remain set after the power supply is turned off. A gyro over-temperature condition, failure of the servoamplifier or gyro spin supply will also initiate no-go commands to the control monitor, which will shut down the power supply.

The control monitor also senses the voltage and frequency of the 3-phase, 115-volt ac power and synchro reference inputs at the transformer rectifier. If the 3-phase input is lost or exceeds tolerances, the control monitor will switch the gyro to battery operation and send a signal to the control indicator, causing the BATTERY OPR indicator to come on. If the single-phase input is lost or exceeds tolerances, the control monitor will disconnect the ship's faulty input switch on the inverter, sending a signal to the control indicator, causing the ALARM indicator to set.

Circuit cards and assemblies in the synchro signal amplifier we monitored by hard-wired BITE. The 1X heading amplifier, 36X heading amplifier, roll amplifier, pitch amplifier, and inverter in the synchro signal amplifier have fault indicators located on the individual circuit cards. The fault indicator on the inverter sets when the inverter or inverter magnetics module fails. A fault in any of these circuit cards or module will cause the fault indicator on the respective faulty circuit card to set and a BITE fail signal to be sent to the fault summary logic located in the inverter. The inverter then sends out a signal causing the FAULT BFR indicator on the control-indicator to set.

If either of the heading amplifiers fail, the inverter will send a heading fail signal to light the HDG FAIL indicator on the control-indicator. If the inverter or inverter magnetics module fail during inverter operation, the inverter sends a signal to the control monitor to command a power shutdown. A failure of either the servoamplifier or gyro spin supply, located in the IMU, causes a no-go signal to be sent to the control monitor. The control monitor initiates a power shutdown and the IMU fault indicator on the control indicator to set.

Circuit cards and assemblies in the IMU are tested by a combination of hard-wired and software-monitored BITE. When either the servoamplifier or gyro spin supply circuit card fails, a hard-wired BITE fail signal is sent to the control monitor, which was discussed in the preceding paragraph. The gyro spin supply circuit card is also tested under control of the processor. The remaining circuit cards and assemblies are tested by the processor. If the processor detects a fault, a signal is sent, causing the four indicators located on the front of the IMU to set in the proper combination to indicate the faulty card. The control indicator also receives a signal, setting the FAULT IMU indicator.

ALARM RELAYS.— A circuit card in the control power supply contains alarm summary logic for the BITE circuits. The alarm summary logic receives hard-wired BITE fault signals, alarm signals from faults detected by the processor, and alarm signals from the transformer rectifier via the control monitor. Any one or all of these signals will cause the alarm summary logic to send a signal to the control indicator, lighting the ALARM indicator, and an alarm relay on signal to the normally energized alarm relay. The alarm relay on signal causes the alarm relay to reenergize, completing the circuit for the malfunction summary alarm.

When the 3-phase power input is lost or exceeds tolerances, the control monitor switches the operation to battery power and sends out an alarm signal to the circuit card containing the alarm summary logic. The alarm summary logic sends a signal to the on-battery relay, which is normally de-energized. When this relay energizes, it completes the circuit for the on-battery alarm.

4.9.6.7 SECURING PROCEDURES

To secure the AN/WSN-2 compass under normal conditions, refer to figure 4-35 and perform the following steps:

1. Set the MODE control to the POWER OFF position.

2. Place the SYN REF switch to the OFF position.

3. Place the PWR switch to the OFF position.

To secure the compass under emergency conditions, refer to figure 4-35 and perform the following steps:

1. Place the PWR switch to the OFF position.

2. Place the SYN REF switch to the OFF position.

3. Set the MODE control to the POWER OFF position.

4.9.6.8 WATCH STANDING
The AN/WSN-2 operates unattended after a mode of operation has been selected and the automatic alignment sequence is completed. Audible and visual extension alarms will alert watch standers at various locations upon loss of normal power to the compass or if a malfunction exists within the compass.

4.10.0 AN/WSN-7B(V) RING LASER GYROCOMPASS (RLG) INERTIAL NAVIGATION SYSTEM
The AN/WSN-7B(V) (Figure 4-41) is a self-contained system whose Inertial Measuring Unit (IMU) employs three RLGs and three accelerometers, in strapdown configuration. Unlike a stabilized gimballed system, high speed digital processing is employed to determine the ship's attitude (pitch, roll, and heading). The AN/WSN-7B(V) requires external ship's speed input and periodic input of position data. It uses ship's log speed to provide damping of vertical gyro loops. Position data from the Global Positioning System (GPS) is used to calibrate gyro drifts and to provide position resets to the inertial navigation function. The inertial sensor, speed, and position reset data are processed to generate continuous, accurate position and velocity data, in addition to heading, roll, and pitch reference.

4.10.1 Normal Operation
The AN/WSN-7B(V) is designed to operate automatically after application of power and requires minimum operator intervention during normal operation. A six-line, 40-character display and 28-key keypad provide display and operating controls for selection of a wide range of functions. These functions can be accessed for monitoring and modifying operating parameters, for evaluating system performance, and for selecting test and calibration modes.

4.10.2 Test Features
A Built-In Test (BIT) function, incorporating both hardware and software tests, continuously monitors operation and periodically performs self-tests to determine the integrity of the AN/WSN-7B(V) and its inputs/outputs. Faults are automatically announced and fault codes which indicate the type of fault detected are displayed on the local control panel.

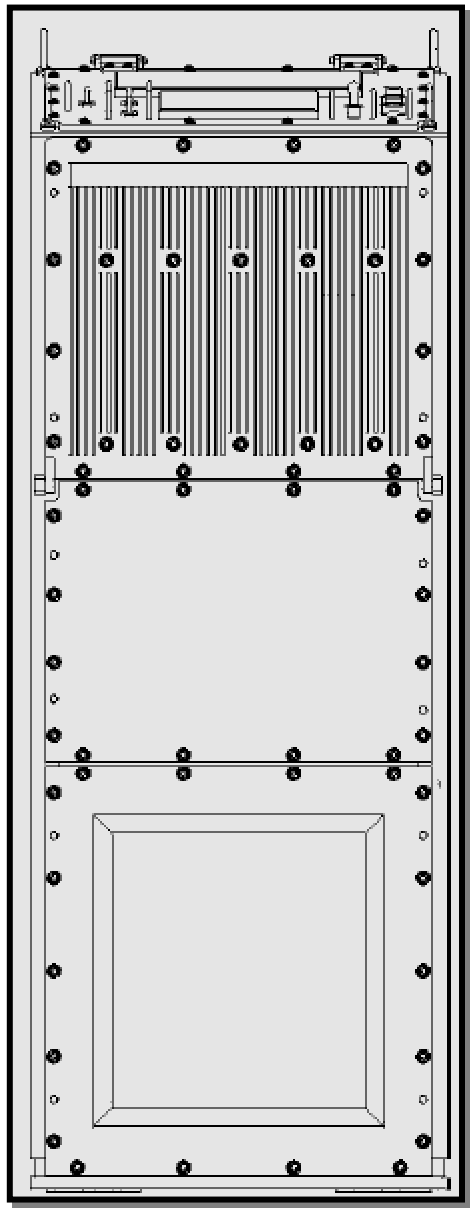


Figure 4-41.— AN/WSN-7B(V) Ring Laser Gyro.

4.10.3 Power

In the configuration described in this technical manual, the AN/WSN-7B(V) requires 115 VAC, 60 Hz or 400 Hz, 3-phase power; and 115 VAC, 400 Hz, single-phase synchro reference. An internal battery and inverter provide emergency power for operation with digital output and synchro heading and attitude output for a limited period of time in the event of failure of the ship's power input. Table 4-3 lists the major design and physical characteristics of the AN/WSN-7B(V).

ENVIRONMENTAL CHARACTERISTICS	
Temperature	Operating Full accuracy: 0 to 50 C (32 to 122 F) Operating without damage: 0 to 65 C (32 to 149 F) Storage: -40 to 75 C (-40 to 167 F)
Humidity	0 to 95% (non-condensing)
Shock	Meets the requirements of MIL-STD-901D. System functions may be interrupted during application of shock.
Vibration	Meets the requirements of MIL-STD 167-1 for Type 1 equipment.
Linear Acceleration	1 G PEAK (PLUS GRAVITY)
Magnetic Fields	Operating: 20 Gauss Non-operating: 30 Gauss
PHYSICAL/ELECTRICAL CHARACTERISTICS	
Size	Height: 1215 mm (47.84 in) Width: 435 mm (17.13 in) Depth: 486 mm (19.12 in)
Weight	With IMU198 kg (435 lbs)
Primary Power	115 VAC, 3 phase, 60 or 400 Hz
Power requirements	500 VA
Heat dissipation to air	300 Watts (max)

Table 4-3.— Design and Physical Characteristics.

Heading, roll, and pitch output is provided as analog (synchro) data. Synchro Buffer Amplifier (SBA) is installed to provide additional load capability for the 1X and 36X heading outputs. Table 4-4 lists the synchro output characteristics and defines the synchro reference requirements.

ANALOG INPUT (SHIP'S LOG)	
Reference	115 VAC, 60 or 400 Hz
Format	90 V Low-Level (L-L) Synchro
Scaling(1)	20 - 125 Knots/Revolution
Fore/Aft Gradient(1)	90/10 or 50/50 percent
REFERENCE VOLTAGE (NON-VITAL):	
Synchro reference voltage is applied to the system from the ship's 400 Hz main power. Non-vital reference voltage and the synchro signals are affected in amplitude and frequency by variations in the reference voltage.	
Voltage/Frequency	115 VAC, 400 Hz
Power capacity	100 VA
Grounding	Must not be grounded
ANALOG OUTPUT: (HEADING, ROLL, PITCH)	
Reference	115 VAC, 400 Hz
Format	90 V L-L Synchro
Synchro Load	Vital Heading: 100 ma Roll and Pitch 25 ma
Two Speed (Heading)	Fine 36:1 (10 degree/revolution) Coarse 1:1 (360 degree/revolution)
Two Speed (Roll and Pitch)	Fine 36:1 (10 degree/revolution) Coarse 2:1 (180 degree/revolution) or 1:1 (360 /revolution)(2)
NOTE: (1) Selectable at installation based on Speed Log. (2) Selectable at installation based on attitude user requirements.	

Table 4-4.— Analog Synchro Input/Output and Reference Characteristics.

4.10.4 External Data Interfaces

The basic digital data interface to the AN/WSN-7B(V) includes an RS-422 Input/Output (I/O) channel which provides interface for Doppler Sonar Velocity Log (DSVL) digital speed input, an RS-422 interface for an external (optional) Remote Control Display Unit (RCDU), and one spare RS-422 interface which can be configured for specific serial data requirements. Table 4-5 lists the functions and characteristics of the three standard serial digital data interfaces.

I/O PORT	DATA CHARACTERISTICS
RCDU Interface (1J16)	Data Rate - 9,600 bits/second
	Transmitted Character Format:
	1 start bit
	8 data bits
	1 stop bit
	Bits total: 10
	Least significant bit is transmitted first
DSVL Interface (1J7)	Data Rate - 9,600 bits/second
	Transmitted Character Format:
	1 start bit
	8 data bits
	1 stop bit
	Bits total: 10
	Least significant bit is transmitted first
	Signal Polarity (Output signals are referenced to AN/WSN-7B(V) ground):
	MARK: RS422 + High, RS422 - Low
	SPACE: RS422 + Low, RS422 - High
NMEA GPS Serial Digital Input and User Configurable Output (1J17)	Input: NMEA Serial Data Input from GPS Output: Configured Serial Data Output Message (See Note)
NOTE: The message content and data characteristics of this interface output are configurable. If this interface is used, the details of the message configurations and their specified data characteristics are given in the Interface Design Document (Litton Marine Systems document number 280-28901). Message type and content are selected at installation to match user requirements associated with the specific installation. Refer to Chapter 8 of S9427-AT-MMO-010/WSN-7**,** Table 8-5, for interface configuration possibilities.	

Table 4-5.— Standard Digital (RS-422A) Data Interface.

4.10.5 Maintenance Concept

The AN/WSN-7B(V) is designed for ease of maintenance through a modular design. Lowest Replaceable Units (LRUs) include the IMU, circuit cards, power supply, fuses, relays, and switches. All circuit cards and the power supply are connectorized for easy replacement. Replacement of relays and switches can be accomplished using standard screwdrivers and wrenches; no soldering or de-soldering is required. The IMU is positioned by precision alignment surfaces. IMU alignment offset parameters are maintained in a Programmable Read-Only Memory (PROM) on the Inertial Electronics (IE) card in the IMU.

This feature, along with optical calibration data which is stored in Non-Volatile Random Access Memory (NVRAM) and Indexer Assembly alignment calibration data stored in a PROM (U20) on the Sensor Interface Circuit Card Assembly (CCA) (A13) in the card rack, allows the IMU to be replaced without the requirement to optically realign the system. In addition, the system uses a passive cooling design, eliminating the need for periodic shipboard maintenance for air-filter replacement.

4.10.6 Units and Assemblies

The AN/WSN-7B(V) cabinet is a single unit which is bolted directly to the ship's deck in a sheltered naval environment (i.e., not on the weather deck). The cabinet can be oriented in azimuth to any multiple of 90 degrees relative to the ship's keel. The AN/WSN-7B(V) must be optically aligned at installation using an alignment fixture which is temporarily mounted to Indexer Assembly mounting surfaces inside the unit. Alignment is then obtained by measuring offsets between the Alignment Fixture and the ship's reference lines. The AN/WSN-7B(V) includes the following functional elements:

- Display/Control Panel
- IMU
- Mechanical Indexer Assembly
- IMU/Shock Isolation System (SIS) Assembly
- Card Rack Backplane Assembly containing the following CCAs:
    - Digital Processing and Sensor I/O Function Circuit Cards (3)
    - Indexer Control Electronics Circuit Card (1)
    - 4-Channel RS-422 Serial Data Interface Card (1)
    - Digital-to-Synchro/Synchro-to-Digital (D-S/S-D) Converter Circuit Cards (2)
    - Optional Interface Cards (up to 4)
- Battery-Backed Power and Power Fault Detection System consisting of the following assemblies:
    - Electro-Magnetic Interference (EMI)/Radio Frequency Interference (RFI) Filter (1)
    - 25 VAC/DC, DC/DC Power Supply (Transformer Rectifier) (1)
    - Battery (1)
    - DC/AC Inverter Power Supply (1)
    - Vital Bus(fault detector) Printed Wiring Assembly(1)
    - Low Voltage Power Supply (1)

- Status and Alarm Relays (3) and Status Fault Indicator lamp (1)

Table 4-6, lists the AN/WSN-7B(V) subassemblies. Some of the subassemblies contain programmed devices. Other subassemblies are calibrated by installing an associated PROM, which contains factory established calibration parameters.

A calibration PROM, which is installed in socket XU20 on the Sensor Interface CCA (A13) in the card rack, contains calibration parameters for the Indexer Assembly in the AN/WSN-7B(V) cabinet. This PROM is serialized to the Indexer Assembly and must always remain with the system if Sensor Interface CCA (A13) is replaced with a new card. Programmed subassemblies are identified by a part number which includes the hardware with the programmed devices installed. The subassembly part number without the programmed device is also provided; however, only the part number for the subassembly with the programmed configuration is applicable for replaceable assemblies.

ASSEMBLY	NOTES	ASSEMBLY PART NO.	NAME/FUNCTION
(Unit 1)		1982852-var	**AN/WSN-7B(V) RING LASER GYRO**
1A1		1900123	EMI/RFI Filter Assembly
1A2		1982618	Inverter Assembly (400 Hz)
1A3		1978322	Vital Bus CCA
1A4		1982863	Backplane Assembly
1A5		1982847	Battery Assembly
1A6		1900556	Power Supply (Transformer/Rectifier) Assembly
1A7		1983228-1	Battery Charger Assembly
1A8		1983179-1	Low Voltage Power Supply
1A9		1859873	Membrane Keypad
1A10		1977647	Panel Interface Assembly
1A11		1813734	Central Processor CCA (Nav Processor) CCA
1A12		1980513	Status and Command CCA
1A13	(Note 1)	1982430	Sensor (IMU) Interface CCA
1A14		1979087-3	Synchro Converter Assembly CCA
1A15		1979087-3	Synchro Converter Assembly CCA

Table 4-6.— List of Electrical Units and Assemblies.

ASSEMBLY	NOTES	ASSEMBLY PART NO.	NAME/FUNCTION
1A16		1981171	Quad Serial Interface CCA
1A17		1983222	Indexer Electronics CCA
1A18		1982915	IMU Assembly (MX-11906/WSN-7B)
1A19	(Note 2)	1900157	Indexer Assembly (Calibrated)
(1A13U20)	(Note 2)	1900158	Indexer Assembly Calibration PROM
1A20		1900228	Plasma Display
1A21		1976545-3	Synchro Buffer Amplifier (8 VA)
CABLE AND HARNESS ASSEMBLIES			
1W1		1983494	Main Harness Assembly
1W2	(Note 3)	1900013-2	Fiber Optic Cable
1W3		T967883	Ribbon Cable (Keypad)
1W5		1982880	Cable Assembly
1W6 - 1W11	(Note 4)	P/O 1983494 (1W1)	Triaxial Cable Assembly

NOTE:

1. The Sensor (IMU) Interface CCA contains sockets for two calibration PROMs. One PROM is not needed for the AN/WSN-7B(V) equipment configuration. The second PROM is serialized to the Indexer Assembly (1A19). This PROM is programmed during factory calibration with correction parameters which are used by the system to compensate for mechanical offsets. The indexer calibration PROM must be replaced with the correct serialized PROM if the Indexer Assembly is replaced.

2. Indexer Assembly 1900157 is a calibrated assembly which includes a PROM (1900158) (serialized to the assembly), which is programmed during factory calibration and Indexer 1983233. The PROM is installed in location XU20 on Sensor Interface CCA (1A13).

3. Cable 1W2 is installed only if optional ATM/SONET optical interface CCA is installed in the system.

4. Triaxial Cable Assemblies are included in Main Harness Assembly 1W1, but are only connected and used in conjunction with NTDS Type E interface CCAs installed in locations 1A50, 1A51, or 1A52.

Table 4-6 (Cont'd).— List of Electrical Units and Assemblies.

4.10.7 Optional Data Interface Configuration

In addition to the basic system configuration, four circuit card locations are provided for optional data interface configurations. These interfaces include:

- Standard NATO Agreement (STANAG) 4156 parallel data;
- Navy Tactical Data System (NTDS) Type A and Type B parallel data;
- NTDS Type E serial data; and
- Asynchronous Transfer Mode/Synchronous Optical Network (ATM/SONET) optical serial data interface.

The message protocol and data content for the messages associated with each interface type are programmed in the I/O Processor control software. The selection and configuration of these optional interfaces is dependent on the individual system installation requirements. Table 4-7, lists the possible optional serial data interface board configurations.

		APPLICABLE I/O CCA TYPE				
ASSEMBLY	**NAME/FUNCTION**	**NTDS A**	**NTDS B**	**NTDS E**	**STANAG**	**ATM**
CCA locations designated 1A50 through 1A53 are used for optional interface boards. Options include NTDS Standard interface, STANAG 4156 interface, and ATM/SONET optical interface. The quantity of each type interface board used is determined by the system part number. The part numbers for cables which interface between each interface board and the external connectors on the cabinet are determined by type of the associated interface boards installed (Refer to Figure 5-18 of S9427-AT-MMO-010/WSN-7). The Interface Assembly CCA part numbers currently supported are: NTDS Interface CCA Type A (P/N 1981087) NTDS Interface CCA Type B (P/N 1981562) NTDS Interface CCA Type E (P/N 1981559) STANAG 4156 Interface CCA (P/N 1983410) ATM/SONET Interface CCA (P/N 1900040) (See Note 1)						
1A50	CCA, Type			X	X	
1A51	CCA Type	X	X	X		
1A52	CCA Type			X		
1A53	CCA Type					(Note 1)
NOTE: 1. Board location 1A53 is reserved for future installation of hardware to support an ATM/SONET interface application. This interface type is not currently supported in system software and cannot be configured in the current version of the AN/WSN-7B(V) RLG.						

Table 4-7.— AN/WSN-7B(V) Optional I/O Configurations.

4.10.8 List of Applicable Documents

Table 4-8 lists the specifications that are associated with the AN/WSN-7B(V). These documents list Interface Design Specifications (IDS) which describe the various message types which can be selected for data transfer between the AN/WSN-7B(V) and external equipment; and the NTDS digital interface specifications which describe timing, communication protocol, and transmission characteristics of the NTDS I/O.

DOCUMENT NUMBER	DESCRIPTION
MIL-STD-1397B (NAVY)	Military Standard Input/Output Interfaces, Standard Digital Data, Navy Systems
NAVSEA S9427-AN-IDS-010/WSN-7	Interface Design Specification, Super Channel to User for the AN/WSN-7 Ring Laser Gyro Navigator (RLGN)
NAVSEA SE174-AB-IDS-010/GPS	Interface Design Specification for Shipboard External Computer and NAVSTAR Global Positioning System
NAVSEA S9427-AN-IDS-040/WSN-7	Interface Design Specification, Inertial Navigation Set AN/WSN-7 to External Computer in an Output Only Configuration - For Parallel Channels
NAVSEA S9427-AN-IDS-020/WSN-7	Interface Design Specification, Inertial Navigation Set AN/WSN-7 to External Computer - For Low Level Serial (MIL-STD-1397B Type E) Digital Communication
NAVSEA T9427-AP-IDS-010/RLGN	Navigation Operational Program Interface Design Specification for Use with the Ring Laser Gyro Navigator (RLGN) AN/WSN-7
NAVSEA T9427-AP-IDS-020/RLGN	Navigation Operational Program Interface Design Specification for Use with the Ring Laser Gyro Navigator (RLGN) AN/WSN-7
NAVSEA S9427-AP-IDS-030/RLGN	Navigation Operational Program Interface Design Specification for Use with the Ring Laser Gyro Navigator (RLGN) AN/WSN-7
NAVSEA S9427-AP-IDS-040/RLGN	Navigation Operational Program Interface Design Specification for Use with the Ring Laser Gyro Navigator (RLGN) AN/WSN-7
NAVSEA SN340-BO-SPN-101/AN/WSN-2A	STANAG 4156 Speed Log Interface Design Specification

Table 4-8.— Associated Documents.

4.10.9 Operation

This section identifies all operation control functions and describes their use, provides instructions for turning on and operating the AN/WSN-7B(V) Ring Laser Gyro (RLG), and presents information for identifying system fault conditions. The top panel controls and indicators are shown in Figure 4-42. Operation procedures associated with testing, troubleshooting, optical alignment, and installation configuration are included in the appropriate chapters in S9427-AT-MMO-010/WSN-7.

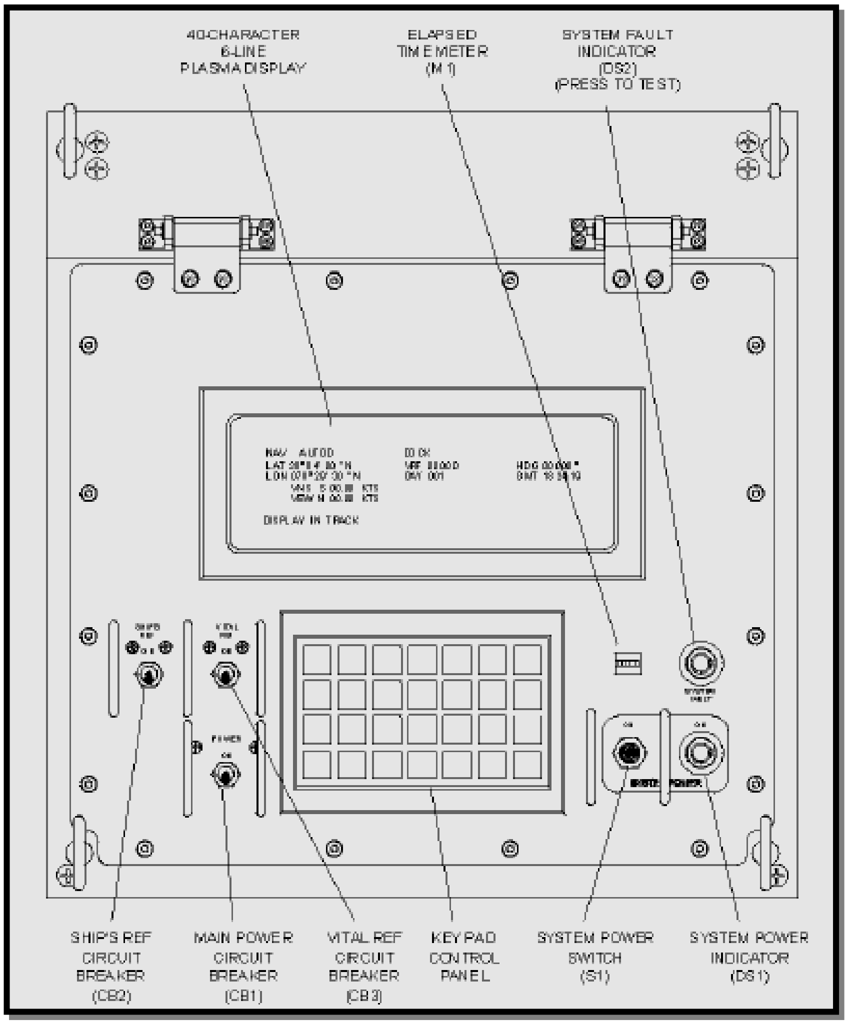


Figure 4-42.— Top Panel Controls and Indicators.

4.10.9.1 System Operating Controls

System operating controls (Figure 4-42) consist of the power controls and indicator; a system fault indicator; a keypad, which provides all operator control interface; a menu display, which provides all mode and status information; and displayed menus, which allow selection of various control functions and display of specific data.

Power Controls and Indicators. The AN/WSN-7B(V) top panel contains the primary power controls and indicators for the system. The power control functions on the AN/WSN-7B(V) are:

- **MAIN POWER** Circuit Breaker (CB1) protects ship's 115 VAC main power input to the system and breaks power to **SYSTEM POWER** switch (S1).
- **SHIP'S REF** Circuit Breaker (CB2) protects ship's 400 Hz synchro reference input to the system.
- **VITAL REF** Circuit Breaker (CB3) protects AN/WSN-7B(V) generated 400 Hz synchro vital reference output.
- **SYSTEM POWER** switch (S1) operates to turn on the AN/WSN-7B(V). ON position - Applies ship's 115 VAC input to the 24-volt power supply in the AN/WSN-7B(V) and selects the system power control function, to turn on the AN/WSN-7B(V).
- **SYSTEM POWER** indicator (DS1) illuminates whenever ship's 115 VAC power is applied to the AN/WSN-7B(V) power supply (**SYSTEM POWER** switch set ON).

Keypad Functions and Menu Selection. The keypad on the AN/WSN-7B(V) (Figure 4-43) is used in conjunction with the displayed menus to perform all control and data entry functions. The keys are grouped into three categories; these are Menu Selection, Data Entry, and Display Control.

Some keys perform dual functions. The operation of these keys is automatically determined by the selected menu, mode, or operation being performed. Each key and its general function is listed below:

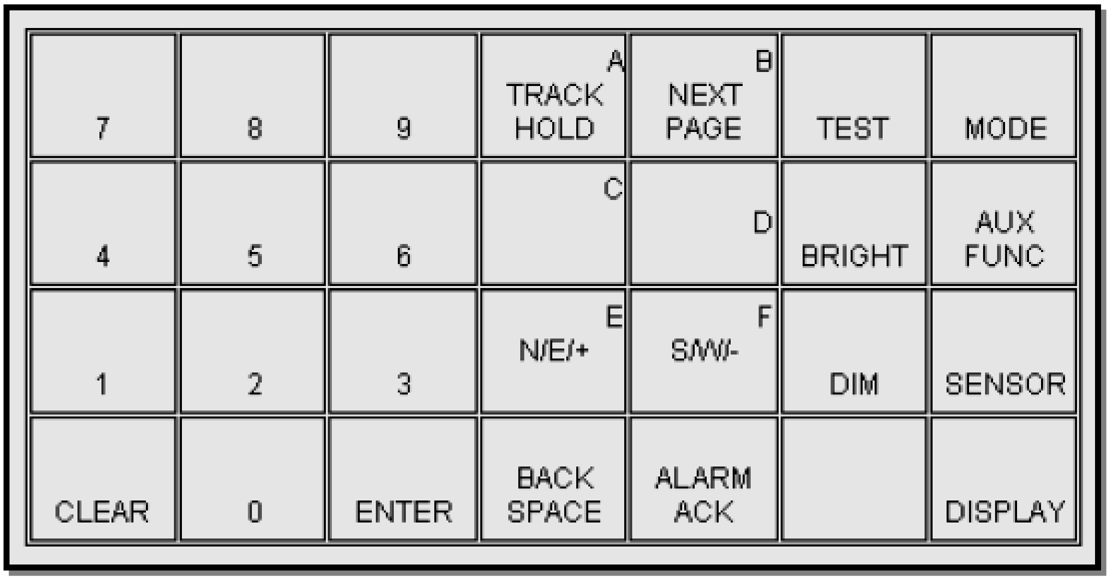


Figure 4-43.— Keypad.

Menu Selection keys consist of:

MODE Selects Page 1 of Mode Functions Menu.

AUX FUNC Selects Page 1 of Auxiliary Functions Menu.

SENSOR Selects Page 1 of Sensor Functions Menu.

DISPLAY Selects Page 1 of Display Functions Menu.

TEST Enables Self-Test Functions Menu (operates only during power-up).

NEXT PAGE Sequentially selects display of menu pages.

Data Entry keys consist of:

0 through **9** Selects numbered function on displayed menu; and used to enter numeric data.

A through **F** Alternate functions reserved for entry of hexadecimal values.

CLEAR Clears displayed or manually entered data without accepting the value.

ENTER Accepts displayed or manually entered data for entry into selected function.

BACKSPACE Erases last entered numeric character for re-entry.

N/E/+ Enter North (N) or East (E) for position or positive (+) for numeric values requiring sign.

S/W/- Enter South (S) or West (W) for position or minus (-) for numeric values requiring sign.

Display Control keys consist of:

TRACK HOLD "Freezes" display of any continuously changing data which is selected for viewing.

BRIGHT Increases display illumination.

DIM Decreases display illumination.

ALARM ACK Removes the fault code from the display when a fault condition is detected.

Operation Menus and Display Functions. Table 4-9 lists the functions included in the four menus associated with operation and presents a brief description of the control and data functions associated with each. Figure 4-44 identifies the general menu layout and data presentation for the operations-related menus and it provides a listing of all mode and status indications that may be displayed on the top line of the Menu Display Panel. The top line indicates the system operating state, selected navigation aid, selected velocity reference, selected damping mode, selected coordinates (normal or transverse), and code for any detected fault. The next two lines display position, velocity, heading, day, and time. The last three lines present variable information and control functions, as determined by the selected menu and page. Figure 4-45 presents the full menu tree listing all functions available for display during normal operation.

A complete listing of the fault codes which may be displayed in the "FAULT" field is provided in Appendix B of S9427-AT-MMO-010/WSN-7, along with a description and analysis of the fault condition which most probably caused the code to be displayed.

Keypad/Menu Operation Procedure. The general procedure for key/ menu operation is:

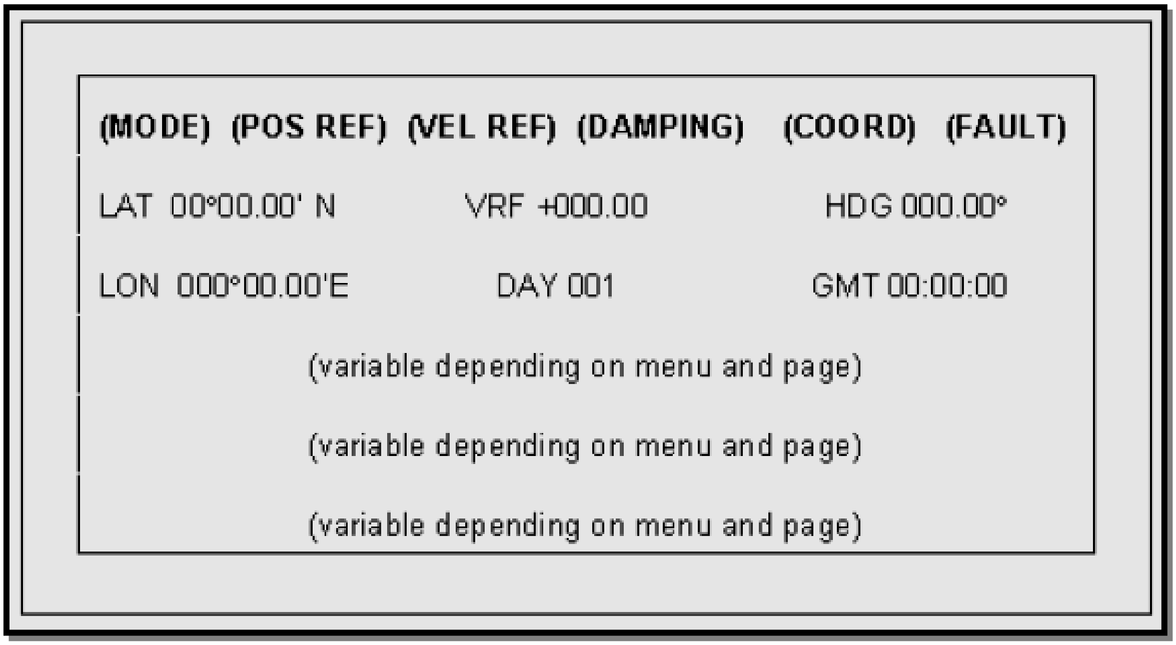
a. Press a Menu Selection (**MODE, AUX FUNC, SENSOR** or **DISPLAY**) key to select the menu with desired function.

b. If selected menu has more than one page, press **NEXT PAGE** key to step through pages (page display sequence cycles back to Page 1 after last page is displayed). The page number is displayed in the lower right-hand corner of the display.

c. When function is located, press the Number key corresponding to the number beside the function to select the function.

d. If data entry is required, enter value using Data Entry keys. Correct error during data entry using **CLEAR** or **BACKSPACE** key. Pressing a Menu selection (**MODE, AUX FUNC, SENSOR,** or **DISPLAY**) key will abort operation completely.

e. After data has been entered, either press **ENTER** key to accept the displayed value or press the **CLEAR** key to clear the displayed value allowing for entry of new value.



POSSIBLE DISPLAY VALUES ON TOP PANEL DISPLAY

(MODE)	(POS REF) (2)	(VEL REF) (3)	(DAMPING)	(COORD)	(FAULT)
STANDBY	GPS	VMAN	AUTOD	ANORM	See Appendix B
TEST (1)	DOCK	ROD 1	AUTOU	ATXVS	
ALIGN	GNMEA	ROD 2	MANU	MNORM	
ALIGN-C	EC	DUMMY	MAND	MTXVS	
ALIGN-F		DSVL			
GYRO		VGPS			
NAV-C		VNVE			
NAV					
SHUTDOWN					

NOTES:

(1) TEST is displayed only when the AN/WSN-7B(V) is turned on in Test Mode. Refer to Chapter 5, Section 5.2.1. of S9427-AT-MMO-010/WSN-7

(2) This display region is blank if position reference is de-selected.

(3) This display region is blank if velocity reference is de-selected.

Figure 4-44.—Menu Display.

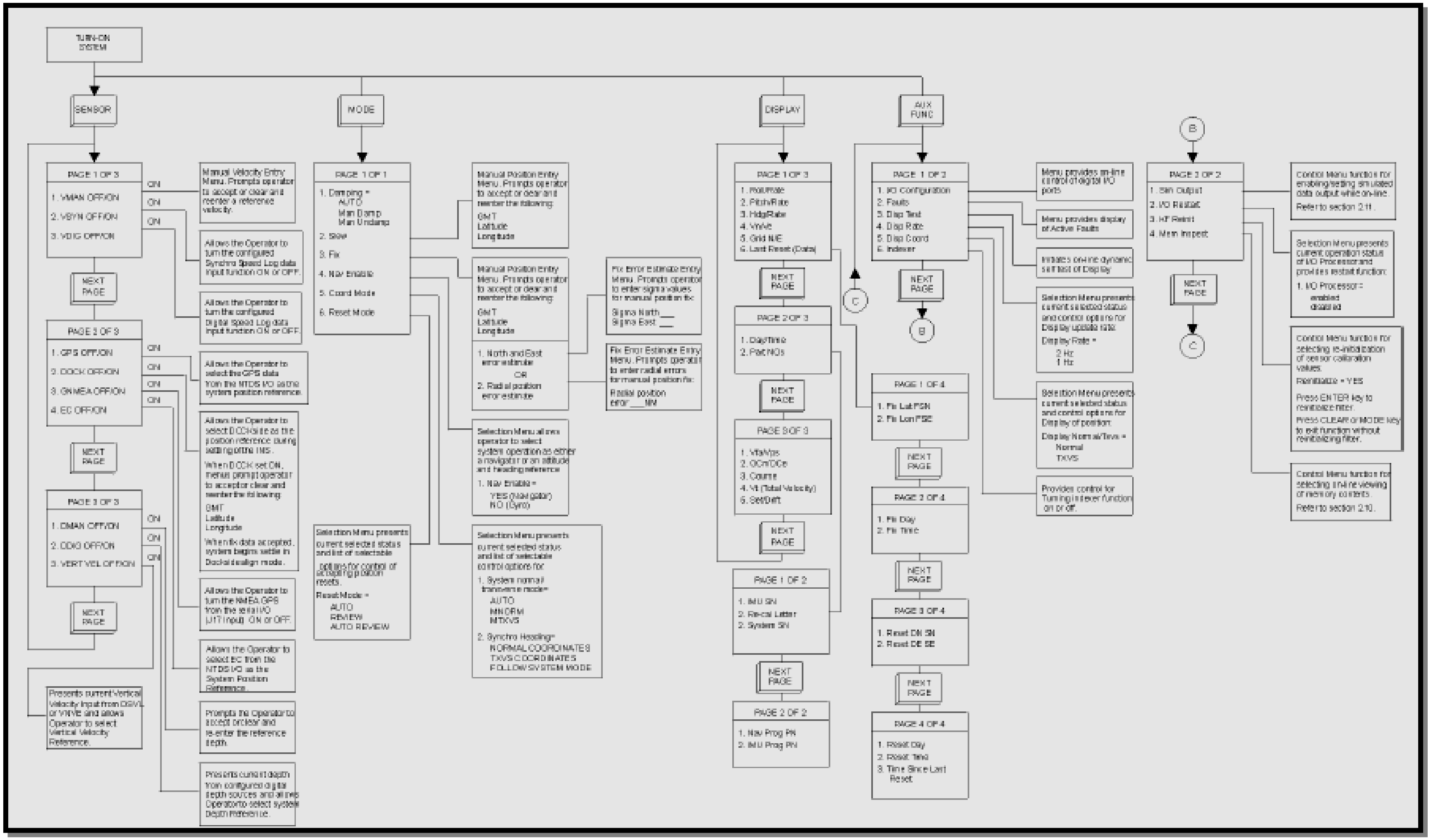


Figure 4-45.—Identifying Operation Menus and Data Entry.

NOTE: This is a representative graphic. Consult S9427-AT-MMO-010/WSN-7, Chapter 2 for Operation Menus.

PAGE	FUNCTION	BRIEF DESCRIPTION
SENSOR Functions (Select by pressing **SENSOR** key.) The SENSOR menu provides three pages of control functions associated with selecting the velocity reference source (page 1), position reference source (page 2), and depth reference (page 3). Select the menu page by pressing the **NEXT PAGE** key. Select each function by pressing the Number key corresponding to the number of the function and then follow the instruction prompts.		
1	1. **VMAN OFF/ON**	When selected, displays current value set for manually entered fore/aft speed. Setting VMAN ON allows manual entry or change of fore/aft speed value. Setting VMAN OFF disables manual speed input as the velocity reference.
	2. **VSYN OFF/ON**	Enables or disables the synchro speed input as the velocity reference. Displays synchro speed to allow verification of selection. ROD 1, ROD 2 or DUMMY must be configured as a velocity reference to be selectable.
	3. **VDIG OFF/ON**	Enables or disables the digital speed input's use as the velocity reference. Displays digital speed to allow verification of selection. ROD 1, ROD 2, DUMMY, DSVL, or VGPS must be configured as a velocity reference to be selectable.
2	1. **GPS OFF/ON**	Enables or disables the use of GPS via the NTDS interface as the position reference. GPS must be configured as a position reference to be selectable. GPS is the default position reference if configured.
	2. **DOCK OFF/ON**	Enables or disables the use of dockside conditions as the position and velocity references. The ship's position is input manually by the operator. The system sets the velocity reference to zero. To disable (exit) DOCK-side mode, a velocity reference must be selected or the operator must enter a reference velocity using **VMAN**.
	3. **GNMEA OFF/ON**	Enables or disables the use of NMEA GPS via the RS-422 interface port 3 (connector J17) as the position reference. NMEA format GPS input must be configured as a position reference input to be selectable.
	4. **EC OFF/ON**	Enables or disables the use of External Computer (EC) position data via the NTDS Type E Super-channel interface as the position reference. EC input must be configured as a position reference to be selectable.

Table 4-9.— Operating Menus/Functions Description.

PAGE	FUNCTION	BRIEF DESCRIPTION
Functions on page 3 of SENSOR menu are used for selecting the depth sensor source to be used. Note: These functions are normally configured only for subsurface installations.		
3	1. **DMAN OFF/ON**	When selected, displays current value set for manually entered depth. Setting DMAN ON allows manual entry or change of depth value. Setting DMANOFF disables manual depth data input to the navigation processor. Depth is ship's keel depth below the surface.
	2. **DDIG OFF/ON**	On RLG configured for depth input from digital depth sensor, enables or disables the digital depth input.
	3. **VERT VEL OFF/ON**	On RLG configured for DSVL or VNVE (Vertical Velocity capable velocity reference), enables or disables use of that vertical velocity input.
MODE Functions (Select by pressing **MODE** key) The MODE menu provides control functions associated with the position filter and navigation calculation modes. Select each function by pressing the Number key corresponding to the number of the function and then follow the instruction prompts.		
1	1. **Damping**	Allows selection of the damping mode for the horizontal velocities. Refer to Section 2.5.1 of S9427-AT-MMO-010/WSN-7 for an explanation of damping operation. Three damping modes are available. These are: **Auto** When selected, switching between damped and un-damped operation is automatic based on system determination of validity of reference velocity data. **Man Damp** When selected, system is forced to remain damped regardless of velocity input or ship dynamics. Change to undamped operation must be selected Manually. **Man Undamp** When selected, system is forced to remain undamped. Change to damped operation must be selected Manually.
	2. **Slew**	Displays current GMT and position data, and allows manual entry of a position slew from the keypad. Position slew data is used to correct the system estimate of position only. **NOTE:** Navigation filter is not reset when position data is entered with this function.
	3. **Fix**	Displays current GMT and position, and allows manual entry of a position fix and error estimates from the keypad. Position data is used to correct the system estimate of position and to update the navigation filter (self-calibrate). To enter new values, press **CLEAR** key to reject displayed value, enter correct value from keypad, and then press **ENTER** key to accept data.
	4. **Nav Enable**	Allows the operator to select the AN/WSN-7B(V) to operate either as an Inertial Navigator providing inertial position and velocity data output in addition to attitude data (YES) or as a gyrocompass providing only heading, roll and pitch data output (NO).

Table 4-9(Cont'd).— Operating Menus/Functions Description.

PAGE	FUNCTION	BRIEF DESCRIPTION
1 (cont)	5. **Coord Mode**	Allows manual or automatic selection of Earth coordinates reference used for calculating position and heading, and allows selection of synchro heading output format independent of system coordinates mode selected. Refer to Section 2.6.1 of S9427-AT-MMO-010/WSN-7 for an explanation of normal and transverse mode operations and display. Three system modes are available, these are: **AUTO** – When selected, INS automatically switches between normal and transverse coordinates reference when normal coordinates latitude is approximately +85 degrees. (Transverse mode should be used above 85 degrees.) **MNORM** – When selected, INS remains in normal coordinates mode regardless of latitude. **MTXVS** – When selected, INS remains in transverse coordinates mode regardless of latitude. Three synchro heading output modes are available, these are: **FOLLOW SYSTEM MODE** – When selected, synchro heading output automatically provides transverse heading when the system is operating in transverse coordinates and provides normal heading when the system is operating in normal coordinates mode. **NORMAL COORDINATES** – When selected, the synchro heading output is always normal coordinates regardless of whether the system is operating in transverse or in normal coordinates mode. **TXVS COORDINATES** – When selected, the synchro heading output is always transverse coordinates regardless of whether the system is operating in transverse or in normal coordinates mode.
	6. **Reset Mode**	Allows selection of the acceptance mode for position fixes from the navigation aid. Refer to Section 2.7 of S9427-AT-MMO-010/WSN-7 for explanation of fix acceptance criteria. Three modes are available, these are: **Review** – Requires that the operator review fix data and either accept or reject each position fix. With this mode selected, when a position fix is received from the navigation aid, the operator is prompted by display of Fault Code 221. The operator must then select the Reset Data function **(DISPLAY, Page 1, Last Reset)** to review the fix values and to accept or reject each position fix. **Auto Review** – Similar to Review mode, except the system automatically accepts valid fixes and allows the operator to review fixes which do not meet valid criteria. If the operator does not accept or reject the fix within 10 minutes, the fix is rejected by the system. **Auto** – System automatically accepts or rejects each position fix from the navigation aid without prompting the operator to review the fix. Display of last accepted fix is available in the Last Reset data display.

Table 4-9(Cont'd).— Operating Menus/Functions Description.

<table>
<tr><th>PAGE</th><th>FUNCTION</th><th>BRIEF DESCRIPTION</th></tr>
<tr><td colspan="3">AUXiliary FUNCtion (Select by pressing AUX FUNC key.)
The AUXILIARY FUNCTION menu provides control functions associated with changing system configuration settings, displaying stored fault codes, performing display self-test, and setting display update rate.
Select each function by pressing the Number key corresponding to the number of the function and then follow instruction prompts.</td></tr>
<tr><td rowspan="6">1</td><td>1. I/O Configuration</td><td>Allows the operator to enable or disable digital interfaces for communications with external devices.</td></tr>
<tr><td>2. Faults</td><td>Displays list of active faults. Active faults are faults which remain active after the alarm condition has been acknowledged by pressing the ALARM ACK key.</td></tr>
<tr><td>3. Display Test</td><td>Initiates a dynamic self-test of the display. Test continues until one of the Menu Selection keys is pressed.</td></tr>
<tr><td>4. Display Rate</td><td>Selects display update rate. Selectable rates are every second (1 Hz) or twice per second (2 Hz). 2 Hz is the default rate.</td></tr>
<tr><td>5. Display Coordinates</td><td>Selects format for position and heading display as either Normal coordinates or Transverse coordinates. This function affects the display format only and does not affect calculation mode.</td></tr>
<tr><td>6. Indexer (Enable)</td><td>Allows the operator to enable or disable the Indexer Assembly turntable torquer motor. Indexing of the IMU is normally enabled and this function is not used during normal operation. The indexing function can be enabled without cycling system power off/on in the event that it is automatically disabled as a result of detection of a fault in the torquer operation.</td></tr>
<tr><td rowspan="3">2</td><td>1. Simulated Output</td><td>Allows the operator to select a simulation mode for system data output and to enter simulated values for heading, roll, pitch, position, and velocity on all outputs. Selection of this function and output of simulated values do not affect system operation.
Some data messages contain status bits which are set to indicate that output data is simulated.
When this mode is exited, the system remains in the Simulate mode for a short period of time while system output parameters are being slewed back to correct values. When all values are reset, the system reverts automatically to normal output.</td></tr>
<tr><td>2. I/O Restart</td><td>Allows the operator to restart (enable) I/O Processing operation without recycling power. Function is used in the event that the I/O is shut down by Built-In Test Equipment (BITE) as a result of detection of a fault condition. Some fault conditions prevent I/O restart. Refer to Appendix B to identify Faults associated with I/O Processing shutdown.</td></tr>
<tr><td>3. KF Reinit</td><td>Allows the operator to re-initialize the Kalman Filter and reset all sensor calibrations to stored PROM values. This function is not used for normal operation and should be used only if the operator is certain that performance is outside of specification. Selection of Kalman Filter re-initialization will realign the system and restore attitude and position accuracy.
Position and velocity reference data must be available for realign.</td></tr>
</table>

Table 4-9(Cont'd).— Operating Menus/Functions Description.

PAGE	FUNCTION	BRIEF DESCRIPTION
1 (cont)	4. **Mem**ory **Inspect**	Allows the operator to observe the data values currently stored in memory. Function allows each memory address location to be selected and to be sequentially stepped up or down. This function is intended primarily as a software development tool.
DISPLAY Functions (Select by pressing **DISPLAY** key.) The DISPLAY menu provides three pages of parameters and data which can be selected for display. After selection of a parameter, the menu listing is replaced by display of the selected parameter data. This condition remains current until a Menu Selection key is pressed. To change the displayed parameter, press the **DISPLAY** key to re-select the menu listing and then select another parameter. Select the menu page by pressing the **NEXT PAGE** key. Select the parameter to be displayed by pressing the Number key corresponding to the number of the parameter.		
1	1. **Roll/Rate**	Displays ship's roll angle and roll rate. For US Navy sign convention configurations: (+) indicates roll to port. (-) indicates roll to starboard.
	2. **Pitch/Rate**	Displays ship's pitch angle and pitch rate. For US Navy sign convention configurations: (+) indicates pitch to bow. (-) indicates pitch to stern.
	3. **Hdg/Rate**	Displays ship's heading and turn rate. (0 degrees to 359.99 degrees)
	4. **Vn/Ve**	Displays system velocity north and east. Range is ±99.99 kts.
	5. **Grid N/E**	Displays system position in grid coordinate format. This display mode is associated with polar operation; however, this function can be selected at any latitude. This function affects the display format only and does not affect calculation mode.
	6. **Last Reset**	Displays last position fix data and resulting reset of system position or pending fix reset. The time of the position fix data, the time since last reset, and the position fix source are also displayed.
2	1. **Day/Time**	Displays day and GMT and allows values to be changed. Normally, day is set relative to first day in calendar year. Time is in military (24 hour) format (HH:MM:SS). For operation with GPS, system will synchronize to GPS UTC.
	2. **Part Nos**	Multiple pages display listing of system level part numbers. These include system serial number, program part number and revision letter, IMU serial number, and recalibration letter.
	3. **Depth**	Displays depth if depth reference configured and selected.

Table 4-9(Cont'd).— Operating Menus/Functions Description.

PAGE	FUNCTION	BRIEF DESCRIPTION
3	1. **Vfa/Vps**	Displays velocity fore/aft and port/starboard. Range is ±99.99 kts.
	2. **Ocn/Oce**	Displays estimated ocean currents north and east. Range is ±99.99 kts.
	3. **Course**	Displays direction of ship's velocity. Range is 0.00 degrees to 359.99 degrees. (Default for ship's velocity less than 0.5 knots is 0 degrees.)
	4. V_T	Displays total velocity (vector sum of Vn/Ve). Range is ±99.99 kts.
	5. **Set/Drift**	Displays Set (the direction of ocean currents) and drift (the vector sum of Ocn/Oce).
	6. **DVn/DVe**	Displays the difference between RLG inertial velocity and selected reference for north and east velocity.

Table 4-9(Cont'd).— Operating Menus/Functions Description.

4.10.10 Operation Procedures (Normal Conditions)

NOTE: The following procedure assumes that the AN/WSN-7B(V) has been installed correctly and configured for available external reference (GPS, Speed log). Data from all configured external references should be available.

To turn on the AN/WSN-7B(V), first turn on and check operation of speed sensor source, external GPS receiver, and any other devices which accept data from the AN/WSN-7B(V). Follow the procedure outlined below for turning on and operating the AN/WSN-7B(V) in a normal situation.

An off-line Test Mode is also available. This mode is selected by turning off the AN/WSN-7B(V) and then setting the **SYSTEM POWER** switch to ON while the **TEST** key on the keypad is held depressed. When Test Mode is selected, the unit does not provide valid attitude or heading output data. Selection of the Test Mode and test functions is covered in Section 5.2.1. of S9427-AT-MMO-010/WSN-7.

Turning On the AN/WSN-7B(V). The following procedures are required when turning on the AN/WSN-7B(V).

a. Set the **POWER, SHIP'S REF**, and **VITAL REF** circuit breakers to ON.

b. Set **SYSTEM POWER** switch to ON. Observe that **SYSTEM POWER** indicator illuminates, and that the **SYSTEM FAULT** alarm indicator remains OFF.

c. Observe that a configuration mode message appears briefly and no fault codes are indicated in the upper right corner of the Display.

d. Press **AUX FUNC** key to select AUXiliary Functions menu and then select **Display Test** function by pressing <3> key and verify that display is functioning properly.

e. Exit Display Test by pressing any Menu Selection.

Turning Off the AN/WSN-7B(V). The following procedures are required when turning off the AN/WSN-7B(V).

a. Set the **SYSTEM POWER** switch to OFF. The system will save all valid data to be used when the system is turned on again.

b. Set the **POWER** circuit breaker to OFF.

SELECTING THE ALIGN MODE.
The AN/WSN-7B(V) will settle and operate as a gyrocompass (with degraded heading accuracy) without a source for either position or speed input and will operate as a full accuracy gyrocompass with only ship's speed applied. Position and velocity reference must both be provided for precise attitude alignment and navigation performance. At start-up, the system will automatically select a configured position and velocity reference based on priority. The operator can select from any configured position or velocity reference following power-up.

Available references are determined by the installed configuration of the position and velocity references. Ship's speed reference is configured through a single-axis synchro interface, through a single-axis STANAG 4156 interface, through a serial interface by DSVL, or through an NTDS interface by GPS. Automatic position input is configured through a GPS or EC interface. The GPS interface is a configurable NTDS interface or an RS-422A NMEA 0183 Guidance Gimbal Assembly (GGA) message interface.

Position fixes can also be entered manually by the operator. Four position references sources may be used for aligning the system. These are GPS, EC, manual entry of a position FIX entry through the operator panel, and DOCKside. The Sensor menus provide operator selection of velocity reference and position reference.

NOTE:
The AN/WSN-7B(V) will use last Lat and Lon from NVRAM when the system is turned on again if the system has run (with no faults which prevent NVRAM update) for at least one hour at last power-up.

DOCKside is a special reference function which provides fixed position and speed input. When DOCKside is selected, the AN/WSN-7B(V) sets the reference ground speed input to zero. Reference ship's position is initialized by Manual entry. This position and zero velocity data continues to be used as the reference while DOCKside remains selected. DOCKside can only be used while the ship remains stationary (at dockside). If the ship is moving, position and speed reference other than DOCKside must be selected.

Procedure for Align Using Dockside Position Reference.
NOTE:
For DOCKside to be available for selection as the alignment reference source, the system must be configured as a Navigator. If the system is currently configured to operate as a gyrocompass (**GYRO**), press the **MODE** key and set **NAV ENABLE = YES**.

a. Press **SENSOR** key, **Page 2**, and then select DOCK ON to enter DOCKSIDE ALIGN.

b. When DOCKSIDE ALIGN is selected, the navigation system automatically selects zero ground speed input and displays the current stored position data along with prompts which allow the operator to either accept (ENTER) the displayed position data or to reject (CLEAR) the display and enter new position fix data. If displayed values are not current ship dockside position, manually enter ship's position within 0.05 nm accuracy.

c. When the position fix is entered, the navigation system checks the values for reasonableness, applies a reset of position, and then enters the Dockside Align mode. ALIGN is displayed in the upper left field, DOCK is the displayed Position reference.

d. When ALIGN-F is displayed in the upper left field, the AN/WSN-7B(V) has achieved a fine aligned state and will transition to NAV mode when the DOCKside reference is removed. To remove the DOCKside reference, Press **SENSOR** key, **Page 2**, and then select DOCK OFF to exit Dockside Align. The AN/WSN-7B(V) will prompt the operator for selection of a velocity reference prior to leaving Dockside Align.

CAUTION:
Leaving the navigation system in Dockside Align while getting underway will result in the display of Fault Code 52 and the navigation system cannot transition to the NAV mode.

e. The operator should exit Dockside Align mode before ship leaves the dock (15 minutes prior to sailing is recommended). Press **SENSOR** key, **Page 2**, and then select DOCK OFF to exit Dockside Align. The AN/WSN-7B(V) will prompt the operator for selection of a velocity reference prior to leaving Dockside Align.

If ALIGN-F is displayed in the upper left field, the AN/WSN-7B(V) will transition to NAV mode on entry of a velocity reference.

If ALIGN or ALIGN-C is displayed in the upper left field, the AN/WSN-7B(V) will continue the Align process with selected velocity reference and position data.

NOTE:
If inertial velocity is greater than 2 knots or 1 knot (filtered), then the AN/WSN-7B(V) will suspend the DOCKside align. The operator will be alerted with Fault Code 52. Operator must select DOCKside OFF to clear fault 52. Operator can then re-select DOCKside ON to continue align/calibrate.

Procedure for Align Using GPS Position Reference.

a. Press **SENSOR** key, select Page 1 of the **Sensor Menu** and select the applicable velocity reference ON, or review the default selection (refer to Section 2.5.1.2 of S9427-AT-MMO-010/WSN-7).

b. Select Page 2 of **Sensor Menu** and select **GPS ON** (or **GNMEA ON**) to select GPS position reference.

NOTE:
Automatic acceptance or operator review of position fix data prior to acceptance of position fixes by the navigation system is selectively controlled by setting of the Reset function on the Mode menu. Selection of the Reset function is a matter of operation preference. A suggested method is to set the Reset function to **Review** and manually review the first fix from the navigation aid; then set the Reset function to **Auto** to allow all subsequent fixes to be automatically accepted/rejected without operator intervention. Operator advisory faults will alert the operator of bad fix data.

With GPS selected as the position reference for align, a velocity reference must also be available. The velocity reference may be manual entry or may be from the configured velocity reference source.

c. Press **MODE** key. On the **Mode** Menu, set **Reset Mode** function <6> key to operation preference for operator review or automatic acceptance of position fixes from the navigation aid. (REVIEW**,** AUTO REVIEW, or AUTO). Selection of REVIEW will require operator accept/reject of all position fix data prior to application of a position fix reset.

d. If **NAV ENABLE = NO**, the AN/WSN-7B(V) will transition through ALIGN-C and reach GYRO state indicating full attitude accuracy. If **NAV ENABLE = YES**, the AN/WSN-7B(V) will transition through NAV-C and reach NAV state indicating that the AN/WSN-7B(V) has achieved full attitude, velocity, and position accuracy.

e. The selection of GPS as an external position reference can remain ON for normal steady state operation of the AN/WSN-7B(V). When GPS position is available and valid, the AN/WSN-7B(V) will remain slaved to the GPS position. During periods of time when GPS is not available or is invalid, the AN/WSN-7B(V) will provide position based on inertial measurements from the last reference position reset. Normal steady state operation requires a reference velocity for damping of inertial velocities.

Procedure for Align Using Operator Entered Position.

a. Verify that GMT and day are correct. If correct, proceed to step i.

b. If incorrect, press the **DISPLAY** key, select Page 2 of the **Display Menu**.

c. Press the <1> key for Day/Time. Press the **CLEAR** key and enter correct Julian date.

d. Use the **BACKSPACE** key to eliminate keypunch errors.

e. Press the **ENTER** key to accept the entry.

f. Press the **CLEAR** key and enter correct GMT.

g. Use the **BACKSPACE** key to eliminate keypunch errors.

h. Press the **ENTER** key to accept the entry.

i. Press **SENSOR** key, select Page 1 of the **Sensor Menu** and select the applicable velocity reference ON, or review the default selection (refer to Section 2.5.1.2 of S9427-AT-MMO-010/WSN-7).

j. Select **Mode Menu** and select **FIX** (<3> key) to enter a position fix.

k. Position fixes must be entered and applied periodically for 20 hours to achieve full NAV state. If available, position fixes should be applied every 15 minutes for at least the first 2 hours, and then every 1 hour.

l. If **NAV ENABLE = NO**, the AN/WSN-7B(V) will transition through ALIGN-C and reach GYRO state indicating full attitude accuracy. If **NAV ENABLE = YES**, the AN/WSN-7B(V) will transition through NAV-C and reach NAV state indicating that the AN/WSN-7B(V) has achieved full attitude, velocity, and position accuracy.

m. Position fixes can be applied as available to maintain AN/WSN-7B(V) accuracy for subsequent NAV state operation.

Procedure for Align Without Operator Entered Position:

a. Press **SENSOR** key, select Page 1 of the **Sensor Menu** and select the applicable velocity reference ON, or review the default selection (refer to Section 2.5.1.2 S9427-AT-MMO-010/WSN-7).

b. AN/WSN-7B(V) will use previous position data stored in NVRAM as an initial position.

c. The AN/WSN-7B(V) will transition through ALIGN-C and reach GYRO state indicating full attitude accuracy.

d. If **NAVENABLE =YES** and sufficient position fix data is applied, the AN/WSN-7B(V) will then transition through NAV-C and reach NAV state indicating that the AN/WSN-7B(V) has achieved full attitude, velocity, and position accuracy.

Procedure for Align Using EC Position Reference:

a. Press **SENSOR** key, select Page 1 of the **Sensor Menu** and select the applicable velocity reference ON, or review the default selection (refer to Section 2.5.1.2 S9427-AT-MMO-010/WSN-7).

b. Select Page 2 of **Sensor Menu** and select **EC ON** to select EC position reference.

NOTE:
Automatic acceptance or operator review of position fix data prior to acceptance of position fixes by the navigation system is selectively controlled by setting of the Reset function on the Mode menu. Selection of the Reset function is a matter of operation preference. A suggested method is to set the Reset function to **Review** and manually review the first fix from the navigation aid; then set the Reset function to **Auto** to allow all subsequent fixes to be automatically accepted/rejected without operator intervention. Operator advisory faults will alert the operator of bad fix data.

With EC selected as the position reference for align, a velocity reference must also be available. The velocity reference may be manual entry or may be from the configured velocity reference source.

c. Press **MODE** key. On the **Mode Menu**, set **Reset Mode** function <6> key to operation preferences for operator review or automatic acceptance of position fixes from the navigation aid. (REVIEW, AUTO REVIEW, or AUTO). Selection of REVIEW will require operator accept/reject of all position fix data prior to application of a position fix reset.

d. If **NAV ENABLE = NO**, the AN/WSN-7B(V) will transition through ALIGN-C and reach GYRO state indicating full attitude accuracy. If **NAV ENABLE = YES**, the AN/WSN-7B(V) will transition through NAV-C and reach NAV state indicating that the AN/WSN-7B(V) has achieved full attitude, velocity, and position accuracy.

e. The selection of EC as an external position reference can remain ON for normal steady state operation of the AN/WSN-7B(V). When EC position is available and valid, the AN/WSN-7B(V) will remain slaved to the EC position. During periods of time when EC is not available or is invalid, the AN/WSN-7B(V) will provide position based on inertial measurements from the last reference position reset. Normal steady state operation requires a reference velocity for damping of inertial velocities.

Alignment Sequence. After power is turned on, the AN/WSN-7B(V) self-aligns system roll, pitch, and heading using the reference velocity and internal sensors. The self-align process outlined in Table 4-10 and Figure 4-46, takes place automatically following power-up self-test and consists of three stages:

- Leveling and Coarse Align.
- Latitude Coarse Align.
- Fine Align.

The latitude coarse align period is not used if any of the following operation conditions are valid:

- A position fix is accepted from the selected GPS or is entered manually by the operator at power-up.
- The NVRAM stored value of latitude and longitude are valid.

The AN/WSN-7B(V) will automatically transition through this self-align process and achieve a steady state operation as an Attitude and Heading Reference (GYRO) using default velocity reference.

Reference velocity should be provided during the self-align process using either a synchro speed input (**VSYN ON**) or digital speed input (**VDIG ON**) or manual velocity (**VMAN ON**). If no reference velocity input is provided, a value of zero reference velocity is used during the align period. If the ship is underway during this time, heading align error will be proportional to the ship velocity north.

System advisory 222 will alert the operator that no velocity reference data is available. For improved heading accuracy, the operator should provide correct manual velocity if an automatic source is not available.

Operating in Align Modes. After power-on, the AN/WSN-7B(V) leaves the STANDBY mode and starts to align the inertial platform. The following conditions apply:

a. If GPS is configured, the system will default to use GPS data at power-up as available.

b. The configured velocity reference (synchro or digital speed log) will be the default speed reference if available.

Within the first few minutes, roll and pitch attitude is determined and the mode word “ALIGN” is displayed.

During ALIGN, the AN/WSN-7B(V) aligns heading by aligning the inertial platform with respect to earth’s rotation (in a fashion similar to a gyrocompass). When heading is coarse aligned, the mode word changes from “ALIGN” to “ALIGN-C”. At ALIGN-C, the navigation system attitude outputs are of sufficient accuracy to be used for stabilization or steering purposes. The navigation system continues to align to the accuracy (fine align) required for an inertial navigator.

When heading is fine aligned, the mode word transitions from “ALIGN-C” to “ALIGN-F” or “NAV-C”. During a DOCKside align, once ALIGN-F has been reached, the navigation system can be put into NAVIGATE mode by de-selecting DOCKSIDE as a reference. If DOCKside is de-selected while coarse aligned (ALIGN-C is displayed), the navigation system will continue to align with available position and velocity data.

While underway (At-sea Align) and with GPS selected, the navigation system will automatically transition from ALIGN to NAV-C and then into NAVIGATE mode.

<table>
<tr><th>DISPLAY MODE</th><th>TIME SINCE POWER-UP (Minutes)</th><th>PROCESS</th></tr>
<tr><td colspan="3">DOCKSIDE (DOCK ON) SELECTED</td></tr>
<tr><td>STANDBY</td><td>0</td><td>Power-up self-test.</td></tr>
<tr><td rowspan="2">ALIGN</td><td>0 to 3</td><td>Coarse Align mode in progress

Level in Roll and Pitch. Leveling adjusts system roll and pitch values toward actual roll and pitch. Heading is initialized with a value of zero at start-up position of ship fore/aft axis.

Operator should select DOCK ON and enter ship position accurate to 0.05 nm.</td></tr>
<tr><td>3 to 8.5</td><td>Calculate heading coarse align reset.

Heading coarse align is applied to AN/WSN-7B(V) heading.

DOCKSIDE position is used for align.</td></tr>
<tr><td>ALIGN-C (DOCK ON reference selected and initial position reset entered)</td><td>8.5 to 1200</td><td>Fine Align mode in progress

With valid DOCKSIDE position, system will complete attitude Fine Align in 10 minutes at dockside (static). When NAVIGATE is enabled, DOCK OFF, and a valid velocity reference is selected by the operator prior to the ship leaving dockside, system will switch to NAV-C mode.</td></tr>
<tr><td>ALIGN-F (DOCK ON reference selected)</td><td>1200 with DOCKSIDE position reference</td><td>Fine Align mode completed

Steady state operation after attitude align if DOCK ON remains selected. When NAVIGATE is enabled, DOCK OFF, and a valid velocity reference is selected by the operator prior to the ship leaving dockside, system will switch to NAV mode.</td></tr>
<tr><td>NAV (DOCKSIDE position reference removed)</td><td>1200 with DOCKSIDE position reference removed</td><td>Full specification accuracy Navigation mode.

System will continue self-calibrate with available position data.</td></tr>
</table>

Table 4-10.— Alignment Sequence and Settling Times for Inertial Navigator.

DISPLAY MODE	TIME SINCE POWER-UP (Minutes)	PROCESS
AT SEA (GPS OR EC ON) SELECTED		
STANDBY	0	Power-up self-test.
ALIGN	0 to 3	**Coarse Align mode in progress** Level in Roll and Pitch. Leveling adjusts system roll and pitch values toward actual roll and pitch. Heading is initialized with a value of zero at start-up position of ship fore/aft axis.
	3 to 8.5	Calculate heading coarse align reset. Insert heading coarse align. Determine latitude value to be used for align or if the process should continue with latitude coarse align. **NOTE:** If latitude is entered from the GPS or is entered manually at the AN/WSN-7B(V), use input latitude for Fine Align. or If NVRAM stored latitude is valid, use stored latitude for Fine Align.
ALIGN-C (At Sea with GPS ON selected)	8.5 to 30	**Fine Align mode in progress** With valid initial position, system will complete Coarse Align in 30 minutes at sea (under motion) and will switch to NAV-C mode.
NAV-C	10 (not moving) 30 (moving)	**Fine Align mode completed** Navigate transition state if Nav Enable function is set YES and at least one position reset has been applied. System enters this mode from Fine Align if internal performance measure indicates that navigation performance does not yet meet specification. Reduced accuracy inertial position and velocity, and valid roll, pitch, and heading data is available.
NAV	1200 with sufficient reference data	**Full specification accuracy Navigation mode.** NAV is displayed if at least one position reset has been applied and navigation data is within specification. System will continue self-calibrate with available position data.

Table 4-10(Cont'd).— Alignment Sequence and Settling Times for Inertial Navigator.

DISPLAY MODE	TIME SINCE POWER-UP (Minutes)	PROCESS
AT SEA (NO INITIAL POSITION) OR NAVIGATE NOT SELECTED		
STANDBY	0	Power-up self-test.
ALIGN	0 to 3	**Coarse Align mode in progress** Level in Roll and Pitch. Leveling adjusts system roll and pitch values toward actual roll and pitch. Heading is initialized with a value of zero at start-up position of ship fore/aft axis.
	3 to 8.5	Calculate heading coarse align reset and cos (latitude) reset. Insert heading coarse align. Determine latitude value to be used for align or if the process should continue with latitude coarse align. **NOTE:** If latitude is entered from the GPS or is entered manually at the AN/WSN-7B(V), use input latitude for Fine Align. or If NVRAM stored latitude is valid, use stored latitude for Fine Align.
ALIGN-C (Without initial position)	8.5 to 240	**Fine Align mode in progress** If valid initial latitude is not provided, system will complete Coarse Align in 240 minutes either while static or at sea (under motion). System will go to GYRO but will not progress to NAV-C or NAV mode unless a position fix or position slew is entered.
GYRO (NOTE 1)	15 (not moving) 45 (moving) 240 (no initial position)	**Fine Align mode completed**. Steady state operation if Nav Enable function not set YES or no position reset has been applied. Valid roll, pitch, and heading data is available.
NOTE: 1. **GYRO** mode is a valid system operating state when: a. The system is selected to operate as a gyrocompass [Navigate Enabled (NO) selected in the off-line configuration or in the on-line MODE menu] b. No valid position reset has been applied to the system.		

Table 4-10(Cont'd).— Alignment Sequence and Settling Times for Inertial Navigator.

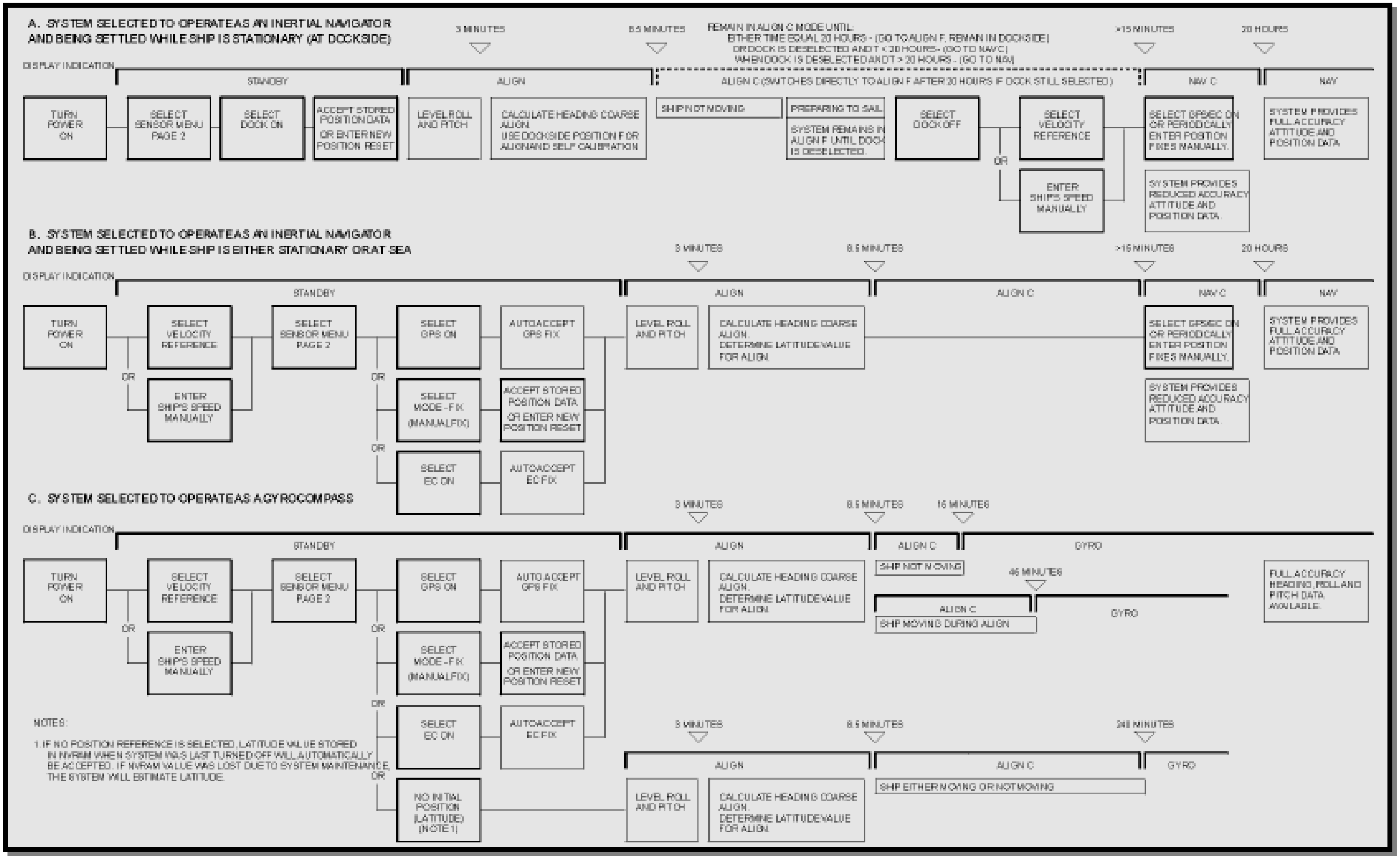


Figure 4-46.— Alignment Sequence Timing Diagram.

NOTE: This is a representative graphic. Consult S9427-AT-MMO-010/WSN-7, Chapter 2 for Alignment Sequence Timing.

4.10.11 Monitoring and Changing System Parameters

Selecting the Velocity Damping Mode and Source:

Selecting Damped or Undamped Operation. Based on the selection of the damping mode (**MODE menu, Damping** function) damping of the horizontal velocity loops will either be automatically selected based on the filtered velocity or will be manually selected to fully damped or fully undamped operation.

- When **Auto** damping is selected, the system automatically selects damped (**AUTOD** displayed) or undamped (**AUTOU** displayed) mode based on comparison of the reference velocity with the systems inertial velocity. As long as this corrected difference does not exceed the internal limit, the system uses reference velocity to damp inertial velocities. If the corrected difference between the reference velocity and inertial velocity exceeds an internal limit, the system will automatically switch to undamped mode. Automatic damping (Auto selected) is the preferred mode since it provides velocity damping and minimizes the effects of ship's speed reference errors due to ship's maneuvers or other sources.

- When **Man Damp** is selected, the system is forced into the damped mode (**MAND** displayed) regardless of the reference comparison. The operator can use this function to force the system to accept data from the velocity source and keep the system damped. Selection of **Man Damp** is used to force manual damping if advisory Fault Code 223 is displayed. This indicates that the system has remained undamped for an excessive period of time with **Auto** damping selected.

- When **Man Undamp** is selected, the system is forced into the undamped mode (**MANU** displayed) regardless of the reference comparison. This function is useful if the system is in NAVIGATE Mode and reference velocity is incorrect or is not available from the selected device. An example of this condition would be the case where an EM log with a retractable sword is the selected damping source but cannot be used until operating depth permits or the doppler speed log velocity is incorrect due to water depth.

Selecting the Horizontal Velocity Damping Reference:

When automatic damping is selected, damping and un-damping of the velocity loop is determined by the filtered velocity differences. The criterion for determining the damping mode is periodically tested, and the system switches from damped to undamped operation whenever the filtered velocity difference exceeds the internal limit. The transition from undamped operation to damped operation will occur whenever the filtered velocity's differences have settled to within the internal limit.

The available speed reference interface for velocity damping is determined by the system configuration. The speed reference interface is selected on **SENSOR Menu, Page 1**.
If either VDIG or VSYN is selected and is not available or is invalid, the AN/WSN- B(V) will default to using a zero water speed for damping. This mode of operation will be announced with display Fault code 222. AN/WSN-7B(V) errors will be proportional to ship velocity north. Correct manual speed should be entered in the event of loss of valid speed reference.

4.10.12 Selecting for Display

During operation, the operator can select any display of system parameters and data in addition to the normal position, heading, velocity reference speed, day and time display. Display of additional parameters is not necessary for normal system operation; however, selection of these display functions is useful for manually verifying data transmitted to external systems. Data is selected for display by pressing the DISPLAY key and selecting the PAGE with the parameters to be displayed (see Table 4-9).

Selecting Transverse Coordinate Mode and Display

In a gyro stabilized platform, torque values based on the Tangent (Tan) and Secant (Sec) of latitude are used in system control loops. While the AN/WSN-7B(V) is a strapdown system based on ring lasers, calculations involving these functions are also utilized. As the AN/WSN-7B(V) approaches 90-degrees latitude, these values become indeterminate (approach infinity) and are no longer valid for calculations. In addition, at high latitudes, the magnitude of east/west vectors has less meaning. For this reason, an alternate (Transverse) Earth coordinates reference system is utilized when the AN/WSN-7B(V) is operating at latitudes greater than approximately 85 degrees.

The Transverse North Pole is located at the intersection of the geographic 180-degree meridian and the equator. The geographic 90-degree and 270-degree meridians become the Transverse equator, and the geographic equator becomes the Transverse 90-degree and 270-degree meridians. Refer to Figure 4-47.

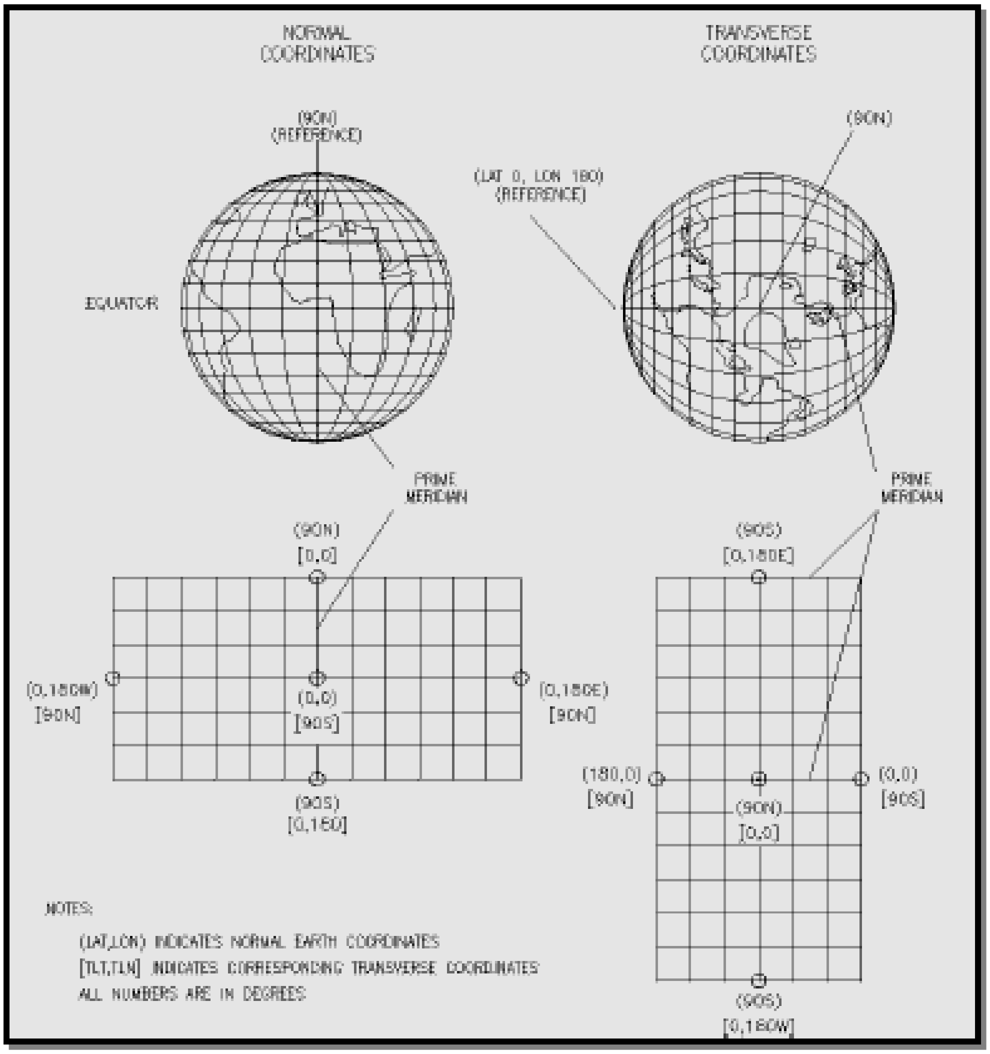


Figure 4-47.— Earth Coordinates References.

Three modes of selection are available for selecting operation using Transverse coordinates reference. These are selected from **MODE menu, Page 1** and are: **AUTO**, **MNORM**, and **MTXVS**. Normally, **AUTO** should be selected. When **AUTO** is selected, the AN/WSN-7B(V) automatically switches from normal to Transverse coordinates when the AN/WSN-7B(V) crosses 86 degrees north/south latitude and switches back to normal coordinates when the AN/WSN-7B(V) crosses back through 84 degrees. Selecting **MNORM** forces the AN/WSN-7B(V) to continue using the normal (geographic) reference regardless of operating latitude. Selecting **MTXVS** forces the AN/WSN-7B(V) to use Transverse coordinates reference regardless of operating latitude and longitude. The selected mode and the operating mode presently being used by the AN/WSN-7B(V) is displayed in the **COORD**inates field of the display (see Figure 4-44). Displayed indications are:

- **ANORM** - AUTO selected, normal coordinates being used.
- **ATXVS** - AUTO selected, Transverse coordinates being used.
- **MNORM**- Normal coordinates manually selected.
- **MTXVS** - Transverse coordinates manually selected.

In addition to the operation mode, the position and heading can be displayed in either normal or transverse coordinates regardless of the selected AN/WSN-7B(V) operation reference. Display of position and heading is selected from **AUX FUNC menu, Page 1, Display Coord** function. This function is a toggle selection. When Transverse position and heading are being displayed, the LAT, LON, and HDG indications are replaced by Transverse Latitude (TLT), Transverse Longitude (TLN), and Transverse Heading (THD) respectively.

4.10.13 Accepting and Entering Position Fixes

Position resets are based on inertial position, an uncertainty area (system accuracy) defined by system calculated sigma latitude (SN) and sigma longitude (SE), and position fix data. The estimated values of SN and SE increase with time, but are decreased by the application of a position fix. Entry of valid fix data with suitable fix variances should always improve system accuracy.

Several available functions allow the operator flexibility in selecting the manner in which automatic fixes are accepted or rejected, and allow review of last accepted fix data. They also allow review of and overriding acceptance of pending fixes which have been rejected by the system as being unreasonable.

The fix review mode can be selected from the **Mode menu, Reset Mode** function. The mode selected on this menu determines how the system involves the operator in the process of review and acceptance of fixes from external position sensors.

Manual fixes can be entered into the system at any time using the **Mode menu, Fix** function. When fixes are entered manually, the system checks the fix data for reasonableness in the same manner as for fixes received from external position sensors. If the manually entered fix data is determined to be invalid, an appropriate fault code is displayed and a Reset Data menu is displayed. This allows the operator to review the entered fix data and either force acceptance or discard the data.

At any time, the operator can review the data for the last position fix accepted by the system. This function is selected from the **Display menu, Page 1, Last Reset** function. Figure 4-48, presents an outline of the various states associated with the position fix functions.

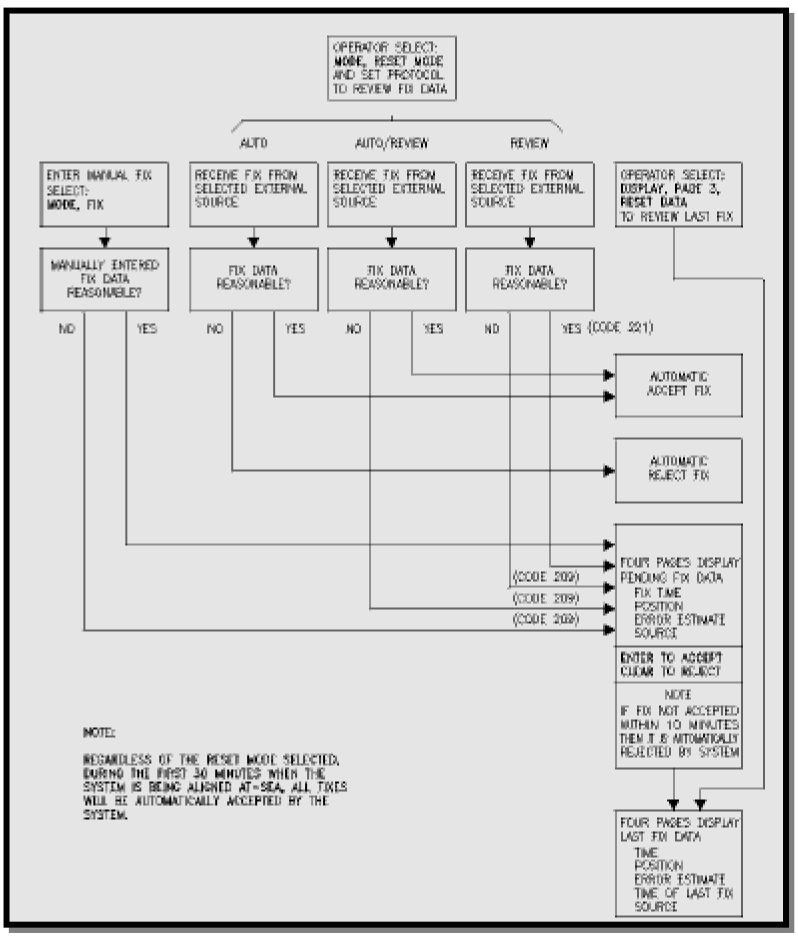


Figure 4-48.— Position Fix, Data Entry and Review Functions.

Processing of a Position Fix

When a fix is entered, either manually or automatically from a navigation aid, such as a GPS, the Kalman Filter compares the inertially derived position with the available position reference (fix) data and operates on these measurements to generate corrections to the modeled system states. The process attributes navigational errors to sensor or system drifts and then modifies the Kalman parameters to neutralize the error pattern. Corrections are made to latitude, longitude, velocities, tilts, heading, gyro biases, and horizontal accelerometer biases. The Kalman Filter operates on the fix as entered. Fix processing within the Kalman Filter calculates the latitude and longitude resets using the difference between system position and fix position. The Kalman Filter calculates a weighting based on the estimate of system accuracy (SN and SE) as compared to the fix accuracy as defined by fix sigma latitude (FSN) and fix sigma longitude (FSE). This weighting is used to determine the proportion of the difference in position to be applied as the position reset. If a fix is entered with a small sigma value (high accuracy), then a large percentage of the difference in position will be applied as a reset.

The difference between the system position and the fix position does not determine the weighting. The weighting is determined by the estimated system accuracy and fix accuracy. The estimated value of system error increases with time, but is decreased by the application of fix data as a reset. This results in a higher weighting being given to fix data following a long navigate period as compared to fix data entered closely spaced in time. The latitude and longitude weighting or gain (K) is calculated using the system sigma values at the time of fix and the fix sigma values (or the sigma values calculated from Radial Position Error (RPE) data) which are used as entered:

$K = (\text{system sigma})^2/((\text{system sigma})^2 + (\text{fix sigma})^2)$
FSN and FSE = $0.707 \times$ RPE

The north and east distances that the reset will move the system position (DN and DE) are given by:

Reset = $K \times$ (fix position - system position)

Criteria for Acceptance of a Position Fix

When a position fix is entered, the Kalman Filter checks the fix using the following limits:

$(\text{Position error})^2 = (\text{system lat - fix lat})^2 + [(\text{system lon - fix lon}) \times \cos(\text{fix lat})]^2$
$\text{Error limit} = 9 \times (SN^2 + FSN^2 + SE^2 + FSE^2)$

If $(\text{Position Error})^2$ is greater than the Error Limit, then an operator advisory (Fault Code 209) is announced, the fix is rejected, and may be held for review. The system resets for latitude, longitude, velocity, and various system feedback parameters are also checked using appropriate limits similar to the above limit on fix position error. If a reset exceeds an error limit, then an operator advisory (Fault Codes 212 through 217) will be declared.

If the fix data is unreasonable, the operator should then review the reset DN and DE (the north and east distances the reset will move the system solution) and either correct the fix data or, if the fix data is known to be accurate, accept it and "force" the reset.

If operation of the AN/WSN-7B(V) during the prior navigation period has excessive error due to any cause (loss of reference velocity, operation in an area of changing vertical deflection, excessive time since last reset, etc.), then the operator should apply the position fix data as a position slew.

The operator is alerted (using Fault Codes 209 - 217) to fix data or a reset outside acceptable bounds.

Reset Modes and Operator Acceptance of a Position Fix

The reset mode (**MODE Menu, Reset Mode** function) defines the conditions for fix entry and is set by the operator. The effect of the fix is calculated and can be displayed for review before acceptance; but once the reset is applied, its effects cannot be undone. The operator may select from the following reset modes:

a. **REVIEW** Reset mode - An operator accept/reject is required after review of the reset data. When a position fix is received, the system will prompt the operator by announcing a fault and by displaying Fault Code 221. To review and either accept or reject the fix data, select **DISPLAY menu, Page 1, Last Reset** function.

NOTE:
Fix must be either accepted or rejected by the operator or the system will not process new fix data for ten (10) minutes.

b. **AUTO REVIEW** Reset mode - Position fixes or resets which meet the error limit criteria are applied without operator review. Position fixes or resets which do not meet the error limit criteria are held for operator review. When a position fix or reset is rejected, the system will prompt the operator by announcing a fault and by displaying a Fault Code. To review the out of limit fix data, select **DISPLAY menu, Page 1, Last Reset** function. If the fix is not reviewed within 10 minutes, the fix data is discarded. Additional fixes received during this time are not processed and may be overwritten by later fix data.

c. **AUTO** Reset mode - No advisory Fault Codes are provided. Position fixes or resets which do not meet the error limit criteria are not applied. Position fixes which do meet the error limit criteria are applied to the system without operator review. Automatic acceptance/rejection of position fixes is the mode normally selected for system operation.

CAUTION:
Depending on the review mode selected, a rejected fix may be entered by the operator. These functions allow the operator to force the acceptance of a good fix to correct system errors. This is useful if a fix is rejected as a result of errors in the system's estimate of position. Care should be taken when manually entering or accepting a fix which has been rejected. Acceptance of an unreasonable fix introduces position errors and will cause calculations of position and velocity to diverge. Changing system position with a position slew will avoid introducing errors and will reset system Lat, Lon to reference position.

NOTE:
Any position fix for which the resulting radial position reset exceeds 2 nm should be reviewed closely before accepting. Any fix which exceeds the range of the latitude and longitude reset (DN and DE) display (+/- 100 nm) is immediately suspect.

Automatic Entry of a Position Fix or Position Slew

Fixes may be entered automatically via the data interface from a configured navigation aid (**SENSOR menu**, page 2, **GPS** (or **GNMEA**) set to **ON**). These fixes will either be automatically accepted or rejected by the system, or the operator will be prompted to review the fix data and manually accept or reject the fix depending on the reset mode selected at the **MODE menu, Reset Mode** function (see above).

If continuous position data is available from GPS (NTDS or NMEA interface), then the AN/WSN-7B(V) position output is slaved to the GPS input and will provide performance similar to GPS. If AUTO Reset mode is selected, then erroneous GPS data will be rejected. If GPS data has not been continuously available, then the operator can select AUTO/REVIEW mode to review any unreasonable fixes prior to application of reset.

4.10.14 Manual Entry of a Position Fix or Position Slew

Position Fix vs Position Slew

Position data is entered into the system either as a fix or as a slew. The way that the data is entered determines how it affects system operation. Refer to Section 2.7.1 of S9427-AT-MMO-010/WSN-7.

- A **position slew** directly updates the system's position estimate to agree with the current position data entry but does not change the system's navigation filter values. The first position data applied to the system (either automatic or manual) after start-up is always applied as a slew.

CAUTION:
Ensure that position slew data is accurate. Entry of inaccurate position slew data will cause the system's navigation performance to be adversely affected.

- A **position fix** is used to correct the system estimate of position and to update the navigation filter (self-calibrate). The amount (or weighting) of the fix is determined by the system's estimate of fix accuracy and by the elapsed time since the last fix was applied.

CAUTION:
Ensure that position fix data is accurate. Entry of inaccurate position fix data will cause the system's navigation performance to be adversely affected.

General Information

A manual position fix may be entered at any time when the system is in navigate or align modes, even when navigation aids are selected for automatic entry of position fixes.

To perform a manual position reset (i.e., to enter a fix), the operator must enter fix time; latitude, longitude, and estimate of fix accuracy (Sigma value of the fix) in nautical miles.

After the fix data is entered through the display, the system will not immediately use the data for reset, but will first calculate the system parameters based on the fix data. The operator must review the calculated effect of accepting the fix by examining the delta (DN and DE) and sigma (FSN and FSE) latitude and longitude values. If it is determined that the reset data is acceptable, the manual fix is accepted for reset by pressing the ENTER key. If the operator decides not to accept the fix, he may clear the fix data by pressing the CLEAR key. If the ENTER or CLEAR key is not pressed, the system will retain only the last accepted fix.

NOTE:
The system will find the manual fix unreasonable if the reset exceeds the error limits described in Section 2.7.2 of S9427-AT-MMO-010/WSN-7. Care must be taken when manually forcing acceptance of a fix which has been rejected by the system. Forcing acceptance of an unreasonable fix introduces position errors and will cause the system calculations of position and velocity to diverge. Changing system position with a position slew will avoid introducing errors into the navigational filter and will reset system LAT, LON to reference position.

Manual Fix Entry Procedure

Proceed as follows:

a. Press **MODE** key and select **Fix**. The display will prompt the operator for entry of fix time. Current time is displayed and may be accepted by pressing **ENTER**. To enter any other time (up to a maximum of 1 hour in the past) press **CLEAR** and enter the fix time in HH:MM:SS format. The **BACKSPACE** key may be used to eliminate data entry errors. Press **ENTER** to accept the entry.

b. The display will now prompt for entry of fix latitude. Current system latitude is displayed, and may be accepted by pressing **ENTER**. To enter a different value, press **CLEAR** and enter fix latitude in DD^{0}MM.mm’ format, and North or South Hemisphere. Press **ENTER** to accept the entry.

c. The display will now prompt for entry of fix longitude. Current system longitude is displayed, and may be accepted by pressing **ENTER**. To enter a different value, press **CLEAR** and enter fix longitude in DDD^{0}MM.mm’ format, and East or West Hemisphere. Press **ENTER** to accept the entry.

d. The display will now present two options for entry of fix error estimate, 1/North and East Error or 2/Radial Position Error. Only one option may be selected. North and East Error: Press <1> key to select North and East Error format. The display will now prompt for entry of fix Sigma North. Current Sigma North (SN) is displayed, and may be accepted by pressing **ENTER**.

To enter a different value, press **CLEAR** and enter fix Sigma North in xx.x NM format. Press **ENTER** to accept the entry. The display will now prompt for entry of fix Sigma East. Current Sigma East is displayed, and may be accepted by pressing **ENTER**. To enter a different value, press **CLEAR** and enter fix Sigma East (SE) in xx.x NM format. Press **ENTER** to accept entry.

Radial Position Error: Press <2> key to select RPE format. RPE is equal to 1 sigma CEP (Circular Error Probable). The CEP defines that circular area within which the actual ship position exists with a certain defined probability. The RPE defines that probability as 68.3% (i.e., the size of the CEP is defined by RPE such that there is a 68.3% probability that the ship’s position exists within the CEP). The display will now prompt for entry of RPE. Current system RPE is displayed, and may be accepted by pressing **ENTER**. To enter a different value, press **CLEAR** and enter fix RPE in xx.x NM format. Press **ENTER** to accept the entry. The system now uses the RPE to calculate FSN and FSE.

NOTE:
In either of these fix error estimate options, the Sigma values must reflect the true position fix accuracy. Assigning a large Sigma to an accurate fix will not disturb the system, but the reset will have a reduced correction to the system. On the other hand, assigning a small Sigma to an inaccurate fix will disturb the system and result in position and velocity divergence.

e. The display will now show the complete fix data, and prompt the operator to enter the fix by pressing **ENTER** or reject by pressing **CLEAR**. When the fix data is correct, press **ENTER** and the system will calculate and display the reset parameters.

f. If the fix parameters are within the error limits, the system will prompt the user with "REASONABLE." If outside the error limits, the system will prompt the user with "UNREASONABLE." In either case, the operator has the following choices:

(1) Reject the fix by pressing **CLEAR**.

(2) Accept the fix by pressing **ENTER**.

(3) Do nothing and allow the fix to be discarded after 10 minutes.

NOTE:
The system maintains a history of position data to allow fix computations using the data obtained up to 60 minutes prior to the current time. Fault Code 218 will be declared if the fix data is more than 60 minutes old or has an invalid time.

Manual Position Slew Procedure

Proceed as follows:

a. Press **MODE** key and select Slew. The display will prompt the operator for entry of fix time. Current time is displayed and may be accepted by pressing **ENTER**. To enter any other time (up to a maximum of 1 hour in the past) press **CLEAR** and enter the fix time in HH:MM:SS format. The **BACKSPACE** key may be used to eliminate data entry errors. Press **ENTER** to accept the entry.

b. The display will now prompt for entry of latitude. Current system latitude is displayed, and may be accepted by pressing **ENTER**. To enter a different value, press **CLEAR** and enter new latitude in DD MM.mm' format, and North or South Hemisphere. Press E**NTER** to accept the entry.

c. The display will now prompt for entry of fix longitude. Current system longitude is displayed, and may be accepted by pressing **ENTER**. To enter a different value, press **CLEAR** and enter new longitude in DDD MM.mm' format, and East or West Hemisphere. Press **ENTER** to accept the entry.

d. The display will now show the slew data, and prompt the operator to enter the position slew by pressing **ENTER** or reject by pressing **CLEAR**. When the data is correct, press **ENTER** and the system will calculate and apply the position slew.

4.10.15 Acknowledging and Identifying Fault Conditions
The AN/WSN-7B(V) contains a complete and versatile fault indication system. The system provides five on-line sources for fault announcements.

- Three sets of relay contact closures for operator use to actuate audible or visual alarms.
- Two lamp drivers for operator use to actuate visible alarms.
- SYSTEM FAULT indicator lamp on front panel.
- Display of faults for operator.
- Display list of active faults.

At start-up and during operation, the AN/WSN-7B(V) BIT function continually monitors hardware and software functions and checks calculation results for reasonableness. Any fault condition detected by BIT is announced by setting appropriate relays, turning the SYSTEM FAULT indicator (DS2) ON, and displaying the Fault Code in the upper right corner of the display. Each detected condition results in the generation of a system Fault Code which is stored for display and review as long as the fault remains active.

Appendix B, Table B-1 of S9427-AT-MMO-010/WSN-7, provides a complete listing of all BIT Fault Codes, indicates the source of the fault, and indicates the classification(s) of the fault(s) with an asterisk in the adjacent classification column(s).

Appendix B, Table B-2 of S9427-AT-MMO-010/WSN-7, provides diagnostic information and references off-line BIT to be performed to verify and troubleshoot the fault condition.

Based on the type of Fault Code displayed, the operator may acknowledge the fault by pressing the ALARM ACK key and choose to continue operation of the AN/WSN-7B(V) or may take the unit out of service. Certain faults automatically shut down the AN/WSN-7B(V) and cannot be overridden by the operator. The following list outlines the major fault classifications of interest to the operator:

a. Fault Codes classified as “**operator advisory**” inform the operator that manual intervention is required to review data or to select functions related to system operation. An example of an operator advisory code is Fault Code 221.

b. Fault Codes classified as "**non-critical**" indicate that a fault condition exists which may be bypassed by changing operation modes or selecting other sensors, or by manual entry of data. Non-critical codes generally result from conditions which allow continued operation at reduced capability or at degraded performance levels. Non-critical faults may also result from a fault condition in the I/O, data messages, or in equipment external to the AN/WSN- 7B(V). An example of a non-critical code is Fault Code 222.

c. Fault Codes classified as "**critical**" indicate that a fault condition exists which makes the system unusable as a reference source. Critical faults may or may not result in automatic shutdown of the AN/WSN-7B(V).

NOTE:
In addition to the defined Fault Codes, several "spare" code numbers are reserved for future expansion of the system. These codes will not be announced by the system during normal operation.

4.10.16 Operating with System Faults

NOTE:
Before acknowledging each fault, first record the displayed Fault Code number.

If a fault is detected during operation, the appropriate relays are set and the Fault Code generated by the BIT function is displayed in the upper right corner of the display. To acknowledge the fault, press the **ALARM ACK** key. For each fault condition, proceed as follows: Determine the Fault type:

a. Operator advisory - Acknowledge advisory and perform required action.

b. Non-Critical fault - Acknowledge the fault and observe system operation to determine if the fault is cleared or if the fault condition is again announced, or appears in persistent fault list (**AUX FUNC, Faults**). If the fault condition is repeated, acknowledge fault and determine operating status or alternate mode for continued system operation. Record the Fault Code(s) displayed for future troubleshooting reference.

c. Critical fault - Record Fault Code(s) displayed for future troubleshooting reference. Turn off system power and tag system OUT OF OPERATION. Perform fault testing (refer to Chapter 5 of S9427-AT-MMO-010/WSN-7).

d. System automatic shutdown - Turn off system power and tag system OUT OF OPERATION. Perform fault testing (refer to Chapter 5 of S9427-AT-MMO-010/WSN-7).

The following paragraphs outline the recommended operator action with selected non-critical faults.

Speed Data Source Faults

For Fault Codes 36, 56, 57, 222, and 223:

Loss of speed data or unreasonable speed input will cause the system to switch to undamped operation. Loss of log data can result from the selected velocity reference or speed sensor equipment being turned off or switched to a test mode at the source. In installations where more than one synchro speed reference can be externally selected to provide the synchro speed input to the system, (such as synchro input from Rod 1 and Rod 2) loss of log may result when changing the external selection. If any of the indicated Fault Codes are displayed, it may be necessary to select manual entry of ship's speed. If the system is operating with **Auto** damping selected and if the system is excessively undamped, an operator advisory (Fault Code 223) will be displayed.

This code alerts the operator to take corrective action. If the operator does not change the damping selection, the system will automatically go into the forced damped mode (**AUTOD** displayed) for the next 128 minutes using the currently selected speed data source as the velocity reference.

If Fault Code 223 is displayed, the operator should review the status of the selected velocity reference source. If the selected velocity reference is found to be accurate, then the operator may elect to manually select forced damping of the system (select **Man Damp**) for approximately two hours and then return to **Auto** damping.

If the operator finds that the selected velocity reference is not sufficiently accurate to provide velocity damping, then the operator should select **SENSOR Menu, Page 1,** and select a different source as the velocity reference. Select **Man Damp** for approximately two hours, or select force undamping of the system (select **Man Undamp**).

Selection of either **Man Damp** or **Man Undamp** will reset the 128 minute forced damping timer.

If a valid speed reference is not available, select **SENSOR Menu, Page 1, VMAN ON** and manually input ship's forward water speed from the keypad. Ship's speed should be monitored by the operator and the manually entered value should then be changed whenever the ship's speed changes by more than ±10 percent from the set value.

Velocity Reference Error Faults

For Fault Codes 210, 211, and 212:

Fault Codes 210 and 211 indicate that the reference velocity data does not agree with the system calculated velocity within the system reasonableness bounds.

Fault Code 212 indicates that a reset resulting from the reference velocity data is outside the system reasonableness bounds.

The operator should review the provided velocity data during the time when faults are being reported (only multiple fault occurrences will degrade navigation performance). The system may undamp if Auto damping is selected (refer to Section 2.5.1 of S9427-AT-MMO-010/WSN-7). If reference velocity data is found to be invalid or noisy, then another velocity reference should be selected.

If reference velocity is found to be continuously valid, then the system should be manually damped for approximately two hours, then returned to Auto damping. If the faults recur, the system may need realignment using **KF reinit** to restore full navigation accuracy.

Position Reference Error Faults

For Fault Codes 209, 213 through 217:

Fault Code 209 indicates that the position fix data does not agree with the system calculated position within the system reasonableness bounds.

Fault Codes 213 through 217 indicates that a reset resulting from the position data is outside the reasonableness bounds.

CAUTION:
Forced acceptance of correct position fix data over a period of time will restore a system to full navigation data accuracy; however, forced acceptance of incorrect position fix data will quickly degrade navigation performance. It may be necessary to realign the system following a Kalman Filter re-initialization to restore navigation accuracy if an invalid position fix has been force accepted.

If the position fix was processed in a Review or Auto/Review mode, then the operator should review the data for correct LAT, LON, fix time, and fix variance. If the data is found to be incorrect, then the operator can reject the fix. If the data is found to be correct, then the operator can force acceptance of the fix. The error codes will occur again on a forced acceptance of the position fix.

GPS or GPS I/O Faults

For Fault Codes 53 through 55:

Failure of the GPS position sensor input to the AN/WSN-7B(V) will result in slow degradation in the accuracy of the estimate of position. Position performance degrades approximately as a function of the square root of time as shown in Figure 4-49. The chart below is shown for illustration of proportion only, no units are implied. System performance can be maintained by periodically entering a position fix manually. To manually enter position fix data, select **MODE menu, Fix** function.

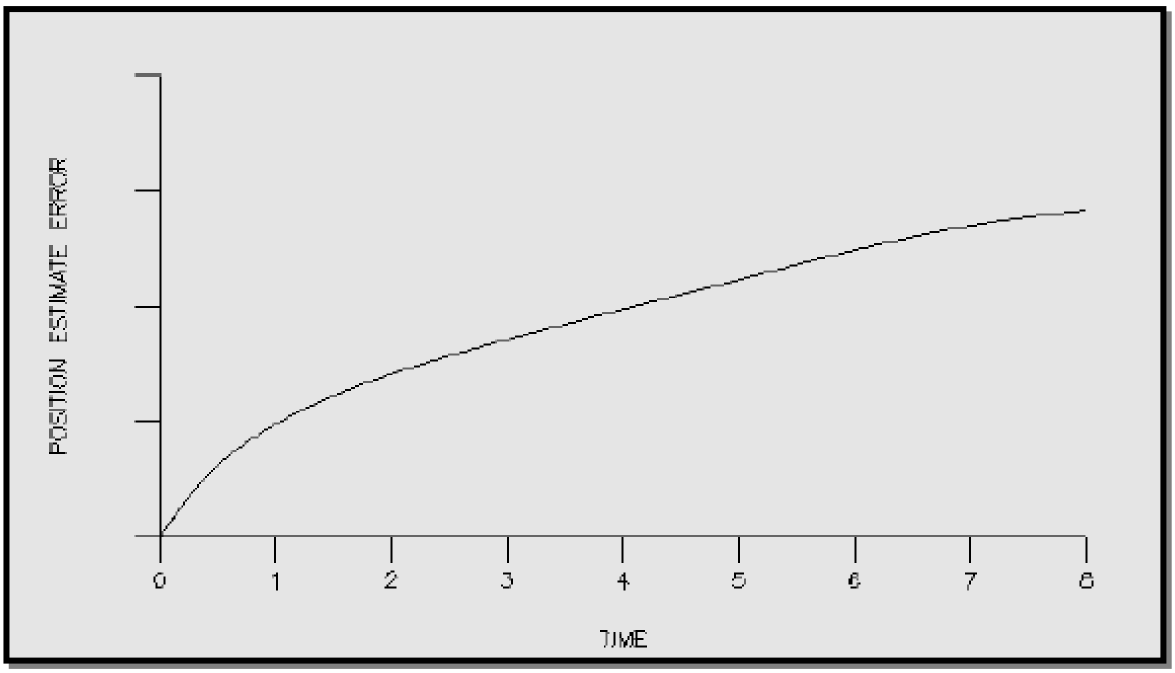


Figure 4-49.— Position Estimate Accuracy vs. Time without Position Update.

External Serial Interface or I/O Processor Fault

For Fault Codes 256 through 282, 338, 347 through 351:

Detection of a fault which results in any of the listed Fault Codes will cause the I/O Processor to shut down. While the AN/WSN-7B(V) may continue to operate normally and to provide local display of data, as well as output of synchro format data, input of GPS data, and all other input and output data messages will be halted.

To restart the I/O Processor, clear the Fault Code(s) and then select the **AUX FUNC** menu **Page 2**, **I/O Restart** function, and set the I/O Processor to Enabled. If the fault condition is cleared by restarting the I/O Processor, normal operation can be resumed. If the operator was successful in restarting the I/O Processor, the "Enabled" message will change from flashing to non-flashing. If the operator was not successful in restarting the I/O Processor, the "Enabled" message will again read "Disabled".

If the fault condition recurs, select the **AUX FUNC** menu **I/O Config** function, disable the associated interface port(s), and then select the **I/O Restart** function to enable the I/O Processor. If the fault condition is cleared, enable each interface port (one at a time) and check operation to determine if the fault is in the I/O communications interface port or in an external device. If the condition cannot be corrected by use of the above procedure, the AN/WSN-7B(V) must be shut down and then restarted in the off-line Test Mode so that troubleshooting can be performed to isolate and correct the fault condition. Refer to Section 5.2.2 of S9427-AT-MMO-010/WSN-7.

Laser Intensity Monitor Faults

For Fault Codes 105, 106, and 107:

The voltage sample associated with the laser intensity for each ring laser gyro in the Inertial Measuring Unit (IMU) is periodically compared with a pre-established lower limit (or "pull voltage"). If the sample voltage falls to the pull voltage, the system will announce a fault for the affected gyro. This fault is intended to warn the operator that the gyro may be reaching the acceptable limit for reliable operation and that the IMU should be replaced at the next scheduled maintenance opportunity. When the fault is acknowledged, a seven day timer is reset which prevents the fault from being announced again within the next seven days. This function allows the AN/WSN-7B(V) to continue operation without the annoyance of a repetitious fault being announced. Detection of these faults does not affect other system operation and does not indicate an immediate operational concern.

4.10.17 Viewing Memory Contents
The contents of each memory location in the Navigation Processor can be inspected while the system is operating on-line. This function, selected from **AUX FUNC** menu **Page 2** is incorporated into the operating program primarily to assist software development and has no operation or maintenance significance for the level of information addressed by this technical manual.

To inspect Nav Processor memory, select **Mem Inspect**. Follow menu prompts to select the memory type (16 or 32 bit) and then enter the address (in hexadecimal) of the first memory location to be inspected. To step up or down sequentially through the memory address, press the NE+ or SW- keys. To change to a new starting address, press **CLEAR**, select the change address function and enter a new starting address. The contents of memory locations cannot be changed using this function.

4.10.18 On-line Simulated Attitude, Velocity, and Position Outputs
The on-line Simulated Outputs function is similar to the off-line Simulated Outputs function described in Section 5.4 of S9427-AT-MMO-010/WSN-7 This function provides a means of generating static output data values from the AN/WSN-7B(V) while the unit is operating in a normal mode. This function is available for checking the operation of external systems which receive data from the AN/WSN-7B(V). The simulated values are applied on all applicable configured synchro and digital I/O functions.

To select and enable the simulated outputs functions, proceed as follows:

a. Press **AUX FUNC**tion key, select **Page 2** and select **1. Simulated Outputs**.

b. Observe that the Simulated Outputs Menu is displayed. This menu provides an enable/disable toggle function for the simulated outputs and provides three categories of menus which may be selected for setting the output data values. Displayed functions are:

1 Enable Simulated Outputs = ON (or OFF)

2 Modify Attitude Output

3 Modify Velocity Output

4 Modify Position Output

c. At the Simulated Outputs Menu, if Enable Simulated Outputs is set to OFF, press the <1> key to toggle the selection to ON.

d. Select the applicable category of operation functions <2>, <3>, or <4> key.

e. When any category of operation functions is selected, a list of associated parameters will be displayed. To change the value of any parameter, press the number key corresponding to the number of the parameter. The display will indicate the currently set data value for the parameter and the bottom line will display "ENTER to accept, CLEAR to reject". To change the data, press **CLEAR**. The data value will change to a data entry field to allow entry of a new value and the operator entry will be echoed directly into the field.

f. After the new value has been entered, press the **ENTER** key. Output value will then slew to the entered value.

Table 4-11 provides a brief outline of the simulated output settings associated with each of these functions.

SIMULATED FUNCTION	DESCRIPTION	ENTRY RANGE
2 Modify Attitude Output Functions (Select by pressing the <2> key)		
1 Roll	Sets a positive or negative roll angle which is output from Synchro Converter CCA (A15).	-45 to +44.99 degrees
2 Pitch	Sets a positive or negative pitch angle which is output from Synchro Converter CCA (A15).	-45 to +44.99 degrees
3 Heading	Sets a heading angle which is output from Synchro Converter CCA (A14).	0 to 359.99 degrees
3 Modify Velocity Output Functions (Select by pressing the <3> key)		
1 Vel N (North Velocity)	Sets a north/south velocity value which is output in all applicable output data messages.	-128 to +127.99 knots
2 Vel E (East Velocity)	Sets a east/west velocity value which is output in all applicable output data messages.	-128 to +127.99 knots
4 Modify Position Output Functions (Select by pressing the <4> key) When entering Latitude and Longitude, the N/S field is set with the N/E/+ or S/W/- key		
1 Latitude	Sets a latitude value which is output in all applicable output data messages.	0 to 90 degrees 0 to 59.99 minutes
2 Longitude	Sets a longitude value which is output in all applicable output data messages.	0 to 180 degrees 0 to 59.99 minutes

Table 4-11.— Simulated Outputs Description.

4.11.0 RING LASER GYRO NAVIGATOR INERTIAL NAVIGATION SYSTEM, AN/WSN-7(V)1, -7(V)2, -7(V)3

The AN/WSN-7(V) Ring Laser Gyro Navigator (RLGN) (Figure 4-50) is part of the AN/WSN-7(V) INS. Each RLGN is a self-contained unit that employs an Inertial Measuring Unit (IMU) using three single-axis Ring Laser Gyros (RLGs) and three accelerometers as the inertial reference to determine ship's position, velocity, heading, roll and pitch. The system continuously accepts ship's speed information from a speed log and/or Global Positioning System (GPS), and periodically accepts ship's position information from an external navigation reference (GPS), manually via a keypad and display on the RLGN control panels, or from the IP-1747/WSN Control Display Unit (CDU).

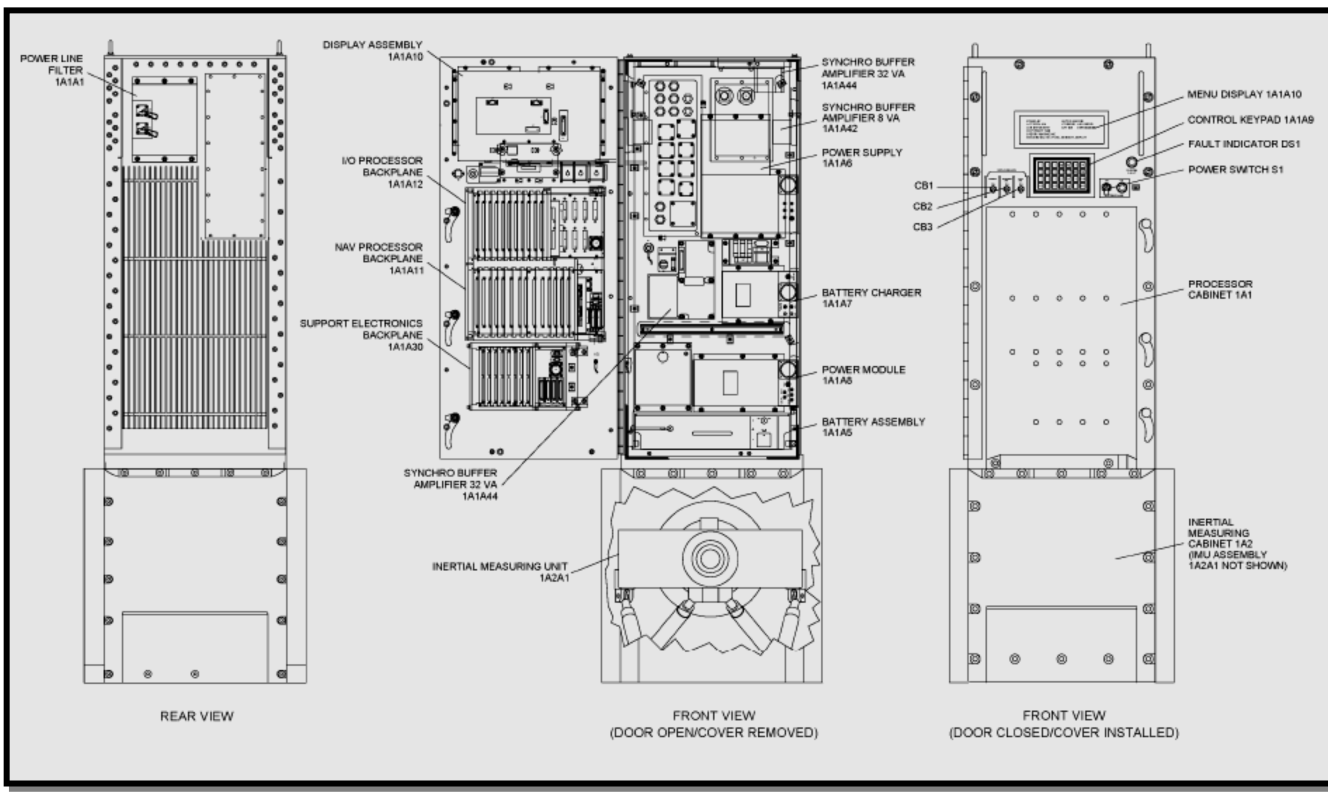


Figure 4-50.— PART NUMBERS CN-1695/WSN-7(V), CN-1696/WSN-7(V), and CN-1697/WSN-7(V).

As shown in Figure 4-51, sheet 1 and Figure 4-51, sheet 2, each RLGN is part of a dual system that provides ship's heading, log speed and distance, ship's velocities, pitch, roll, attitude rates, position and time data to other ship's systems and indicators. The AN/WSN-7(V) INS comprises two single-enclosure AN/WSN-7(V) RLGNs and a single IP-1747/WSN CDU, supported by a GPS Navigator interface and a Speed Log data interface. Only the RLGN and the power and signal interface to the RLGN are covered in this technical manual. The IP-1747/WSN is Unit 4 of the RLGN, but it has a separate technical manual. Refer to appropriate technical manuals for details on installation, operation, and maintenance of the CDU, GPS, Doppler Sonar Velocity Log (DSVL), and other support equipment. (See Table 4-12.)

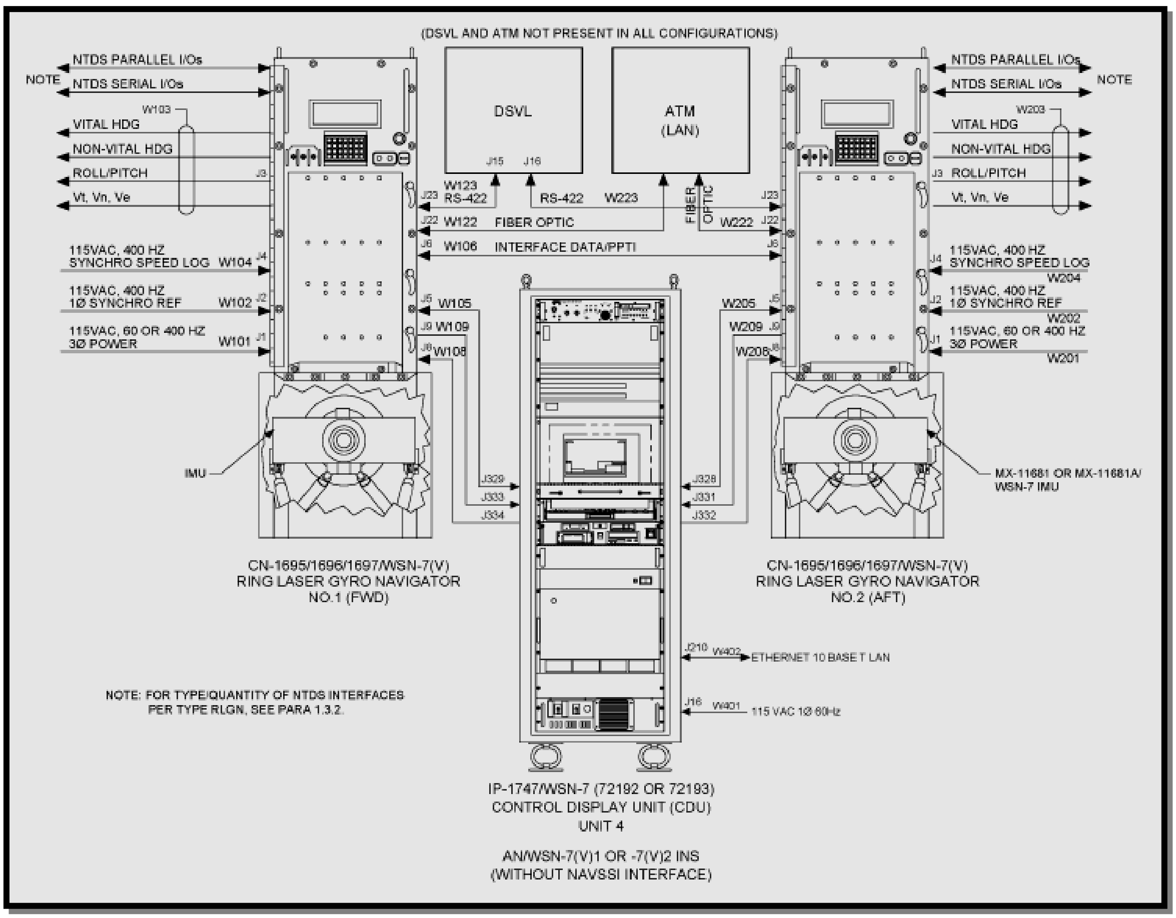


Figure 4-51.— Typical System Configuration (Sheet 1 of 2).

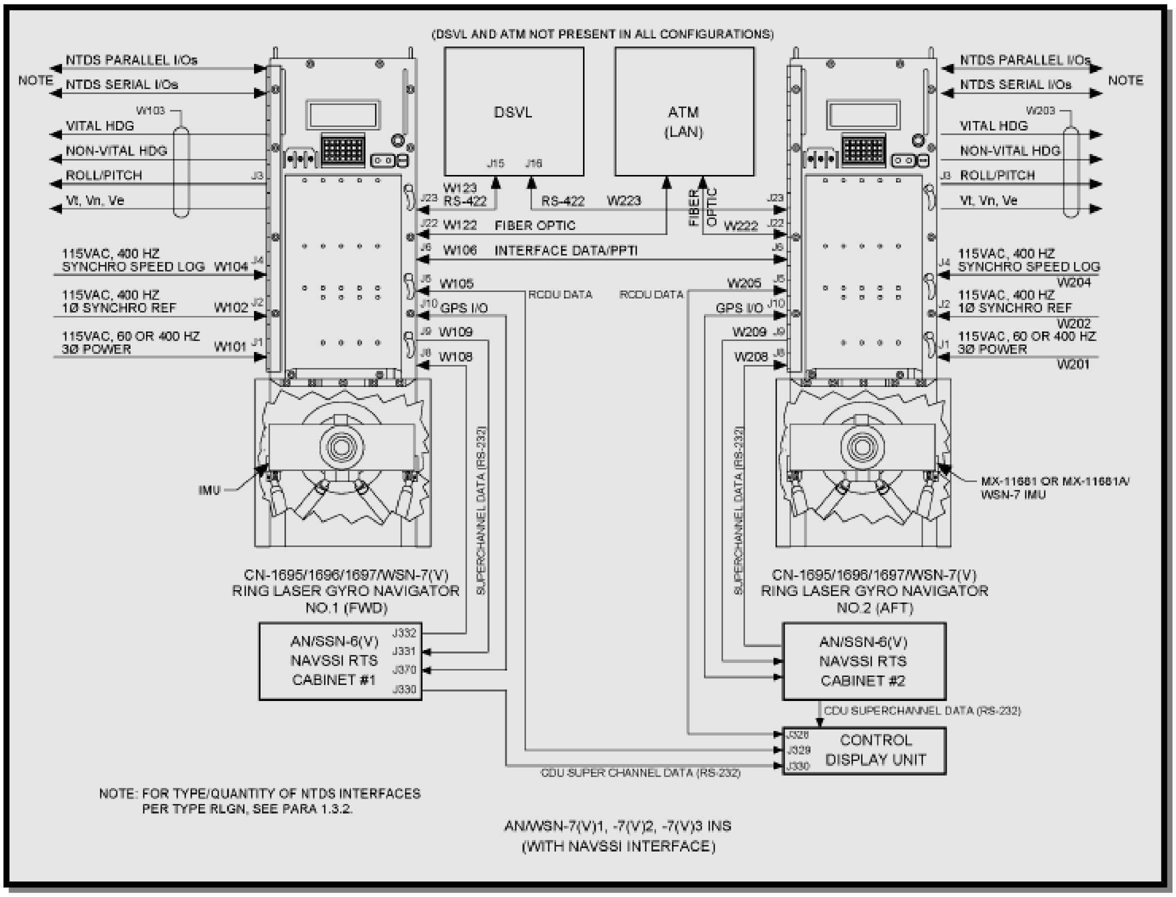


Figure 4-51.— Typical System Configuration (Sheet 2 of 2).

DOCUMENT NO.	DESCRIPTION
NAVSEA Dwg. No. 7100680	Inertial Navigation System AN/WSN-7(V) Drawing List
NAVSEA Dwg. No. 7100681	Inertial Navigation System AN/WSN-7(V) Block Diagram
NAVSEA Dwg. No. 7100682	Inertial Navigation System AN/WSN-7(V) Summary List of Installation Materials
NAVSEA Dwg. No. 7100683	Inertial Navigation System AN/WSN-7(V) Input/Output Sheets
NAVSEA Dwg. No. 7100684	Inertial Navigation System AN/WSN-7(V) Cable Running Sheets
NAVSEA Dwg. No. 7100685	AN/WSN-7(V) Ring Laser Gyro Navigator Outline and Installation Drawing
MIL-STD-1397B(NAVY)	Military Standard Input/Output Interfaces, Standard Digital Data, Navy Systems
NAVSEA S9427-AN-IDS-010/WSN-7	Interface Design Specification, Super Channel to User for the AN/WSN-7(V) Ring Laser Gyro Navigator (RLGN)

Table 4-12.— Documents Required but Not Supplied.

DOCUMENT NO.	DESCRIPTION
NAVSEA SE174-AB-IDS-010/GPS	Interface Design Specification for Shipboard External Computer and Navigation Satellite Timing and Ranging (NAVSTAR) Global Positioning System
NAVSEA T9427-AB-IDS-050/WSN-7	Interface Design Specification, Aircraft Carrier Navigation System (CVNS) to External Computer
EE17A-AA-OMI-010 (Windows software version) with Change A	Operator and Maintenance Manual, Organizational Level for Control Display Unit, IP-1747/WSN-7 and Secondary Control Display Unit, IP-1746/WSN-7A
EE17A-AA-OMI-A10 (Linux software version)	Operator and Maintenance Manual, Organizational Level for Control Display Unit, IP-1747/WSN-7 and Secondary Control Display Unit, IP-1746/WSN-7A
EE17A-AC-IEM-010/ EE17A-AD-IEM-010	IP-1747/WSN Control Display Unit and IP-1746/WSN-7A Secondary Control Display Unit Interactive Electronic Technical Manual and Interactive Courseware
NAVSEA S9427-AN-IDS-010/WSN-7	Interface Design Specification, Superchannel to User for the AN/WSN-7 Ring Laser Gyro Navigator (RLGN) System
NAVSEA S9427-AN-IDS-020/WSN-7	Interface Design Specification, Inertial Navigation System AN/WSN-7(V) to External Computer - for Low Level Serial (MIL-STD-1397B Type E) Digital Communication
NAVSEA S9427-AN-IDS-030/WSN-7	Interface Design Specification, Inertial Navigation System AN/WSN-7(V) to Users - for MIL-STD-1397 Type D Serial Channels No. 1 and No. 2
NAVSEA S9427-AN-IDS-040/WSN-7	Interface Design Specification, Inertial Navigation System AN/WSN-7(V) to External Computer in an Output Only Configuration - for Parallel Channels
NAVSEA S9427-AN-IDS-050/WSN-7	Interface Design Specification, Ring Laser Gyro Navigator (RLGN) System to External Computer
NAVSEA S9427-AN-IDS-070/WSN-7	Inertial Navigation System AN/WSN-7 External Computer for Parallel (MIL-STD-1397B Type A) Input/Output Digital Communication, Interface Design Specification
NAVSEA S9427-AP-IDS-010/RLGN	Navigation Operational Program Interface Design Specification for Use with the Ring Laser Gyro Navigator (RLGN)
NAVSEA S9427-AP-IDS-020/RLGN	Navigation Operational Program Interface Design Specification for Use with the Ring Laser Gyro Navigator (RLGN)
NAVSEA S9427-AP-IDS-030/RLGN	Navigation Operational Program Interface Design Specification for Use with the Ring Laser Gyro Navigator (RLGN)
NAVSEA S9427-AP-IDS-040/RLGN	Navigation Operational Program Interface Design Specification for Use with the Ring Laser Gyro Navigator (RLGN)

Table 4-12(Cont'd).— Documents Required but Not Supplied.

DOCUMENT NO.	DESCRIPTION
NAVSEA S9427-AN-IDS-080/WSN-7	Interface Design Specification for the AN/WSN-7(V) Ring Laser Gyro Navigator (RLGN) to user via ATM Local Area Network (LAN)
03956 SCM-25417	Interface Design Specification for the AN/WQN-2 Doppler Sonar Velocity Log (DSVL) to AN/WSN-7(V) Ring Laser Gyro Navigator (RLGN) Interface
Part Number 03956-JA17-6608	DSVL Data Interface Supplement for CN-1695(V)/WSN-7(V) Ring Laser Gyro Navigator (RLGN)
03956-PL1813788-Var	DSVL Interface Field Change Kit Parts List
NAVSEA SE178-A2-MMM-010	Doppler Sonar Velocity Log (DSVL), AN/WQN-2(V)2 through 2(V)7, Electronic Equipment, Operation and Maintenance Instructions
03956-4300201-1	ATM Interface Field Change Kit
S9427-AN-FCB-001/WSN-7	AN/WSN-7/7A(V) Field Change Bulletin 1
S9427-AN-FCB-002/WSN-7	AN/WSN-7/7A(V) Field Change Bulletin 2
S9427-AN-FCB-003/WSN-7	AN/WSN-7/7A(V) Field Change Bulletin 3
S9427-AN-FCB-004/WSN-7	AN/WSN-7/7A(V) Field Change Bulletin 4
S9427-AN-FCB-006/WSN-7	AN/WSN-7/7A(V) Field Change Bulletin 6
S9427-AN-FCB-009/WSN-7	AN/WSN-7/7A(V) Field Change Bulletin 9

Table 4-12(Cont'd).— Documents Required but Not Supplied.

General Equipment Function

Table 4-13 lists the major design and physical characteristics of the AN/WSN-7(V) RLGN. The RLGN requires external ship's speed input and periodic input of position data. The RLGN uses ship's log speed or velocities obtained from a GPS or DSVL to provide damping of vertical gyro loops. Position data from a GPS is used to calibrate gyro drifts and to provide position resets to the inertial navigation function. The inertial reference, speed, and filtered position reset data are processed to generate continuous and accurate position and velocity data in addition to heading, roll, and pitch reference. The RLGN transfers data to and from Battle Force Tactical Trainer (BFTT) equipment via the Asynchronous Transfer Mode (ATM) interface.

ENVIRONMENTAL CHARACTERISTICS	
Temperature	Storage: -40° to 75° C (-40° to 167° F) Operating: 0° to 50° C (32° to 122° F) Extreme Operating:[1] -6.7° to 65° C (20° to 149° F)
Humidity	Humidity (relative): 0 to 95%
Barometric Pressure	Storage: 0.5 to 30 psi Operating: 10 to 30 psi

Table 4-13.— Design and Physical Characteristics.

ENVIRONMENTAL CHARACTERISTICS	
Shock	Meets the requirements of MIL-STD-901D. System functions may be interrupted during application of the shock.
Vibration	Meets the requirements of MIL-STD-167-1 for Type 1.
Linear Acceleration	Operating: Horizontal: ±0.5 g peak Vertical: 1.0 g ±0.5 g peak
PHYSICAL/ELECTRICAL CHARACTERISTICS	
Size	Height: 169.7 cm (66.8 in) Width: 59.7 cm (23.5 in) Depth: 73.3 cm (28.9 in)
Weight	381 kg (840 lbs)
Power requirements[2]	105-125 VAC, 50, 60 or 400 Hz, 3-phase, 600 Volt Amps (VA) (max)
Heat dissipation	600 Watts (max)

1 The AN/WSN-7(V) RLGN is capable of withstanding environmental extremes with no interruption of system functions. The RLGN returns to operating condition at full accuracy following restoration of applicable environment and performance of a reset cycle.

2 The main power fault detector is configured to match input power frequency by switch S1 on Vital Bus CCA (**1A1A3**). The AN/WSN-7(V) is configured for 60 Hz main power input from the manufacturer.

Table 4-13(Cont'd).— Design and Physical Characteristics.

Normal Operation

The RLGN is designed to operate automatically after application of power and acceptance of the first position reset and requires minimum operator intervention during normal operation. A 6-line, 40-character display and 28-key keypad provide display and operating controls for selection of a wide range of functions. These functions can be accessed for monitoring and modifying operating parameters, for evaluating system performance, and for selecting test and calibration modes.

Test Features

A Built-In Test (BIT) function incorporating both hardware and software tests continuously monitors operation and periodically performs self-tests to determine the integrity of the AN/WSN-7(V) RLGN and its inputs/outputs. Faults are automatically announced, and fault codes that indicate the type of fault detected are displayed on the local/remote control panels.

Power
In the configuration described in this technical manual, the RLGN requires 115 Volts, Alternating Current (VAC), 60 Hertz (Hz), 3 phase power and 115 VAC, 400 Hz, single-phase synchro reference. An internal battery and inverter provide emergency power for operation with digital output and limited synchro outputs (vital heading and synchro velocities) for approximately 30 minutes in the event of failure of the system power.

4.11.1 AN/WSN-7 (V) Configurations and Interfaces

Configurations
The AN/WSN-7(V) INS is available in three configurations. CN-1695/WSN-7(V) is installed on selected surface combatants. CN-1696/WSN-7(V) is installed on selected cruisers and LHA-1 class ships. CN-1697/WSN-7(V) is installed on aircraft carriers and LHD-1 class ships.

External Data Interfaces
The basic external data interface to each RLGN consists of Naval Tactical Data System (NTDS) Standard Type A parallel slow, NTDS Standard Type D high level serial, and Type E low level serial interfaces. These interfaces are Circuit Card Assemblies (CCAs) located in the Input/Output (I/O) Card Rack Assembly. The combat systems suite or aircraft alignment aboard the ship on which the RLGN system is installed determines the specific configuration of NTDS interface circuit cards.

PLATFORM	TYPE	QUANTITY
DDG	CN-1695/WSN-7(V)	
	NTDS Type A	3 ea
	NTDS Type D	1 ea
	NTDS Type E	4 ea
CG/LHA	CN-1696/WSN-7(V)	
	NTDS Type A	5 ea
	NTDS Type D	1 ea
	NTDS Type E	2 ea
CVN/LHD	CN-1697/WSN-7(V)	
	NTDS Type A	7 ea
	NTDS Type E	1 ea

Table 4-14.— RLGN/NTDS Configurations.

The basic external data interface also consists of a 1-pulse per second timing interface, which provides time synchronization in a dual-system configuration; an RS-422 serial data interface, which exchanges position, velocity, and status information in a dual-system configuration; an RS-422 interface to an external CDU; and an ATM interface to External Local Area Network (LAN). Heading, roll, pitch, north-south velocity, east-west velocity and total velocity are output as analog (synchro) data. Synchro amplifiers are provided for the heading, roll and pitch outputs. Table 4-15 outlines the serial interface and data message characteristics. Table 4-16 lists the synchro output characteristics and defines the synchro reference requirements.

I/O PORT	DATA CHARACTERISTICS
RLGN to RLGN Interface (J6)	Data Rate – 38,400 bits/second Transmitted Character Format: 1 start bit 8 data bits 1 stop bit Bits total: 10 Least significant bit is transmitted first Signal Polarity (Output signals are referenced to INS ground): MARK: RS-422 + High, RS-422 - Low SPACE: RS-422 + Low, RS-422 - High
Display-Control Unit Interface (J5)	Data Rate – 9,600 bits/second Transmitted Character Format: 1 start bit 8 data bits 1 stop bit Bits total: 10 Least significant bit is transmitted first Signal Polarity (Output signals are referenced to INS ground): MARK: RS-422 + High, RS-422 - Low SPACE: RS-422 + Low, RS-422 - High
DSVL Interface (J23)	Data Rate – 9,600 bits/second Transmitted Character Format: 1 start bit 8 data bits 1 stop bit Bits total: 10 Least significant bit is transmitted first Signal Polarity (Output signals are referenced to INS ground): MARK: RS-422 + High, RS-422 - Low SPACE: RS-422 + Low, RS-422 - High

Table 4-15.— Digital (RS-422A) Data Interface.

SYNCHRO INPUT (SHIP'S LOG)	
Reference	115 VAC, 400 Hz; 90 V L-L Synchro
Scaling[1]	20 - 125 Kt/Rev
Fore/Aft Gradient[2]	90/10 or 50/50 percent
TRANSMITTERS OUTPUT: (HEADING, ROLL, PITCH)	
Type/Signal Format	Amplifier: Equivalent to synchro 115 VAC 11CX4
Output Power	Heading: Total (Vital + Non-vital) = 32 VA max (400 ma/leg) Vital = 2.5 VA max (100 ma/leg) Roll/Pitch: 8 VA max (100 ma/leg)
Two Speed (Heading) Format	Fine 36:1 (10°/revolution) Coarse 1:1 (360°/revolution)
Two Speed (Roll and Pitch) Format	Fine 36:1 (10°/revolution) Coarse 2:1 (180°/revolution)2 or 1:1 (360°/revolution)
Synchro Velocity Output: (Vn, Ve, and Vt)	
Output Power	2 VA max (20 ma/leg)
Two Speed (Vt) Format	Fine 10:1 (10 kt/revolution) Coarse 1:1 (100 kt/revolution)
Two Speed (Vn, Ve) Format	Fine 10:1 (±10 kt/revolution) Coarse 1:1 (±100 kt/revolution)
Reference Voltage (Non-Vital): Synchro reference voltage is applied to each RLGN. Reference is always derived from own ship's 400 Hz main power. The reference voltage and the synchro signals are affected in amplitude and frequency by variations in the reference voltage.	
Voltage/Frequency	115 Volts, 400 Hz
Power capacity	3 VA
Power factor	≥0.9
Grounding	Must not be grounded

1 Selectable at installation based on Speed Log output.
2 Selectable at installation.

Table 4-16.— Analog Synchro Input/Output and Reference Characteristics.

4.11.2 Units and Assemblies

As shown in Figure 4-50, the RLGN Cabinet consists of an upper Cabinet Assembly and a lower Measurement Cabinet Assembly, which are separated by a heat shield. The upper cabinet houses power supplies, synchro amplifiers, and rack-mounted circuit cards that contain the interface, control, and data processing circuits. The lower cabinet contains the IMU components.

Table 4-17 lists the units and assemblies that make up the AN/WSN-7(V) RLGN. Some assemblies contain programmed devices. Other assemblies are calibrated by installation of an associated Programmable Read-Only Memory (PROM), which contains calibration parameters that are determined at factory test and are specific to the assembly with which the PROM is supplied. These assemblies are identified with a programmed part number, which specifies the hardware with the programmed configuration, and with a hardware part number, which identifies only the hardware without the programmed device. Normally, only the programmed part number is applicable for identifying replaceable assemblies. The RLGN contains the following functional elements:

- IMU(**1A2A1**)
- IMU support electronics
- Navigation (Nav) Processor (**1A1A13**), I/O Processor (**1A1A21**), ATM Processor (**1A1A4**), and interface electronics
- Power Supplies (**1A1A6**), (**1A1A8**) and Battery (**1A1A5**) for emergency power generation
- Keypad (**1A1A9**) and Display Panel (**1A1A10**)
- IP-1747/WSN CDU

Consult the Allowance Parts List (APL) for the appropriate revision level of each assembly.

ASSEMBLY	NOTES	ASSEMBLY PART NO.	NAME/FUNCTION
Unit 1		1981101-6	AN/WSN-7(V) Ring Laser Gyro Navigator (CN-1695/WSN-7)
		1981101-2	AN/WSN-7(V) Ring Laser Gyro Navigator (CN-1696/WSN-7)
(1A1)		1981101-3	AN/WSN-7(V) Ring Laser Gyro Navigator (CN-1697/WSN-7)
(1A1A1)		1981539-var	Processor Cabinet Electrical Equipment Assembly
		1981532	Filter, Power Line
(1A1A2)	1, 11	1982618	Inverter Assembly, 400 Hz
(1A1A3)	11	1978322	Vital Bus CCA
(1A1A4)	11, 12, 13	1900040	AN/WSN-7(V) ATM Processor Computer Software Configuration Item (CSCI)
(1A1A5)		1981554	Battery Assembly
(1A1A6)		1979342	Power Supply
(1A1A7)		1810853	Battery Charger
(1A1A8)		1205050-3	Power Module
(1A1A9)		1859873	Membrane Keypad
(1A1A10)		1979344	Display Assembly
(1A1A11)	11	1981660	Backplane Assembly, Nav Processor
(1A1A12)		1981534	I/O Processor, Backplane Assembly
(1A1A13)	2, 12, 13	1812590-XX	Nav Processor CCA (Programmed Navigation Processor)
(1A1A14)		1977455	Dual Panel Interface CCA (RLGN-to-RLGN)

Table 4-17.— Summary of AN/WSN-7(V) Units and Assemblies.

ASSEMBLY	NOTES	ASSEMBLY PART NO.	NAME/FUNCTION
(1A1A15)		1980513	Status and Command CCA
(1A1A16)		1977455	Dual Panel Interface CCA
(1A1A17)		1977538-0	IMU Interface CCA
(1A1A18)		1977569	Torquer CCA (Roll)
(1A1A19)		1977569	Torquer CCA (Azimuth)
(1A1A20)		1980488-2	Bus Interface CCA
(1A1A21)	3, 12, 13	1812591-XX	I/O Processor CCA (Programmed I/O Processor)
(1A1A23)	11	1980486-2	Dual Port Memory CCA
(1A1A30)	11	1981572	Support Electronics, Backplane
(1A1A31)		1981570	I/O Control Built-in Test Equipment (BITE) and Filter CCA
(1A1A32)	4, 11	1811791	IMU Processor CCA
(1A1A33)		1979023	Repositioning Interface CCA
(1A1A34)		1979047	Analog-to-Digital (A/D) Multiplexer CCA
(1A1A35)		1979046	Accelerometer and Sensor Electronics Assembly
(1A1A36)		1979348	Gyro Support Electronics CCA
(1A1A37)		1979057	Support Electronics Power Supply
(1A1A38)		1979087-3	Synchro Converter CCA
(1A1A39)		1979087-3	Synchro Converter CCA
(1A1A40)		1979087-3	Synchro Converter CCA

Table 4-17(Cont'd).— Summary of AN/WSN-7(V) Units and Assemblies.

ASSEMBLY	NOTES	ASSEMBLY PART NO.	NAME/FUNCTION
(1A1A41)		1976545-3	Synchro Buffer Amplifier (8 VA)
(1A1A42)		1976545-3	Synchro Buffer Amplifier (8 VA)
(1A1A43)		1976547-4	Synchro Buffer Amplifier (32 VA)
(1A1A44)		1976547-4	Synchro Buffer Amplifier (32 VA)
(1A1A51) through **(1A1A58)**	5, 10, 11	1981087	NTDS Interface, Type A (See Table 4-18)
		1981561	NTDS Interface, Type D
		1981559	NTDS Interface, Type E
(1A1DS1), **(1A1DS2)**	11	FF200CW600-28V-P or FF200-0CW-028B	Lamp
(1A1MP3)		1981510	Upper Card Rack Assembly, Navigation and I/O
(1A1MP4)		1979347	Card Rack Assembly, Support Electronics
(1A1MP2)		1891448	Heat Shield Assembly
(1A1MP6)	11	1983105	Connector Plate (CN-1695/WSN-7)
	11	4800307	Connector Plate (CN-1696/WSN-7)
	11	1983108	Connector Plate (CN-1697/WSN-7)
(1A2)		1981548	Measurement Cabinet Electrical Equipment Assembly
(1A2A1)	6	1812593 or 4300859	IMU MX-11681/WSN-7 or MX-11681A/WSN-7A(V) Assembly (Matched Set, with all EPROMs)
1A1A32U13	6	1810807	IMU Assembly Calibration PROM
1A1A32U03	6	1812809	IMU Assembly Calibration PROM
(1A2A1A1)		1981549 or 4800592	IMU Assembly
(1A2A1A1A1)	7	1812594-3	RLG Assembly (Matched Set) (Gyro A)
1A1A32U15	7	1810563	RLG Calibration PROM

Table 4-17(Cont'd).— Summary of AN/WSN-7(V) Units and Assemblies.

ASSEMBLY	NOTES	ASSEMBLY PART NO.	NAME/FUNCTION
(1A2A1A1A2)	7	1812594-2	RLG Assembly (Matched Set) (Gyro B)
1A1A32U02	7	1810563	RLG Calibration PROM
(1A2A1A1A3)	7	1812594-1	RLG Assembly (Matched Set) (Gyro C)
1A1A32U04	7	1810563	RLG Calibration PROM
(1A2A1A1A4)	11	1979045	High Voltage Power Supply (HVPS)
(1A2A1A1A4A1)		1980509	HVPS "A" and "B" CCA
(1A2A1A1A5)	8	1810720	Calibrated Accelerometer (Matched Set) (Accel. A)
1A1A32U12	8	1810562	Accelerometer Calibration PROM
(1A2A1A1A6)	8	1810720	Calibrated Accelerometer (Matched Set) (Accel. C)
1A1A32U01	8	1810562	Accelerometer Calibration PROM
(1A2A1A1A7)	8	1810720	Calibrated Accelerometer (Matched Set) (Accel. B)
1A1A32U14	8	1810562	Accelerometer Calibration PROM
(1A2A1A1MP1)		1979356	Frame Assembly, Inner
(1A2A1A1MP2)		1979354	Frame Assembly, Outer
(1A2A1A1A9A1)		1980596	Accelerometer Stimulus CCA
(1A2A1A1A9W1)		T968693	Harness Assembly
(1A2A1A1A10)		1810553-1	Slip Ring Assembly (Electrical Contact Ring Capsule Assembly)
(1A2A1A1A11)		1810553-2	Slip Ring Assembly (Electrical Contact Ring Capsule Assembly)
(1A2A1A1A12)		1810553-3	Slip Ring Assembly (Electrical Contact Ring Capsule Assembly)
(1A2A1A1A13)		1810553-4	Slip Ring Assembly (Electrical Contact Ring Capsule Assembly)

Table 4-17(Cont'd).— Summary of AN/WSN-7(V) Units and Assemblies.

ASSEMBLY	NOTES	ASSEMBLY PART NO.	NAME/FUNCTION
CABLE ASSEMBLIES			
(**1A2A1A1B1**)		1979358	Motor, Direct Current, Torquer (Outer Gimbal)
(**1A2A1A1B2**)		1979358	Motor, Direct Current, Torquer (Inner Gimbal)
(**1A2A1A1B3**)		1243107-2	Synchro Transmitter, Multispeed (Outer Gimbal)
(**1A2A1A1B4**)		1243107-2	Synchro Transmitter, Multispeed (Inner Gimbal)
(**1A2A1A1M1**)		1975362-6	Meter, Time Totalizing
1W1		T968889	Harness Assembly
1W2		T968890	Cable Assembly
1W3		T968891	Cable Assembly
1W4		T968892	Cable Assembly
(**1A1W1**)	9, 11	T969420	Main Cabinet Cable and Harness Assembly
(**1A1W2**)		T968840	Cable Assembly (Door Cable and Harness Assembly)
(**1A1W3**)		T967883	Ribbon Cable Assembly
1A1W4		T968841	Cable Assembly
1A1W5		T968842	Cable Assembly
1A1W6		T968894	Harness Assembly
(**1A1W7**)	11	1900013-1	Cable Assembly, Fiber Optic ATM/Synchronous Optical Network (SONET) Interface
1A1W10 through 1A1W26	5	(See Table 4-18)	(See Table 4-18)
P/O **1A1W1**	11	T969380	Harness Assembly for DSVL
Unit 2	Same as Unit 1		

Table 4-17(Cont'd).— Summary of AN/WSN-7(V) Units and Assemblies.

ASSEMBLY	NOTES	ASSEMBLY PART NO.	NAME/FUNCTION

NOTE:

1. Inverter Assembly P/N 1982618 is manufactured with high reliability screened parts. This assembly is directly interchangeable with P/N 1980379.

2. Nav Processor CCA, 1812590-XX, is the programmed part number of unprogrammed Central Processing Unit (CPU)/Memory assembly part number 1981127. After assembly part number 1981127 is programmed with the stored program assembly, it is reidentified as part number 1812590-XX.

3. I/O Processor CCA, 1812591-XX, is the programmed part number of unprogrammed CPU/Memory assembly part number 1983195. After assembly 1983195 is programmed with the stored program assembly, it is reidentified as part number 1812591-XX.

4. IMU Processor CCA, 1811791, is the programmed part number of unprogrammed Bus Control Electronics assembly part number 1979021. After assembly 1979021 is programmed with the stored program assembly, it is reidentified as part number 1811791.

5. CCAs (**1A1A51**) through (**1A1A58**) and associated cables are selected based on the NTDS interface requirements for each installation. The assemblies and cables installed are defined by the Unit 1 part number. Refer to Table 4-18 for applicability.

6. The IMU Assembly part number includes two PROMs (serialized to the IMU Assembly) programmed during factory calibration with correction parameters which are used by the system to compensate for mechanical offsets in the IMU normal and inverted positions.

7. Each RLG Assembly part number includes a PROM (serialized to the RLG) programmed during factory calibration with correction parameters which are used by the system to compensate for mechanical offsets in the RLG.

8. Each Accelerometer Matched Set part number includes a PROM (serialized to the accelerometer) programmed during factory calibration with correction parameters which are used by the system to compensate for mechanical offsets in the Accelerometer.

9. If the RLGN has Field Change 1 (DSVL Interface), then the Harness Assembly (**1A1W1**) part number is T969420.

10. Part Number 1981087 (Rev A) is unacceptable if Programmable Array Logic (PAL) chip U11 part number is 1812652 (Rev A). Acceptable PAL U11 part number is 1812652 (Rev B).

11. Part of Field Change 1.

12. Part of Field Change 2 or 3.

13. Part of Field Change 4

Table 4-17(Cont'd).— Summary of AN/WSN-7(V) Units and Assemblies.

DSVL Interface Modification

The DSVL interface (part of RLGN Field Change 1) uses I/O Channel No. 2 on Dual Panel Interface Circuit Card Assembly (CCA) (**1A1A14**) (previously an unused spare). This data I/O channel is wired from I/O Backplane connector J9 to an added connector 1J23 on the back of the cabinet using an added harness assembly T969380. I/O Central Processor (**1A1A21**) and the Navigation Central Processor (**1A1A13**) are replaced with a later part revision containing software support for the DSVL data interface function.

ATM Interface Modification

(Part of RLGN Field Change 1) The ATM interface assembly consists of the ATM Processor Assembly **1A1A4A1A1** and the Peripheral Component Interface (PCI) Mezzanine **1A1A4A1A2**. This data I/O channel is cabled, using fiber optic cable, from the front of the PCI Mezzanine to an added connector 1J22 on the back of the cabinet using harness assembly (**1A1W7**).

4.11.3 INS Interface Systems

The AN/WSN-7(V) INS interfaces with numerous ship systems using digital and analog communications.

Additional and hull-specific interface information is available in the Combat Systems Technical Operation Manual (CSTOM) and Combat Systems Operational Sequencing System (CSOSS) and in Navigation (System) Operating Procedures (NOPs) for each ship class. (See Table 4-12.)

AN/WSN-7(V) Master to AN/WSN-7(V) Slave

A synchronous interface occurs between RLGNs in an AN/WSN-7(V) navigation suite with two RLGNs. This interface exchanges position, velocity and status information between the RLGNs.

IP-1747/WSN Control Display Unit (CDU)

The CDU is the primary man-machine interface to/from the RLGN. The CDU is part of the AN/WSN-7 INS and is identified as Unit 4 of the system. It can monitor and control the RLGNs from a separate installation location from the RLGNs. This interface sends INS Super Channel data to the CDU.

Additionally, the Remote Control Display Unit (RCDU) function, which simulates the display and keypad for the RLGN, is displayed on the CDU and enables remote operation of the RLGN from the CDU. Although the CDU is part of the AN/WSN-7(V) INS, operation and maintenance instructions for the CDU are not contained in this technical manual. (See Table 4-12 for information on the CDU technical manual.)

4.11.4 Troubleshooting and Maintenance Concept

The AN/WSN-7(V) RLGN is designed for ease of maintenance through replacement of failed Lowest (or Line) Replaceable Units (LRUs) with replacements drawn from On-Board Repair Part (OBRP) stock. All LRUs, including power supplies and circuit boards, use plug and jack connectors for ease of replacement. The organizational level of maintenance will use the self-contained capability of system BIT and the diagnostic software program to identify faults to the LRU. RLGN alignment and configuration data are stored in Non-Volatile Random Access Memory (NVRAM) and Electrically Erasable Programmable Read-Only Memory (EEPROM).

Calibration information associated with the attitude and acceleration sensors is stored in PROM chips, which allow maintenance to be performed on the RLGN without the need for mechanical or electrical realignment after repairs have been performed.

4.11.5 List of Applicable Documents

Table 4-12 provides a list of technical manuals and specifications associated with the AN/WSN-7(V) INS, but not supplied. These documents provide operation, maintenance, and installation information; Interface Design Specifications (IDSs), which describe the various message types that can be selected for data transfer between the RLGNs and external equipment; and the NTDS digital interface specifications, which describe timing, communication protocol, and transmission characteristics of the NTDS I/Os listed in Table 4-18. Table 4-19 describes the document supplied with the equipment.

CCA	NAME/FUNCTION	AN/WSN-7(V)		
		CN-1695	CN-1696	CN-1697
Locations (**1A1A51**) through (**1A1A58**) are used for NTDS Standard Interface.				
(**1A1A51**)	NTDS Interface CCA, Type	E	E	E
(**1A1A52**)	NTDS Interface CCA, Type	E	A	A
(**1A1A53**)	NTDS Interface CCA, Type	E	E	A
(**1A1A54**)	NTDS Interface CCA, Type	E	D	A
(**1A1A55**)	NTDS Interface CCA, Type	D	A	A
(**1A1A56**)	NTDS Interface CCA, Type	A	A	A
(**1A1A57**)	NTDS Interface CCA, Type	A	A	A
(**1A1A58**)	NTDS Interface CCA, Type	A	A	A
Cables used with the NTDS interface are determined by the part number of the system.				
1A1W10	Coaxial Cable Assembly T968912	*	*	*
1A1W11	Coaxial Cable Assembly T968912	*	*	*
1A1W12	Coaxial Cable Assembly T968912	*	*	*
1A1W13	Coaxial Cable Assembly T968912	*	*	*
1A1W14	Coaxial Cable Assembly T968912	*	*	
1A1W15	Coaxial Cable Assembly T968912	*	*	

Table 4-18.— AN/WSN-7(V) NTDS I/O Configurations.

CCA	NAME/FUNCTION	AN/WSN-7(V)		
		CN-1695	CN-1696	CN-1697
1A1W16	Coaxial Cable Assembly T968912	*	*	
1A1W17	Coaxial Cable Assembly T968912	*	*	
1A1W30	Coaxial Cable Assembly T968914	*	*	
1A1W10	Coaxial Cable Assembly T968914	*	*	
1A1W20	Cable and Harness Assembly T968913[1]	*	*	*
1A1W21	Cable and Harness Assembly T968913[1]	*	*	*
1A1W22	Cable and Harness Assembly T968913[1]	*	*	*
1A1W23	Cable and Harness Assembly T968913[1]	*	*	*
1A1W24	Cable and Harness Assembly T968913[1]			*
1A1W25	Cable and Harness Assembly T968913[1]			*
1A1W26	Cable and Harness Assembly T968913[1]			*

1 Part of Field Change 1.

Table 4-18(Cont'd).— AN/WSN-7(V) NTDS I/O Configurations.

TMIN/VID NO./ IDENTIFICATION NO.	NSN	TITLE/DESCRIPTION	QTY.
Technical Manuals			
S9427-AN-OMP-010/WSN-7, Rev 1	0910-LP-102-7705	Technical Manual, Organizational Level, Ring Laser Gyro Navigator Inertial Navigation System, AN/WSN-7(V)1, -7(V)2, -7(V)3, Part Numbers CN-1695/WSN-7(V), CN-1696/WSN-7(V), and CN-1697/WSN-7(V); Operation and Maintenance with Parts Lists	1 ea
CD-ROMs			
S9427-AN-IEM-010/REV1	0913-LP-101-6143	Interactive Electronic Technical Manual and Interactive Courseware for Navigation Unit, Ring Laser Gyro Navigator, AN/WSN-7(V)1, (V)2, (V)3 Inertial Navigation System	

Table 4-19.— Documentation Supplied.

4.11.6 Equipment and Accessories

Table 4-20 provides a list of equipment and accessories supplied with the equipment. Table 4-21 provides a list of equipment required, but not supplied. Table 4-22, provides the Field and Factory Changes applicable.

QTY	ITEM NAME OR NOMENCLATURE	UNIT NUMBER	OVERALL DIMENSIONS			WEIGHT AND VOLUME
			HEIGHT	WIDTH	DEPTH	
1	Ring Laser Gyro Navigator (RLGN) CN-1695/WSN-7(V), CN-1696/WSN-7(V), CN-1697/WSN-7(V)	1, 2	66.8 in.	23.5 in.	28.9 in.	840 lb.
1	Processor Cabinet Electrical Equipment Assembly	**(1A1)**				
1	Inertial Measurement Cabinet Assembly	**(1A2)**				

Table 4-20.— Equipment and Accessories Supplied.

SUBCATEGORY (SCAT) CODE	TEST EQUIPMENT CATEGORY	TEST EQUIPMENT MODEL NUMBER	EQUIPMENT TEST PARAMETERS	APPLICATION
-	Digital Multimeter	89536-77/AN	- -	Continuity testing and analog signal and voltage checks
-	Wild T2 Theodolite(2 each)	- -	±0.5 arc seconds	Equipment Installation

Table 4-21.— Equipment Required but Not Supplied.

CHANGE NUMBER	PURPOSE	DESCRIPTION
Field Change 1 (ECP N84-1) (ECOs 525, 526, 531, 539, 541, 546, 547, 548, 563, 577, 583, 588, 698, 702, 736, 802)	1. Adds a new fiber-optic I/O interface [ATM/Network Time Protocol (NTP)]. 2. Adds BFTT interface. 3. Adds AN/WQN-2 DSVL interface. 4. Revises the AN/WSN-7(V)2 I/O configuration. 5. Adds a feature for improving the RLGN position accuracy during periods of valid GPS data. 6. Adds support for the NTDS Type A I/O Interface. 7. Improves selected LRUs due to parts obsolescence or improvement of reliability. 8. Makes improvements to Navigation and I/O Operational programs.	1. Upgrades the revision level of the Nav Processor and I/O Processor CCAs. 2. Modifies the IMU High Voltage Power Supply. 3. Modifies the IP-1747/WSN CDU. 4. Modifies the NTDS Type A interface CCA. 5. Modifies the Navigation rack and Support Electronics backplane assemblies. 6. Changes the part number for two indicator lamps to improve reliability. 7. Adds the DSVL interface. 8. Alters the NTDS I/O configuration of the CN-1696/WSN-7 by removing one NTDS Type E interface and replacing it with an NTDS Type A interface. 9. Adds ATM hardware. 10. Updates the revision levels of the IMU, Vital Bus, 400 Hz Inverter Assembly, and Dual Port Memory CCAs.
Field Change 2 (ECP N84-2) (ECOs N84-814, -815, -816)	Upgrades firmware to enable AN/WSN-7(V) to interface with BFTT equipment, without the need for the external ATM switch.	Upgrades the revision level of the ATM, Nav Processor, and I/O Processor CCAs.
Field Change 3 (ECP N84-2) (ECOs N84-814, -815, -816)	Upgrades firmware to enable AN/WSN-7(V) to interface with BFTT equipment, without the need for the external ATM switch if Field Change 2 has not been installed.	Upgrades the revision level of the ATM, Nav Processor, and I/O Processor CCAs if Field Change 2 has not been installed.
Field Change 4 (ECOs N84-869, -870, -871)	1. Installs Nav Processor CCA P/N 1812590Rev-AB. 2. Installs I/O Processor CCA P/N 1812591Rev-W. 3. Installs ATM Processor CCA P/N 1900040Rev-C.	Upgrades the revision level of the ATM, Nav Processor, and I/O Processor CCAs.
Field Change 6	Installs MX-11681A/WSN-7 Inertial Measuring Unit	Sound isolates the Inertial Measuring Units to lessen structure-borne noise from the equipment to the ship's hull.
Field Change 9	1. Replaces NTDS Type D and NTDS Type E CCAs with NTDS Type A CCAs, P/N 1981087 2. Installs Connector Plate P/N 1983108	Converts AN/WSN-7(V)2 to AN/WSN-7(V)3

Table 4-22.— Field Changes and Factory Changes.

4.11.7 WSN-7 Operation

All operations, including mode control, sensor selection, data entry, and parameter display, as well as initiation of calibration, self-test, and installation setup, are performed using displayed menus and the keypad on the front of the RLGN.

The keypad is used in conjunction with the displayed menus to perform all control and data entry functions. The Front Panel controls and indicators are shown in Figure 4-52 and the keypad is shown if Figure 4-53.

The keys are divided into four categories: Menu Selection, Data Entry, Display Control, and Alarm Acknowledge. Some keys perform dual functions. The operation of these keys is automatically determined by the selected menu, mode, or operation being performed. The function of each key is listed in Table 4-23.

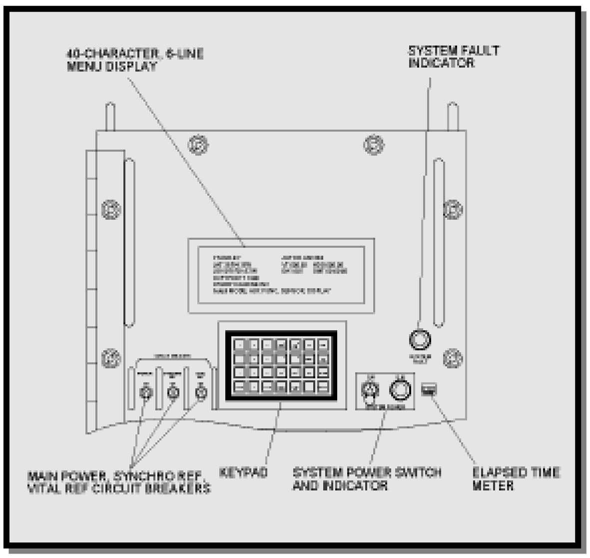


Figure 4-52.— Front Panel Controls and Indicators.

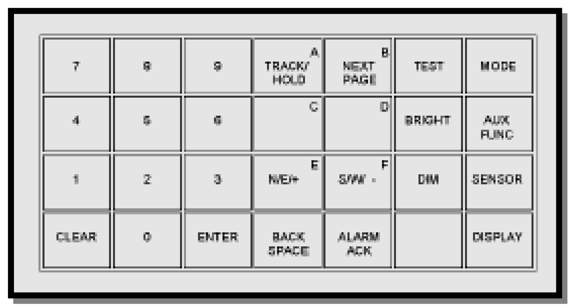


Figure 4-53.— Keypad Controls.

KEY	FUNCTION
Menu Selection keys consist of:	
MODE	Selects Page 1 of Mode Menu.
AUX FUNC	Selects Page 1 of Auxiliary Functions Menu.
SENSOR	Selects Page 1 of Sensor Menu.
DISPLAY	Selects Page 1 of Display Menu.
TEST	Selects Page 1 of Self-Test Functions Menu. (Functions only during power-up)
NEXT PAGE	Sequentially selects display of additional menu pages for each function.
Data Entry keys consist of:	
0 through 9	Selects numbered function on displayed menu and used to enter numeric data.
A through F	Alternate function reserved for entry of hexadecimal values. (Hexadecimal entry is not active in normal operating modes.)
CLEAR	Clears displayed or manually entered data without entering the value.
ENTER	Accepts displayed or manually entered data for entry into selected function.
BACK SPACE	Erases last entered numeric character for re-entry.
N/E+	Enter North (N) or East (E) for position or positive (+) for numeric values requiring sign.
S/W–	Enter South (S) or West (W) for position or minus (-) for numeric values requiring sign.
Display Control keys consist of:	
TRACK/HOLD	Toggle on/off function used to freeze display of any continuously changing data which is selected for viewing.
BRIGHT	Increases display illumination.
DIM	Decreases display illumination.
ALARM ACK	Removes the fault code from the display and clears the Advisory Relay and the Malfunction Relay when a fault condition is detected.
The general procedure for key/menu operation is: 1. Press a Menu Selection key (MODE, AUX FUNC, SENSOR or DISPLAY) to select the menu with desired function. 2. If selected menu has more than one page, press the **<NEXT PAGE>** key to step through pages (page display sequence cycles back to Page 1 after last page is displayed). 3. When function is located, press the Number key corresponding to number beside function to select the function. 4. If data entry is required, either press the **<ENTER>** key to accept displayed value or press the **<CLEAR>** key to clear displayed value for entry of new value. 5. Enter value using Data Entry keys and press the **<ENTER>** key to accept value. Correct error during data entry using the **<CLEAR>** key or the **<BACK SPACE>** key.	

Table 4-23.— Keypad Control Functions.

Table 4-24 lists the functions included in the four menus associated with operation and presents a brief description of the control and data functions associated with each.

Figure 4-54 identifies the general menu layout and data presentation for the operations-related menus and provides a listing of all mode and status indications that may be displayed on the top line of the Menu Display Panel.

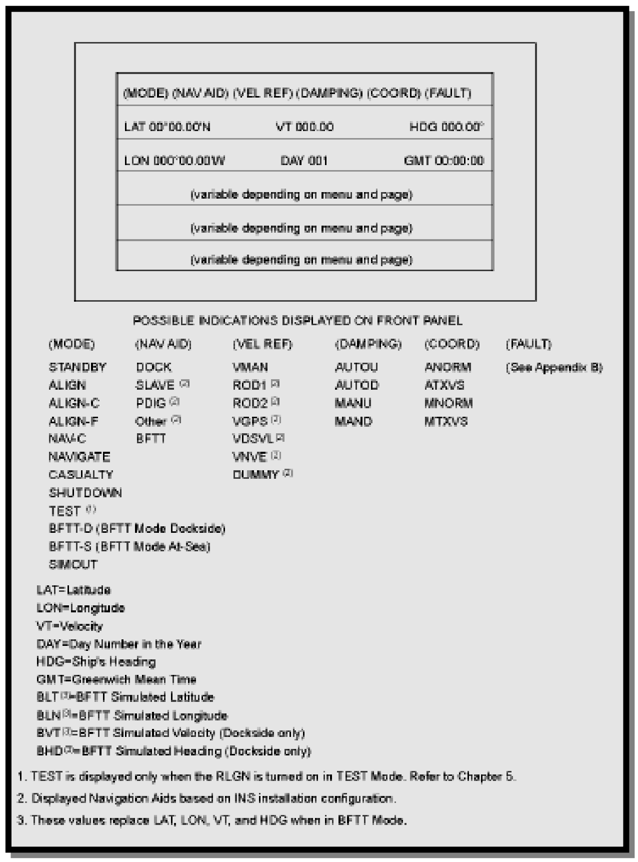


Figure 4-54.— Menu Status/Mode Indicators.

PAGE	FUNCTION	BRIEF DESCRIPTION
NOTE: In the following table, functions indicated with an asterisk (*) are displayed on the menu when Field Change 3 has been accomplished, but are not available for use until Field Change 4 has been accomplished. Items with a double asterisk (**) are displayed on the menu only if installation configuration settings indicate that the function is installed and is available for use. Refer to Chapter 8 of S9427-AN-OMP-010/WSN-7 for installation configuration setup. Items with a triple asterisk (***) are displayed on the menu only if Field Change 4 has been accomplished.		
SENSOR Functions SENSOR control functions are associated with selecting the alignment reference source upon startup, selecting and/or manually entering the position reference, and selecting and/or entering the speed and depth references. SENSOR control functions are presented and accessed via three display menu pages.		
Page 1 of the SENSOR menu provides control functions associated with selecting the RLGN alignment source.		
1	1. **DOCK**	**OFF**: Disables Dockside data as the position.
		ON: Enables Dockside data as the position and inputs zero velocity reference.
	2. **PDIG**	**OFF**: Disables GPS input (PDIG) (via dedicated NTDS interface), and allows data from an External Computer (selected NTDS interface data from port other than GPS interface) as the digital position sensor source. **ON**: Enables GPS input (PDIG) (via dedicated NTDS interface) as the digital position sensor source.

Table 4-24.— Operating Menus/Functions Description.

PAGE	FUNCTION	BRIEF DESCRIPTION
	3. **SLAVE**	**OFF**: Disables the second RLGN as the position reference for the first RLGN. **ON**: (after alignment of second RLGN): Enables the second RLGN as the position reference for the first RLGN. **ON**: (prior to alignment of second RLGN): Initiates at-sea alignment within the second RLGN.
	4. **BFTT OFF/ON***	**OFF**: Disables operator command to "quickly abort" transmission of BFTT Simulated data. **ON**: Enables operator command to "quickly abort" transmission of BFTT Simulated data.
Page 2 of the SENSOR menu provides control functions associated with selecting the RLGN's velocity reference used to damp the velocity loop.		
2	1.**VMAN**	Displays current value set for manually entered ship's speed. **OFF**: Disables manual speed input to the navigation processor. **ON**: Enables manual entry or change of fore or aft speed value.
	2. **VSYN**	**OFF**: Disables a configured synchro velocity input to be selected as the speed data source. **ON**: Enables a configured synchro velocity input to be selected as the speed data source. **NOTE:** If more than one synchro velocity source is available (e.g., Rod1 and Rod2 EM Log), it may be necessary to switch external equipment to provide the correct data to the RLGN synchro velocity input.
	3. **VDIG ****	**OFF**: Disables a configured, digital velocity input as the speed data source. **ON**: (INS configured for digital speed input via NTDS or ATM interface): Enables a configured, digital velocity input as the speed data source.
Page 3 of the SENSOR menu (normally configured only for submarine installations) provides control functions associated with selecting the depth sensor source and vertical velocity reference to be used.		
3	1. **DMAN ****	Displays current value set for manually entered ship's keel depth below the surface. **MAN OFF**: Disables the manual depth input to the navigation processor. **MAN ON**: Enables manual depth data input and change to the navigation processor.
	2. **DDIG ****	**OFF**: Disables depth data input from digital depth sensor for RLGNs configured to accept digital depth input. **ON**: Enables depth, data input from digital, depth sensor for RLGNs configured to accept digital depth input.
	3. **Vert**ical **Vel**ocity	**OFF:** Disables vertical velocity input on RLGNs configured for a three-axis, digital speed and depth input. Enables or disables the vertical velocity input. **ON:** Enables vertical velocity input on RLGNs configured for a three-axis, digital speed and depth input. Enables or disables the vertical velocity input. Horizontal velocity inputs are not affected.

Table 4-24(Cont'd).— Operating Menus/Functions Description.

PAGE	FUNCTION	BRIEF DESCRIPTION
Functions on Page 4 of the SENSOR menu are used for selecting a heading source and entering heading data during High Latitude ALIGN.		
4	1. **HMAN OFF/NORM/TXVS** ***	Operator may manually specify a normal or transverse coordinate heading. Used if no other heading source is available. Manual input of heading may be necessary during High Latitude ALIGN, if the backup compass is providing attitude data via synchro interface (no digital source of heading available) and the other RLGN is inoperative. Manual heading will be taken as a single heading measurement at the time of operator pressing **ENTER** key.
	2. **SINS2 OFF/ON** ***	Turn on if secondary RLGN is operative during High Latitude ALIGN. Status word in RLGN/RLGN interface indicates valid/invalid and normal/transverse.
	3. **HDIG OFF/ON** ***	Turn on during High Latitude ALIGN if external digital heading source is available. Status word in Super Channel interface indicates valid/invalid.
MODE Functions MODE control functions are associated with the position filter and navigation calculation modes. MODE control functions are presented and accessed via one display menu page. The MODE menu provides control functions associated with the position filter and navigation calculation modes.		
1	1.**Damping**	**Auto**: INS is automatically switched between damped and undamped operation depending upon reference velocity data validity and ship's dynamics, such as turn rate. **Man Damp**: When selected, system is forced to remain damped, regardless of velocity input or ship dynamics. Change to **Man Undamp** for undamped operation can only occur when manually selected. **Man Undamp**: When selected, system is forced to remain undamped. Change to **Man Damp** for manually damped operation can only occur when manually selected.
	2. **Fix**	Displays present **Fix Entry** and GMT. **ENTER**: Accepts present Fix values. **CLEAR**: Enables manual position fix data entry via the keypad. Position data is used to correct the INS estimate of position and to update the Kalman filter. Other Kalman filter parameters are not reset when fix is entered via this function.
	3. **Slew**	Displays present slew **Position Reference** and GMT. **ENTER**: Accepts Position Reference values. **CLEAR**: Enables manual position slew to be entered via the keypad. Position data is used to reset INS estimate of position only.
	4. **Norm/Txvs**	1. **System normal/transverse mode**: Provides three control function options for selecting Earth coordinates reference used to calculate position and heading.

Table 4-24(Cont'd).— Operating Menus/Functions Description.

PAGE	FUNCTION	BRIEF DESCRIPTION
		AUTO: When selected, INS automatically switches between normal and transverse coordinates reference when normal coordinates latitude is approximately +85°. (Transverse mode should be used above 85°.) **MNORM**: When selected, INS remains in normal coordinates mode regardless of latitude. **MTXVS**: When selected, INS remains in transverse coordinates mode regardless of latitude. 2. **Synchro heading**: Provides three control function options for synchro heading output formats, which may be selected independently from **System normal/transverse mode**. **Follow system mode**: When selected, synchro heading output automatically provides transverse heading when the system is operating in transverse coordinates reference, and provides normal heading when the system is operating in normal reference mode. **Normal coordinates**: When selected, the synchro heading output is always displayed in normal coordinates regardless of whether the system is operating in transverse or in normal reference mode. **Txvs coordinates**: When selected, the synchro heading output is always displayed in transverse coordinates regardless of whether the system is operating in transverse or in normal reference mode.
	5. **Reset Mode**	Provides three control function options for accepting navigation aid position fixes. **Review**: Requires that the operator review fix data and either accept or reject each position fix. With this mode selected, when a position fix is received from the navigation aid, the operator is prompted by display of Code 221. The operator must then select the Reset Data function (**DISPLAY, Page 3, Reset Data**) to review the fix values. **Auto Review**: Similar to Review mode except that the INS automatically accepts valid fixes and allows the operator to review fixes that do not meet valid criteria. If the operator does not accept or reject the fix within 10 minutes, the fix data is discarded and the fix is rejected by the INS. **Auto**: INS automatically accepts or rejects each position fix from the navigation aid without prompting the operator to review the fix. Display of accepted, last rejected, or pending fix is available in the Reset data display.
	6. **LogCal Mode**	Provides two control function options for disabling and enabling Electromagnetic Logs (EM Logs). **Not Selected**: Disables automatic EM Log (Rod 1 or Rod 2) calibration during normal vessel operation. **Selected**: Enables automatic EM Log (Rod 1 or Rod 2) calibration during normal vessel operation. Also, the selected EM Log's calibration tables are automatically updated with Kalman filter bias calibration values.

Table 4-24(Cont'd).— Operating Menus/Functions Description.

PAGE	FUNCTION	BRIEF DESCRIPTION
AUXiliary **FUNC**tions		
AUXiliary FUNCtions control functions are associated with changing configuration settings, displaying stored fault codes, performing display self-test, setting display update rate, selecting output of simulated position, heading, and velocity, calibrating the speed log data, monitoring system performance, and transferring waypoints. Changes to settings made using the AUX FUNC menus override defaults set by Installation Configuration as long as the AN/WSN-7(V) remains turned on. Except for changes made to speed log calibration tables, all selections return to installation defaults upon completion of the Normal Shutdown procedure. AUX FUNC control functions are presented and accessed via three display menu pages.		
Page 1 of the AUX FUNC menu provides control functions associated with the Remote Control Display Unit (RCDU), System Configuration, Faults, Indexers, I/O Configuration, and I/O Restart.		
1	1. **RCDU Lockout**	The RCDU Lockout control function is associated with controlling AN/WSN-7(V) operation from a separate control unit. **RCDU Locked =** **Yes**: Locks out interface port to CD-125/WSN-7 RCDU or IP-1747/WSN CDU so that the AN/WSN-7(V) can be controlled solely from its control/display. The CDU still works to collect data across the Super Channel. **No**: Enables interface port to CD-125/WSN-7 RCDU or IP-1747/WSN CDU so that the AN/WSN-7(V) can be controlled from the RCDU or CDU.
	2. **Sys**tem **Config**uration	**Sys**tem **Config**uration control functions are associated with velocity damping filters, mode functions menu configuration, attitude comparison, faults, Indexers, I/O configuration. These System Configuration control functions are presented and accessed via six display menu pages.
	(Page 1 of 6)	Sys Config (Page 1) is associated with setting system "Master" status and velocity damping filter control functions. 1. **This RLGN Master =** **No**: Disables the AN/WSN-7(V) as the Master system. **Yes**: Enables the AN/WSN-7(V) as the Master system and affects only a status word output in the NTDS interface messages. Does not affect system master/slave timing protocol as it relates to clock and position reset functions. 2. **Velocity damping =** **KALMAN**: Enables Kalman filter velocity damping. **THIRD ORDER**: Enables Third Order velocity damping. System must be in Navigate mode for Third Order to be selected.
	(Page 2 of 6)	Sys Config (Page 2) is associated with setting the control function options that the operator will be able to review and select via the Mode function menu's **Norm/Txvs** control function. 1. **Normal/Transverse =**

Table 4-24(Cont'd).— Operating Menus/Functions Description.

PAGE	FUNCTION	BRIEF DESCRIPTION
		AUTO/MANUAL: Enables and presents to the operator both the AUTO and the MANUAL control function options. **MANUAL ONLY**: Disables and replaces AUTO/MANUAL, and enables and presents the MANUAL ONLY control function option. 2. **Reset Mode =** **AUTO, AUTO/REVIEW, REVIEW**: Enables and presents to the operator all three **Reset Mode** control function options. **AUTO/REVIEW, REVIEW**: Enables and presents to the operator the **AUTO/REVIEW** and the **REVIEW** control function options only. **REVIEW**: Enables and presents to the operator the **REVIEW** control function option only.
	(Page 3 of 6)	Sys Config (Page 3) is associated with setting attitude comparison control function options. 1. **Att Comp Threshold**: On dual system installations, allows the alarm threshold setting for difference in attitude (heading, roll, and pitch) output to be set from the on-line menu to temporarily override the default value set at installation. 2. **Att Comp Filter Constant**: On dual system installations, allows the time constant setting, used by the system for determining the difference in attitude, to be set from the on-line menu to temporarily override the default value set at installation.
	(Page 4 of 6)	Sys Config (Page 4) is associated with setting the system Subnet Mask and Internet Protocol (IP) addresses. 1. Subnet Mask = xxx.xxx.xxx.xxx 2. IP Address = xxx.xxx.xxx.xxx
	(Page 5 of 6)	Sys Config (Page 5) is associated with setting the system ARP address. 1. ARP Address = xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
	(Page 6 of 6)	Sys Config (Page 6) is associated with setting the system NTP address. 1. NTP Address = xxx.xxx.xxx.xxx
	3. **Faults**	The Faults control function menu displays a list of active faults, which persist after pressing the **<ALARM ACK>** key to acknowledge the fault. The Faults control function is presented and accessed via one display menu page.
	4. **Indexers**	The Indexers control function menu is associated with inner and outer gimbal torquer settings. The Indexers control function is presented and accessed via one display menu page. Torquers are normally enabled and this function is not used during normal operation. Torquers can be enabled without removing system power in the event that they are automatically disabled as a result of detection of a fault in the torquer loop. 1. **Inner indexer**:
		On: Enables the inner (azimuth) torquer (**1A2A1A1B2**). **OFF**: Disables the inner (azimuth) torquer (**1A2A1A1B2**). 2. **Outer indexer**: **On**: Enables the outer (roll) torquer (**1A2A1A1B1**). **OFF**: Disables the outer (roll) torquer (**1A2A1A1B1**).

Table 4-24(Cont'd).— Operating Menus/Functions Description.

PAGE	FUNCTION	BRIEF DESCRIPTION
	5. **I/O Config**uration	The I/O Config control function menu is associated with NTDS/ATM, INS and DSVL digital I/O settings. These I/O Config control functions are presented and accessed via three display menu pages.
	(Page 1 of 3)	I/O settings. NTDS ON/OFF – Allows the operator to select each NTDS, Super Channel, or ATM port, turn the port on or off, and selectively activate or deactivate message data fields. From I/O Config page 1, choose NTDS Super Channel, or ATM to edit I/O configuration settings. **NOTE:** IDS configuration may be changed in Off-Line Test mode only. **The NTDS Configuration Settings control function menu** lists control function options on three display menu pages, which allow specific message protocol and data fields to be selected or enabled for each fitted port, even if the port is selected as disabled. **NOTE:** The letter prefix on each port designation identifies the physical location of the NTDS I/O board that contains the port set. Refer to Table 4-25. a. NTDS Port = (port designation). Step function selects port to be enabled/disabled or reconfigured (up to 16 maximum available). b. **NTDS Port Configuration Settings, Page 1**: (1) Port nn = **DSBL**: Disables the selected NTDS port. **ENBL**: Enables the selected NTDS port. (2) IDS = Applicable to IDS 00 through 31. (3) Retries = Applicable to IDS 08, 09, and 10. **DSBL**: Disables I/O processor output message retries. Message is transmitted only once, even when acknowledgement is not received. **ENBL**: Enables the I/O processor output message to repeat once, if acknowledgement is not received. (4) Secondary = Applicable to IDS 14 and 15. **DSBL**: Disables a message bit setting that identifies the selected port’s status and data to the receiving equipment as secondary when redundant I/O interface functionality is implemented. **ENBL**: Enables a message bit setting that identifies the selected port’s status and data to the receiving equipment as secondary when redundant I/O interface functionality is implemented.

Table 4-24(Cont’d).— Operating Menus/Functions Description.

PAGE	FUNCTION	BRIEF DESCRIPTION
		c. **NTDS Port Configuration Settings, Page 2**: (1) Day = ENBL/DSBL. (Applicable to IDS 11) If ENBL is selected, allows the RLGN to transmit Julian Day data to the OU-174/WSN-5 Data Converter Group. If DSBL is selected, the RLGN will not transmit Julian Day data over this connection. (2) P Sen Fmt = AR57A/AS130. (Applicable to IDS 11) This setting determines the format (AR57A or AS130) for transmitting position senescence data to the OU-174/WSN-5 Data Converter Group. (3) Forced EF = ENBL/DSBL. (Applicable to IDS 04, 08 and 11). If receiving equipment does not implement an EIE line to indicate that it is ready to receive data, selecting ENBL causes the parallel output data message to be transmitted regardless of EIE status. (4) Parity = ENBL/DSBL. (Applicable to IDS 07, 09 and 10). Enables or disables message parity bit checking protocol for serial output. d. **NTDS Port Configuration Settings, Page 3**: (1) Nav Msg = ENBL/DSBL. (Applicable to IDS 04, 08, 09, and 10). Enables or disables the Navigation Data Periodic message transmitted at 1 Hz in the output data. (2) Precision = HIGH (NORM). (Applicable to IDS 04, 07, 08, 09, 10). Sets position data in the Navigation Data Periodic message precision to high or normal precision. (3) Attd Msg = ENBL/DSBL. (Applicable to IDS 04, 08, 09, and 10). Enables or disables the Attitude Data Periodic message output data. (4) Msg Rate = 8 Hz (16 Hz). (Applicable to IDS 04, 08, 09, and 10). Changes transmit rate for Attitude Data message. **The Super Channel configuration settings control function menu** lists control function options on three display menu pages, which allow specific message protocol and data fields to be selected or enabled for each fitted port, even if the port is selected as disabled. a. **Super Channel Port Configuration Settings, Page 1:** (1) Port nn = ENBL/DSBL. Enables or disables selected port. The options listed on Pages 1, 2, and 3 of the menu function allow specific message protocol and data fields to be selected for each fitted port, even if the port is selected as disabled. (2) IDS = 13. The number displayed in this field is a code that indicates the Super Channel IDS assigned to the port during system installation configuration. Data in this field cannot be changed from this on-line I/O Configuration mode. Refer to Table 4-26 for the Port Specification and Type indicated by each IDS number. (3) Ext Fix = ENBL/DSBL. If ENBL is selected, allows RLGN to accept a fix from an external computer, other than GPS, over the Super Channel interface. If DSBL is selected, no external computer fixes will be accepted. (4) GPS Fix = ENBL/DSBL. If ENBL is selected, allows RLGN to accept GPS fixes over the Super Channel interface. If DSBL is selected, no GPS fixes will be accepted.

Table 4-24(Cont'd).— Operating Menus/Functions Description.

PAGE	FUNCTION	BRIEF DESCRIPTION
		b. **Super Channel Port Configuration Settings, Page 2:** (1) Rmt Cntrl = ENBL/DSBL. If ENBL is selected, allows the RLGN to accept Remote Control input over the Super Channel interface. If DSBL is selected, no Remote Control input will be accepted. (2) Vref Input = ENBL/DSBL. If ENBL is selected, allows RLGN to accept reference velocities over the Super Channel interface. If DSBL is selected, velocity references will not be accepted over the Super Channel interface. (3) Attd Data = ENBL/DSBL. If ENBL is selected, allows the RLGN to accept backup attitude data over the Super Channel interface. If DSBL is selected, no backup attitude data will be accepted over the Super Channel interface. (4) Waypoint = ENBL/DSBL. This setting is currently not in use. Should be set to DSBL. c. **Super Channel Port Configuration Settings, Page 3:** (1) Depth = ENBL/DSBL. This setting is not used on surface vessels. Should be set to DSBL. (2) Fcn 8 = ENBL/DSBL. Reserved. Should be set to DSBL. (3) Fcn 9 = ENBL/DSBL. Reserved. Should be set to DSBL. (4) Fcn 10 = ENBL/DSBL. Reserved. Should be set to DSBL. **The ATM Port, configuration settings, control function menu** lists control function options on three display menu pages, which allow specific message protocol and data fields to be selected or enabled for each fitted port, even if the port is selected as disabled. a. ATM Port = I. Step function selects port to be enabled/disabled or reconfigured. b. **ATM Port Configuration Settings, Page 1**: (1) Port I = ENBL/DSBL. Enables or disables selected port. The options listed on Pages 1, 2, and 3 of the menu function allow specific message protocol and data fields to be selected or enabled for each fitted port, even if the port is selected as disabled. (2) IDS = 16. Number displayed in this field is a code which indicates the ATM Interface Design Specification (IDS) assigned to the port during system installation configuration. Data in this field cannot be changed from this on-line I/O Configuration mode. The number 00 in this field indicates that the selected port is not fitted. Refer to Table 4-25 and Table 4-26. (3) Ext Fix = ENBL/DSBL. If ENBL is selected, the RLGN will accept a fix from an external computer, other than GPS, over the ATM interface. If DSBL is selected, no external computer fixes will be accepted. (4) GPS Fix = ENBL/DSBL. If ENBL is selected, the RLGN will accept GPS fixes over the ATM interface. If DSBL is selected, no GPS fixes will be accepted.

Table 4-24(Cont'd).— Operating Menus/Functions Description.

PAGE	FUNCTION	BRIEF DESCRIPTION
		c. **ATM Port Configuration Settings, Page 2**: (1) Fcn 3 = ENBL/DSBL. Reserved. Should be set to DSBL. (2) Vref Input = ENBL/DSBL. If ENBL is selected, the RLGN will accept reference velocities over the ATM interface. If DSBL is selected, velocity references will not be accepted over the ATM interfaces. (3) Attd Data = ENBL/DSBL. If ENBL is selected, the RLGN will accept backup attitude data over the ATM interface. If DSBL is selected, no backup attitude data will be accepted over the ATM interface. (4) Fen 6 = ENBL/DSBL. Reserved. Should be set to DSBL. d. **ATM Port Configuration Settings, Page 3**: (1) Depth = ENBL/DSBL. If ENBL is selected, the RLGN will accept depth inputs via the ATM interface. If DSBL is selected, depth will not be accepted over the ATM interface. (2) BFTT Input = ENBL/DSBL. If ENBL is selected, the RLGN will accept BFTT data over the ATM interface and will distribute simulated data to NTDS I/O, as instructed by BFTT port selection. If DSBL is selected, RLGN will not accept BFTT simulated data. Users will only receive real data. (3) Grav Grad = ENBL/DSBL. If ENBL is selected, the RLGN will accept Gravity Gradient data for vertical deflection compensation over the ATM interface. If DSBL is selected, gravity gradient data will not be accepted over the ATM interface. (4) SLCM Input = ENBL/DSBL. If ENBL is selected, the RLGN will accept the SLCM enable/disable message over the ATM interface. SLCM enable/disable is applicable to submarine systems only.
	(Page 2 of 3)	I/O Config Page 2, **INS = ON/OFF**, is associated with INS to INS interfacing in dual AN/WSN-7(V) installations. **On**: Enables INS-INS interfacing. **Off**: Disables INS-INS interfacing.
	(Page 3 of 3)	I/O Config Page 3, **DSVL = ON/OFF**, is associated with navigation systems that interface with a DSVL. **On**: Enables the data port for DSVL interfacing. **Off**: Disables the data port for DSVL interfacing.
	6. **I/O Restart**	The I/O Restart control function menu is associated with I/O and ATM processor settings. I/O Restart is used to enable an I/O or ATM Processor disabled by BITE when a fault condition is detected. This control function does not require INS power to be cycled for the processor to be enabled. This control function is enabled by default when the INS is turned on. **Enable**: Restarts (enables) I/O or ATM Processor operation without recycling power.

Table 4-24(Cont'd).— Operating Menus/Functions Description.

PAGE	FUNCTION	BRIEF DESCRIPTION
Page 2 of the AUXILIARY FUNC menu provides control functions associated with the Display Test, Display Rate, Display Normal/Txvs, KF Reinitialize, Log Calibration, and Memory Inspection.		
2	1. **Display Test**	The Display Test control function initiates a dynamic self-test of the display. Test continues until one of the display menu keys is pressed.
	2. **Display Rate**	The Display Rate control function selects display update rate. **1 Hz**: Updates display data once every second. **2 Hz**: Is the default rate, and updates display data once every two seconds.
	3. **Normal/Txvs**	The Display Normal/Txvs control function selects coordinates format for position and heading display. This function affects display format only and does not affect calculation mode. **Normal**: Renders coordinate format as **LAT** XXX.XX **N** and **LON** XXX.XX **W**. **Txvs**: Renders coordinate format as **TLT** XXX.XX **S** and **TLN** XXX.XX **W**.
	4. **KF Reinit**ialize	The KF Reinitialize control function is not used for normal INS operation. This control function should be used ONLY when INS performance is verified as outside of specification and when it is certain that Kalman Filter reinitialization will realign and restore INS attitude and position accuracy.
	5. **Log Cal**ibration	The Log Calibration control function presents an operator interface that enables data entry during a controlled calibration run.
	6. **Mem Inspt**	The Memory Inspection (Mem Inspt) control function enables the operator to observe the data values currently stored in memory. This function allows each memory address location to be selected and to be sequentially stepped up or down. This function is intended primarily as a software development tool.
Page 3 of the AUXILIARY FUNC menu provides control functions associated with Simulated Output, Monitor Performance, Auxiliary Panel, NAV/DR Out, Digital-to-Synchro (D/S) Test, and DR Reset.		
3	1. **Sim**ulated **Output**	The Simulated Output control function is associated with producing and transmitting simulated values. This menu lists control function options on four display menu pages, which allows the operator to select a simulation mode for system data output and to enter simulated values for heading, roll, pitch, position, and velocity on all outputs. Selection of this function and output of simulated values does not affect system operation. Digital data messages contain status bits which are set to indicate that output data is simulated. Relay K6 is set to provide indication that analog outputs are simulated when this mode is active. When this mode is exited, the system remains in the Simulate mode for a short period of time while system output parameters are being slewed back to correct values. When all values are reset, the system reverts automatically to normal output.

Table 4-24(Cont'd).— Operating Menus/Functions Description.

PAGE	FUNCTION	BRIEF DESCRIPTION
		a. Enable On/Off **On**: Enables simulated system data output, and enables the Modify Attitude, Modify Velocity, and Modify Position control functions to be selected and edited. **OFF**: Disables simulated system data output, and disables the Modify Attitude, Modify Velocity, and Modify Position control functions. b. **Modify Attitude** – Enable On/Off control function must be set to On to select and edit. (1) **Roll**: Displays and enables editing of current **Roll** data via the display keypad. (2) **Pitch**: Displays and enables editing of current **Pitch** data via the display keypad. c. **Modify Velocity** – Enable On/Off control function must be set to On to select and edit. (1) **VN**: Displays and enables editing of current Velocity North (**VN**) data via the display keypad. (2) **VE**: Displays and enables editing of current Velocity East (**VE**) data via the display keypad. d. **Modify Position** – Enable On/Off control function must be set to On to select and edit. (1) **Lat**: Displays and enables editing of current latitude (**Lat**) data via the display keypad. (2) **Lon**: Displays and enables editing of current longitude (**Lon**) data via the display keypad.
	2. **Mon**itor **Perform**ance	The Monitor Performance control function is associated with dynamic system performance testing while the system is operating in the Navigate mode. This menu lists control function options on two display menu pages.
	(Page 1 of 2)	1. **Monitor On/Off**: Presents the option to control the monitoring of the dynamic system performance test. **On**: Enables monitoring of dynamic system performance test. **Off**: Disables monitoring of dynamic system performance test.
	(Page 2 of 2)	2. **Monitor data**: Presents data monitoring options on three menu pages. **Page 1 – Monitor Start Time**: Displays dynamic system performance test start time and enables start time editing. **Page 1 – Monitor Elapsed Time**: Displays elapsed time since the dynamic system performance test's start time. **Page 2 – Position Sensor**: Displays position sensor source. **Page 2 – TRMS Position Error**: Displays TRMS position error data as a percentage of system performance specification. **Page 3 – RMS Vel North**: Displays Velocity North data as a percentage of system performance specification. **Page 3 – RMS Vel East**: Displays Velocity East data as a percentage of system performance specification.

Table 4-24(Cont'd).— Operating Menus/Functions Description.

PAGE	FUNCTION	BRIEF DESCRIPTION
	3. **Auxiliary Panel**	The Auxiliary Panel control function is associated with indicating when an IP-1747/WSN Control Display Unit (CDU) or Factory Interface Monitor (FIM) is installed and interfacing with the INS. **Monitor**: Indicates an IP-1747/WSN CDU is installed and is interfacing via the system's I/O interface port. **FIM**: Indicates an FIM is installed and is interfacing with the INS. This value may be toggled to Monitor, thereby forcing the system's I/O interface open and enabling CDU operation without requiring the INS power to be cycled.
	4. **NAV/DR Out**	The NAV/DR Output control function is associated with INS NAV and DR data output to users. **NAV**: (Default) Enables NAV inertial data to be output from the INS to users. **DR**: Disables NAV inertial data output, and enables DR data output from the INS to users.
	5. **D/S Test**	The D/S Test control function is associated with a short loop, on-line wraparound test of the digital synchro converters. a. **Periodic**: **On**: Enables the automatic testing of the D/S converters at periodic intervals. **Off**: Disables the automatic testing of the D/S converters at periodic intervals, and sets the test to be performed ONLY when the INS is started. b. **On Demand Test**: **On**: Enables manual testing of the D/S converters at any time. **Off**: Disables manual testing of the D/S converters.
	6. **DR Reset**	The DR Reset control function is associated with determining the validity of, and resetting, DR position values. If the DR data menu shows asterisks, the DR solution is invalid and the operator should enter this menu and reset the DR position. **Reset DR to Inertial**: Resets DR data to inertial position values. **Reset DR to Manual**: Enables DR latitude and longitude values to be manually entered.
DISPLAY Functions The Display Functions control functions are associated with INS parameters and output data, and their presentation for review. Output data available for review includes position, velocity, heading, and day/time information. Display control functions are presented and reviewed via five display menu pages. Select Display Functions by pressing the **<DISPLAY>** key. Select the menu page by pressing the **<NEXT PAGE>** key. Select the parameter to be displayed by pressing the number key corresponding to the number of the parameter.		

Table 4-24(Cont'd).— Operating Menus/Functions Description.

PAGE	FUNCTION	BRIEF DESCRIPTION
Page 1 of the DISPLAY functions menu provides control functions associated with velocity, roll, pitch, heading and depth.		
1	1. Vn/Ve	Vn: Displays the ship's North/South inertial velocity in Knots (KTS). Ve: Displays the ship's East/West inertial velocity in Knots (KTS).
	2. **Vfa/Vps**	**Vfa**: Displays the ship's fore/aft inertial velocity in Knots (KTS). **Vps**: Displays the ship's port/starboard (stbd) inertial velocity in Knots (KTS).
	3. **Roll/Rate**	**Roll**: Displays the ship's roll angle. **Rate**: Displays the ship's roll rate in Degrees per Second (°/SEC).
	4. **Pitch/Rate**	**Pitch**: Displays the ship's pitch angle. **Rate**: Displays the ship's pitch rate in Degrees per Second (°/SEC).
	5. **Hdg/Rate**	**Hdg**: Displays the ship's heading. **Rate**: Displays the ship's turn rate in Degrees per Second (°/SEC).
	6. **Depth ***	On INS configured with a selected depth input source, displays depth in Feet (FT).
Page 2 of the DISPLAY functions menu provides control functions associated with reference velocities, divergence values in heading, roll, and pitch, ship course, and log biases.		
2	1. **Ref** Vn/Ve	**Ref V**n: Displays the ship's North/South components of the selected reference velocity in Knots (KTS). **Ref V**e: Displays the ship's East/West components of the selected reference velocity in Knots (KTS).
	2. **Ref Vfa/Vps**	**Ref Vfa**: Displays the ship's fore/aft components of the selected reference velocity in Knots (KTS). **Ref Vps**: Displays the ship's port/starboard (stbd) components of the selected reference velocity in Knots (KTS).
	3. **Vk/Ref Vk**	**Vk**: Displays the vertical component of ship's velocity (Vk) in Knots (KTS). **Ref Vk**: Displays the selected reference velocity (Ref Vk) in Knots (KTS).
	4. **Divergence** (Page 1 of 2)	With dual INS installations, displays the difference between the heading, roll, and pitch values as determined by each navigation system. **Hdg:** Displays heading (Hdg) for each INS in minutes. **Roll:** Displays roll for each INS in minutes. **Pitch:** Displays pitch for each INS in minutes.
	(Page 2 of 2)	With dual INS installations, displays the difference between the position values as determined by each navigation system. **Lat:** Displays latitude (Lat) for each INS in minutes. **Lon:** Displays longitude (Lon) for each INS in minutes.
	5. **Course**	**Displays ship's present direction of motion without regard to ship's heading. Display range 0.00° to 359.99°.**

Table 4-24(Cont'd).— Operating Menus/Functions Description.

PAGE	FUNCTION	BRIEF DESCRIPTION
	6. **Log Biases**	Displays up to ten log biases at speed values for Rod 1 and Rod 2 speed sources. **Clear Biases Rod 1**: Enables the operator to erase Rod 1's bias values as stored in memory. **Show Biases Rod 1**: Enables the operator to review Rod 1's bias values as stored in memory. **Clear Biases Rod 2**: Enables the operator to erase Rod 2's bias values as stored in memory. **Show Biases Rod 2**: Enables the operator to review Rod 2's bias values as stored in memory.
Page 3 of the DISPLAY functions menu provides control functions associated with position and velocity variance and divergence, ocean current velocities, reset data and RLGN designation.		
3	1. **Sigma N/E**	Displays position variance estimates. **Sigma N**: Displays 1-sigma estimate for North (N) velocity in Nautical Miles (NM). **Sigma E**: Displays 1-sigma estimate for East (E) velocity in Nautical Miles (NM). **RPE**: Displays 1-sigma estimate for Radial Position errors (RPE) in Nautical Miles (NM).
	2. **Sigma V**n/e	Displays velocity variance estimates. **Sigma V**n: Displays 1-sigma estimate for North (N) velocity in Knots (KTS). **Sigma V**e: Displays 1-sigma estimate for East (E) velocity in Knots (KTS).
	3. **DVn/DVe**	Displays the difference between INS inertial velocity and selected reference velocity. **DVn**: Displays the difference between North (n) INS inertial velocity and selected reference velocity in Knots (KTS). **DVe**: Displays the difference between East (e) INS inertial velocity and selected reference velocity in Knots (KTS).
	4. **OCn/OCe**	Displays the estimated ocean currents velocities. Displayed values are only true if a water speed velocity reference is selected. **OCn**: Displays the estimated North (n) ocean currents velocities in Knots (KTS). **OCe**: Displays the estimated East (e) ocean currents velocities in Knots (KTS).
	5. **Reset Data**	Displays the last received fix values to allow the operator to review the fix data. This menu should be selected by the operator to review the fix data to be within acceptable limits prior to accepting or rejecting the fix, when either Review or Auto/Review is selected for entry of fix reset data. **FixLAT**: Displays the last received Latitude (LAT) fix value to allow the operator to review, and accept or reject the fix data. **FixLON**: Displays the last received Longitude (LON) fix value to allow the operator to review, and accept or reject the fix data.

Table 4-24(Cont'd).— Operating Menus/Functions Description.

<table>
<tr><th>PAGE</th><th>FUNCTION</th><th>BRIEF DESCRIPTION</th></tr>
<tr><td></td><td></td><td>FSN: Displays the last received FSN fix value to allow the operator to review, and accept or reject the fix data.
FSE: Displays the last received FSE fix value to allow the operator to review, and accept or reject the fix data.
GPS: Displays the last received Global Positioning System (GPS) fix value to allow the operator to review, and accept or reject the fix data.</td></tr>
<tr><td></td><td>6. RLGN Designation</td><td>Displays the RLGN’s designation when part of a dual RLGN INS without requiring the RLGN to be shut down and restarted in Test mode. The RLGN designation is used by some IDS users.
This RLGN 1: Identifies the RLGN as number 1 in a dual RLGN INS.
This RLGN 2: Identifies the RLGN as number 2 in a dual RLGN INS.</td></tr>
<tr><td colspan="3">Page 4 of the DISPLAY functions menu provides control functions associated with date/time settings, system part identification numbers, accelerometer and gyro bias data, DR data, and BFTT data.</td></tr>
<tr><td>4</td><td>1. Day/Time</td><td>Displays and allows the date and time to be edited.
Day: Displays the Julian day and time and allows values to be changed.
Time: Displays the time in military 24-hour format.</td></tr>
<tr><td></td><td>2. Part No.</td><td>This control function displays six menu pages containing: serial numbers and information for the RLGN and its sensor block components and assemblies; part numbers and revision numbers for RLGN programs; vendor ID numbers; and network information.</td></tr>
<tr><td></td><td>(Page 1 of 6)</td><td>Presents Accelerometer identification information.
A Accel SN: Displays the A Accelerometer’s serial number.
B Accel SN: Displays the B Accelerometer’s serial number.
C Accel SN: Displays the C Accelerometer’s serial number.</td></tr>
<tr><td></td><td>(Page 2 of 6)</td><td>Presents Gyro identification information.
A Gyro SN: Displays the A Gyro’s serial number.
B Gyro SN: Displays the B Gyro’s serial number.
C Gyro SN: Displays the C Gyro’s serial number.</td></tr>
<tr><td></td><td>(Page 3 of 6)</td><td>Presents INS identification information.
Platform SN: Displays the RLGN’s platform serial number.
Sensor Block SN: Displays the RLGN’s IMU sensor block serial number.
Serial Number AN/WSN-7(V): Displays the RLGN’s serial number.</td></tr>
<tr><td></td><td>(Page 4 of 6)</td><td>Presents processor and IMU program identification information.
Nav Prog PN: Displays the Nav Processor’s program part number.
IMU Prog PN: Displays the IMU program part number.
IO Program PN: Displays the IO Processor’s program part number.</td></tr>
<tr><td></td><td>(Page 5 of 6)</td><td>Presents ATM program and Peripheral Component Interface (PCI) identification information.
ATM Prog PN
PCI Vendor ID
PCI Device ID
PCI Class Code</td></tr>
</table>

Table 4-24(Cont’d).— Operating Menus/Functions Description.

PAGE	FUNCTION	BRIEF DESCRIPTION
	(Page 6 of 6)	Presents PCI subsystem and Media Access Control (MAC) address identification information. **PCI Subsystem Vendor** **PCI Subsystem ID** **MAC Address**
	3. **Accel**erometer **Bias**	Displays accelerometer bias estimates. **A Accel °/Hr**: Displays A accelerometer (Accel) bias estimates in micro gravities within a range of plus or minus (±) 9999 micro-g. **B Accel °/Hr**: Displays B accelerometer (Accel) bias estimates in micro gravities within a range of plus or minus (±) 9999 micro-g. **C Accel °/Hr**: Displays C accelerometer (Accel) bias estimates in micro gravities within a range of plus or minus (±) 9999 micro-g.
	4. **Gyro Bias**	Displays gyro bias estimates: **A Gyro °/Hr**: Displays A Gyro bias estimates in degrees within a range of plus or minus (±) 2.1333°/hour. **B Gyro °/Hr**: Displays B Gyro bias estimates in degrees within a range of plus or minus (±) 2.1333°/hour. **C Gyro °/Hr**: Displays C Gyro bias estimates in micro gravities within a range of plus or minus (±) 2.1333°/hour.
	5. **DR Data**	This on-line menu displays the DR data as calculated by the RLGN. This data includes latitude, longitude, total velocity and heading. The selection of output data (inertial or DR) has no effect on this display. If the DR data display shows asterisks, it indicates that the DR solution is invalid. The DR solution can become invalid, for example, if the DR position hasn't been initialized or heading reference is temporarily lost. A DR position reset is required. Once a DR reset is commanded, the DR data values will no longer be asterisks (assuming heading reference is not lost). (See AUXiliary FUNctions, Page 3, DR Reset.) **LAT**: Displays the DR latitude (LAT) calculated by the RLGN. **LON**: Displays the DR longitude (LON) calculated by the RLGN. **V**t: Displays the DR total velocity (VT) calculated by the RLGN. **HDG°**: Displays the DR heading (HDG) calculated by the RLGN.
	6. **BFTT Data***	When the RLGN is in BFTT mode, displays the BFTT Simulated data being transmitted.
Page 5 of the DISPLAY functions menu provides control functions associated with Grid coordinates and Laser Intensity Monitor (LIM) Voltage.		
5	1. **Grid N/E*****	**Grid = °/S** **Grid = °/W**

Table 4-24(Cont'd).— Operating Menus/Functions Description.

PAGE	FUNCTION	BRIEF DESCRIPTION
	2. **LIM Volts*****	The LIM volts control function menu displays the LIM voltage for the A, B, and C gyro in an RLGN. **A** = Displays the LIM value for A gyro in volts (V). A LIM value greater than +1.1 volts indicate that the A gyro is within acceptable operating specification. **B** = Displays the LIM value for the B gyro in volts (V). A LIM value greater than +1.1 volts indicate that the B gyro is within acceptable operating specification. **C** = Displays the LIM value for the C gyro in volts (V). A LIM value greater than +1.1 volts indicate that the C gyro is within acceptable operating specification.

Table 4-24(Cont'd).— Operating Menus/Functions Description.

Table 4-25 lists identification of port types and physical locations, table 4-26 lists NTDS Port Interfaces, and table 4-27 lists Simulated Outputs.

PORT SET	CCA LOCATION	RECORD BOARD TYPES AND IDS CODES INSTALLED (IN THIS SYSTEM)	
		NTDS I/O BOARD TYPE	IDS CODE
Part Number 1981101-6 AN/WSN-7(V)1			
A1/A2	**(1A1A51)**	Type E (Serial)	
B1/B2	**(1A1A52)**	Type E (Serial)	
C1/C2	**(1A1A53)**	Type E (Serial)	
D1/D2	**(1A1A54)**	Type E (Serial)	
E1/E2	**(1A1A55)**	Type D (Serial)	
F1/F2	**(1A1A56)**	Type A (Parallel)	
G1/G2	**(1A1A57)**	Type A (Parallel)	
H1/H2	**(1A1A58)**	Type A (Parallel)	
I1/I2	**(1A1A4)**	ATM	16
Part Number 1981101-2 AN/WSN-7(V)2			
A1/A2	**(1A1A51)**	Type E (Serial)	
B1/B2	**(1A1A52)**	Type A (Parallel)	
C1/C2	**(1A1A53)**	Type E (Serial)	
D1/D2	**(1A1A54)**	Type D (Serial)	
E1/E2	**(1A1A55)**	Type A (Parallel)	
F1/F2	**(1A1A56)**	Type A (Parallel)	
G1/G2	**(1A1A57)**	Type A (Parallel)	
H1/H2	**(1A1A58)**	Type A (Parallel)	
I1/I2	**(1A1A4)**	ATM	16

Table 4-25.— Identification of Port Type and Physical Location.

PORT SET	CCA LOCATION	RECORD BOARD TYPES AND IDS CODES INSTALLED (IN THIS SYSTEM)	
		NTDS I/O BOARD TYPE	IDS CODE
Part Number 1981101-3 AN/WSN-7(V)3			
A1/A2	(**1A1A51**)	Type E (Serial)	
B1/B2	(**1A1A52**)	Type A (Parallel)	
C1/C2	(**1A1A53**)	Type A (Parallel)	
D1/D2	(**1A1A54**)	Type A (Parallel)	
E1/E2	(**1A1A55**)	Type A (Parallel)	
F1/F2	(**1A1A56**)	Type A (Parallel)	
G1/G2	(**1A1A57**)	Type A (Parallel)	
H1/H2	(**1A1A58**)	Type A (Parallel)	
I1/I2	(**1A1A4**)	ATM	16

Table 4-25(Cont'd).— Identification of Port Type and Physical Location.

IDS CODE	NTDS TYPE	DIRECTION	SPECIFICATION
00	-	-	Not fitted
01	A	Input/Output	NAVSEA SE174-AB-IDS-010/GPS
02[1]	B	Input/Output	NAVSEA SE174-AB-IDS-010/GPS
03	A	Input/Output	S9427-AN-IDS-050/WSN-7
04	A	Input/Output	S9427-AN-IDS-070/WSN-7
05[1]	B	Input/Output	S9427-AP-IDS-010/RLGN
06[1]	B	Output	S9427-AP-IDS-020/RLGN
07	D	Input/Output	S9427-AN-IDS-030/WSN-7
08	A	Output	S9427-AN-IDS-040/WSN-7
09	E	Output	S9427-AN-IDS-020/WSN-7
10	E	Input/Output	S9427-AN-IDS-020/WSN-7
11	A	Output	S9427-AN-IDS-060/WSN-7
12	-	-	(Reserved)
13	E	Input/Output	S9427-AN-IDS-010/WSN-7 (Super Channel)
14[1]	B	Input/Output	S9427-AP-IDS-030/RLGN
15[1]	B	Input/Output	S9427-AP-IDS-040/RLGN
16	ATM	Input/Output	S9427-AN-IDS-080/WSN-7
17-31	-	-	(Reserved)

Table 4-26.— Identification of NTDS Port Interface Design Specification.

SIMULATED FUNCTION	DESCRIPTION	ENTRY RANGE
2 Modify Attitude Output Functions (Select by pressing the <**2**> key)		
1 Roll	Sets a positive or negative roll angle, which is output from Synchro Buffer Amplifier 8 VA (**1A1A41**).	-45 to +44.99 degrees
2 Pitch	Sets a positive or negative pitch angle, which is output from Synchro Buffer Amplifier 8 VA (**1A1A42**).	-45 to +44.99 degrees
3 Heading	Sets a heading angle, which is output from Synchro Buffer Amplifiers 32 VA (**1A1A43**) and 32 VA (**1A1A44**).	0 to 359.99 degrees
3 Modify Velocity Output Functions (Select by pressing the <**3**> key)		
1 Vel N (North Velocity)	Sets a north/south velocity value, which is output from Synchro Converter CCA (**1A1A38**) (in synchro data Format) and in all applicable NTDS output data messages.	-128 to +127.99 knots
2 Vel E (East Velocity)	Sets an east/west velocity value, which is output from Synchro Converter CCA (**1A1A38**) (in synchro data format) and in all applicable NTDS output data messages.	-128 to +127.99 knots
4 Modify Position Output Functions (Select by pressing the <**4**> key)When entering latitude and longitude, the N/S field is set with the <**NE+**> key or <**SW−**> key.		
1 Latitude	Sets a latitude value, which is output in all applicable NTDS output data messages.	0 to 90 degrees 0 to 59.99 minutes
2 Longitude	Sets a longitude value, which is output in all applicable NTDS output data messages.	0 to 180 degrees 0 to 59.99 minutes

Table 4-27.— Simulated Outputs Description.

Selecting the Navigate Mode

Once the RLGN has settled to Fine Align state in the At-Sea Align mode, the RLGN switches automatically from Fine Align to the Navigate mode when error estimate criteria are met. If the RLGN has settled to Fine Align state (ALIGN-F indication) using the Dockside reference (DOCK ON), the operator must remove the selected reference (DOCK OFF) and select a velocity reference. The RLGN will then switch from Fine Align to the Navigate mode. The RLGN will determine position by dead reckoning until a position reference source is selected. In the same manner, when SLAVE is selected as the reference, SLAVE must be deselected to enter the Navigate mode. See Figure 4-55.

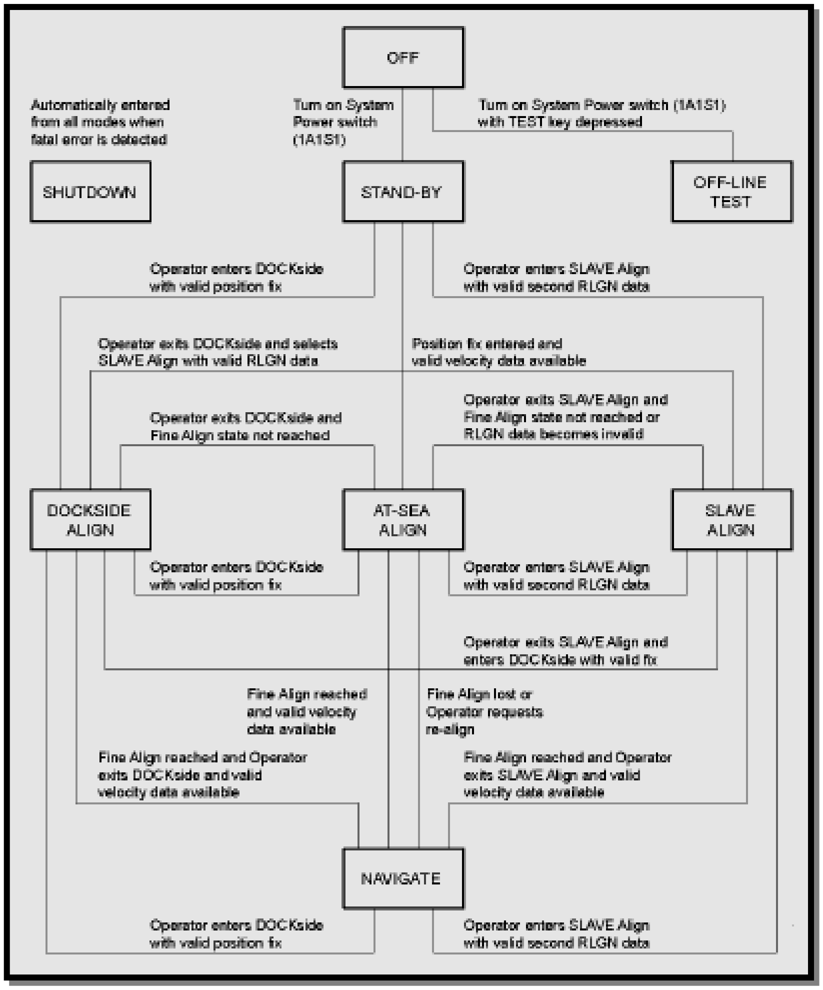


Figure 4-55.— Mode Transition Diagram.

<u>**Use of Transverse Coordinates Reference System**</u>

In a gyro-stabilized platform, torque values based on the tangent (tan) and secant (sec) of latitude are used in system control loops. While the INS is a strapdown system based on ring lasers, calculations involving these functions are also used. As the INS approaches 90 degrees latitude, these values become indeterminate (approach infinity) and are no longer valid for calculations. In addition, at high latitudes, the magnitude of east/west vectors has less validity. For this reason, an alternate (Transverse) Earth coordinate's reference system is used when the INS is operating at latitudes greater than approximately 85 degrees. The Transverse north pole is located at the intersection of the geographic 180-degree meridian and the equator.

The geographic 90-degree and 270-degree meridians become the Transverse equator, and the geographic equator becomes the Transverse 90-degree and 270-degree meridians. (Refer to Figure 4-56.)

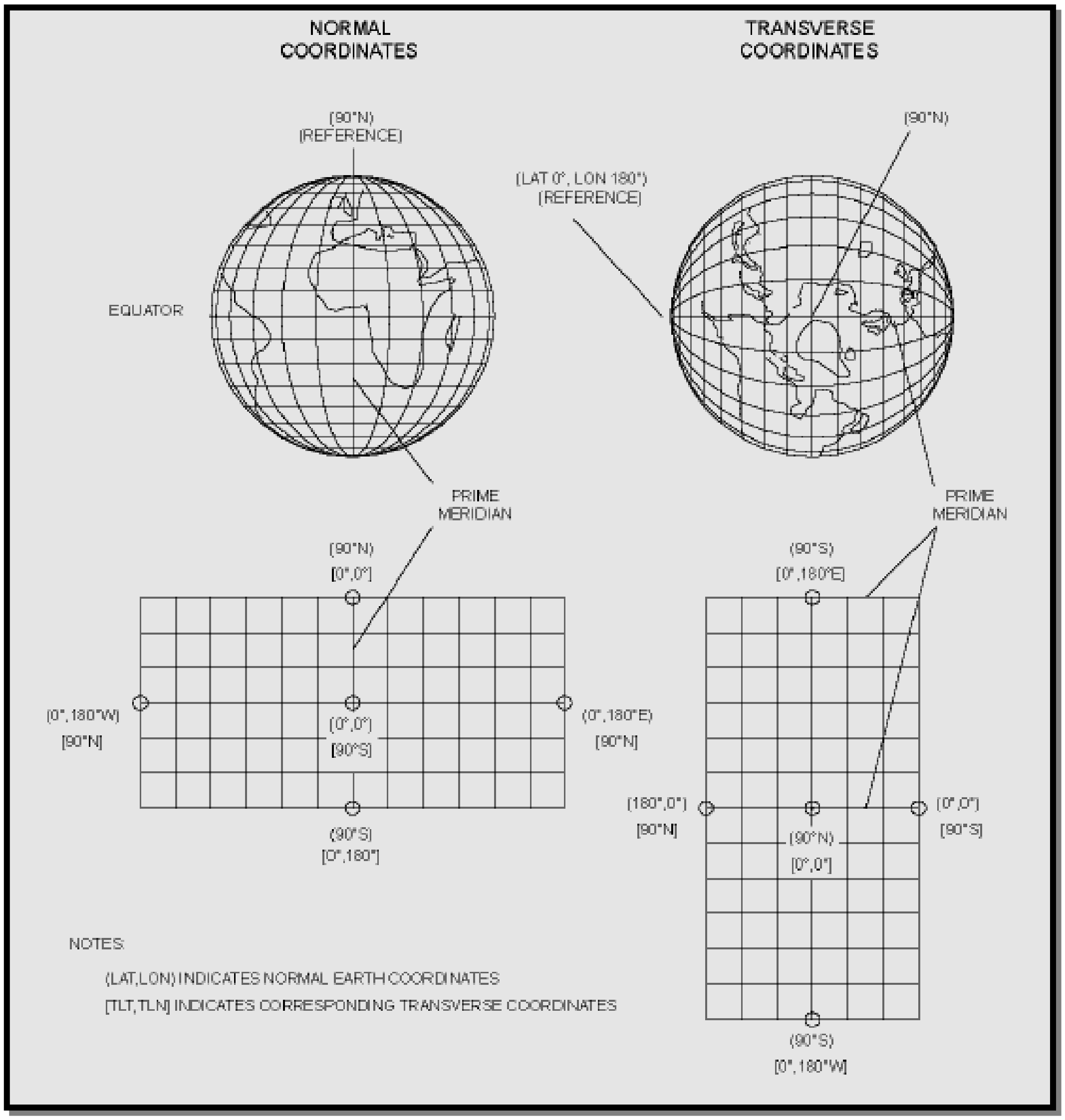


Figure 4-56.— Earth Coordinate References.

Accepting or Rejecting Fixes

The reset mode allows the operator to select how automatic fixes are accepted or rejected, enables review of last accepted fix data, and enables review and manual acceptance of pending fixes that the system has rejected as unreasonable. The Fix Review mode can be selected from the **Mode menu, Reset Mode** function. The mode selected on this menu determines how the system involves the operator in the review and acceptance of fixes from external position sensors. Manual fixes can be entered into the system at any time using the **Mode menu, Fix** function. When fixes are entered manually, the system checks the fix data for reasonableness in the same manner as for fixes received from external position sensors. If the manually entered fix data is determined to be invalid, an appropriate fault code and a Reset Data menu are displayed. This menu allows the operator to review the entered fix data and either force acceptance or discard the data. At any time, the operator can review the data for the last position fix accepted by the system. This function is selected from the **Display menu, Page 3, Reset Data** function. Figure 4-57 presents an outline of the various states associated with the position fix functions.

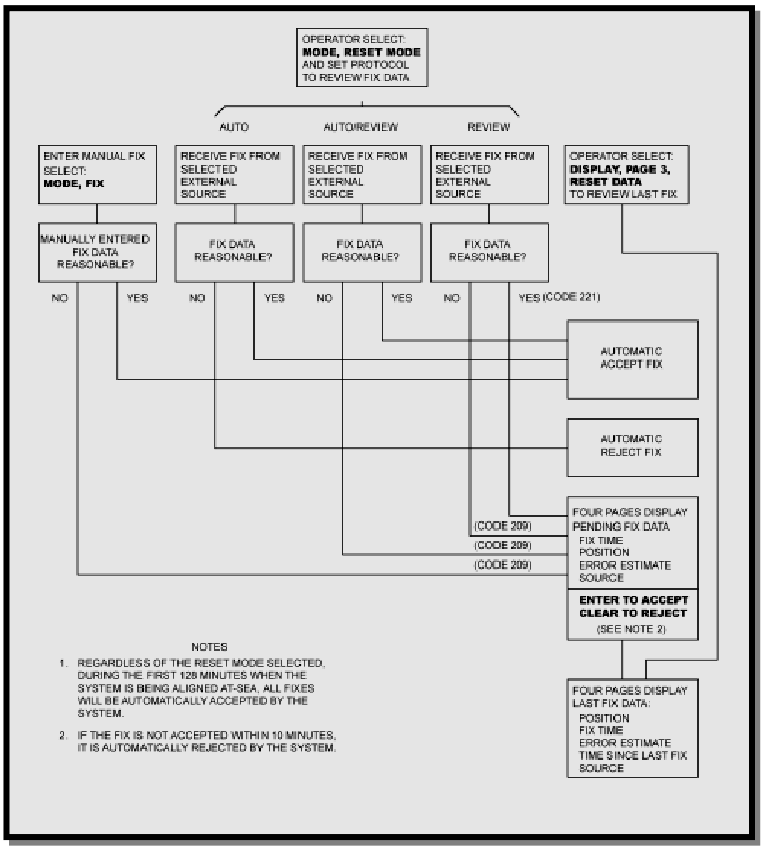


Figure 4-57.— Position Fix, Data Entry and Review Functions.

Enhanced Performance Position Accuracy (EP^{2}A)

(Refer to Figure 4-58) The EP^{2}A feature of the INS addresses the residual errors that remain in the INS position solution. The INS errors are characteristically slowly varying; e.g., the 84.4-minute Schuler period and the 24-hour earth loop. In contrast, the errors in the GPS aiding source are short period, typically on the order of seconds to minutes, and are more random in nature; e.g., ionospheric and multipath errors. The INS uses EP^{2}A to estimate the current value of the slowly varying INS error and to "average out" the short-period GPS errors to provide a Real-time estimate of the correction to the Kalman-derived INS position.

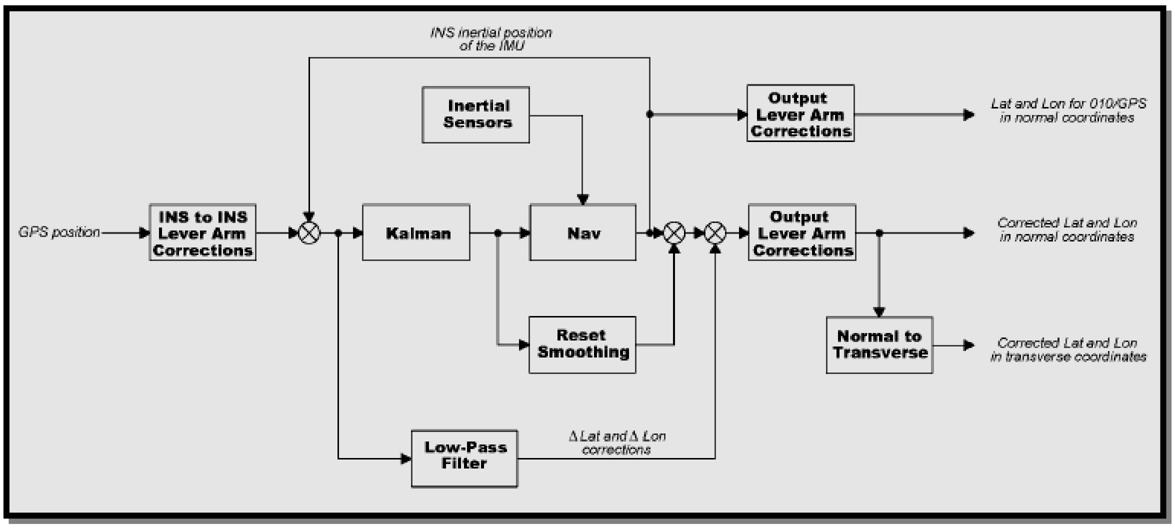


Figure 4-58.— Enhanced Performance Position Accuracy (EP^{2}A) Block Diagram.

GPS or GPS I/O Faults

Failure of the GPS position sensor input to the INS will result in slow degradation in the accuracy of the estimate of position. Position performance degrades approximately as a function of the square root of time as shown in Figure 4-59. INS performance can be maintained by selecting a different position sensor (if configured for additional position sensor) or by periodically entering a position fix manually.

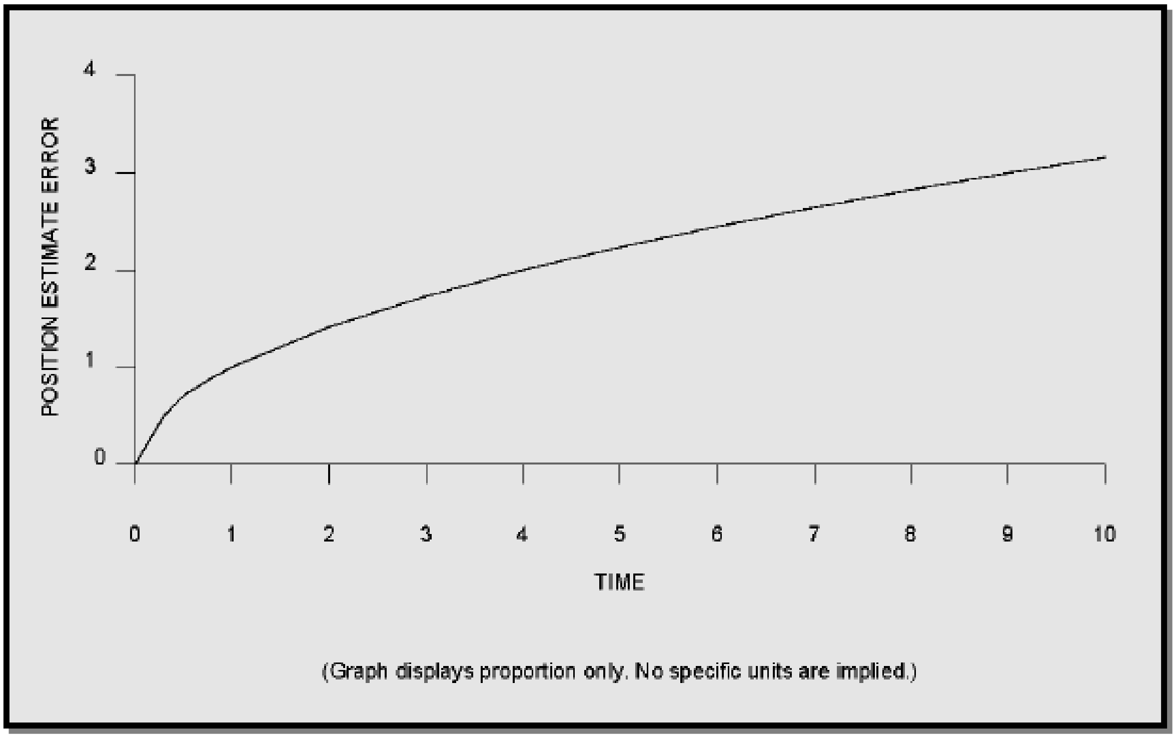


Figure 4-59.— Position Estimate Accuracy vs. Time without Position Update.

TRMS position error

Indicates the Time Root Mean Square (RMS) value of the position error, as calculated from the start time of the Performance Monitor function, as a percentage of a normalized system specification value. For an explanation of TRMS calculation method, refer to Figure 4-60.

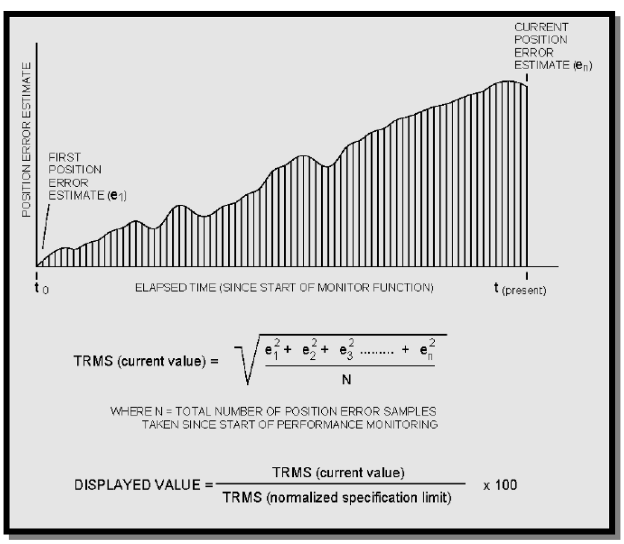


Figure 4-60.— Time RMS (TRMS) Position Error Calculation Method.

Maintenance of Gyrocompasses

Ships having the Planned Maintenance System (PMS) installed should perform gyrocompass maintenance requirements as indicated on the equipment maintenance requirement cards (MRCs).

Such routine maintenance should not be recorded in the service record book. Repairs or replacement of parts resulting from such maintenance, however, should be recorded to aid those involved with future repairs to the gyrocompass.

The technical manual sent with the WSN-2 is laid out in such a manner as to greatly assist the troubleshooter. You should carefully study these technical manuals before starting any maintenance action.

Maintenance should not be undertaken by inexperienced personnel without close supervision of a qualified maintenance technician.

Records

The PMS of the 3-M Systems has cut the records and inspections of the gyrocompass to a minimum. *Naval Ships' Technical Manual,* chapter 252, no longer requires lengthy records to be kept on gyrocompass equipment; however, it specifically requires the record book that is sent with each compass to be scrupulously maintained.

The gyrocompass service record book is used to record important repair information (major part replacement, overhaul, and field change installation), providing a continuous repair history of each gyrocompass. Instructions for maintaining the record book are given in the front of the book.

The service record book remains with the master gyrocompass throughout its service life. Should the compass be removed from the ship, its service record book accompanies it.

4.12.0 AN/SSN-6(V)2 NAVIGATION SENSOR SYSTEM INTERFACE SYSTEM

The AN/SSN-6 Navigation Sensor System Interface (NAVSSI) System is an integrated shipboard system that automatically accepts, processes, and disseminates navigation and time information from various shipboard navigation sources.

The AN/SSN-6 provides a means for users to obtain data verification, digital mapping, and the programming of selected way points. The AN/SSN-6 utilizes inputs from the Inertial Navigation System (INS), AN/UQN-4 Sonar Sounding Set, and EM Log to provide extremely accurate position (latitude and longitude), velocities (N-S, E-W, and vertical), ownship heading (OSH), roll, pitch, depth below keel, speed through the water (OSS), own ships distance (OSD), and extremely accurate time. The AN/SSN-6 also receives GPS satellite data via two embedded GPS VME Receiver Cards (GVRC).

The inputs to the AN/SSN-6 are processed, and in the AUTO mode, NAVSSI selects the best source selection for each output component. In the manual mode, the source selection is made by the operator to provide the appropriate output.

The AN/SSN-6 is composed of three units: the Display Control Subsystem (DCS), the Real Time Subsystem (RTS), and the Bridge Work Station (BWS). The DCS provides overall system control, data processing, data storage, and Man-Machine Interface (MMI) for both operation and maintenance. The DCS also houses the Sensor Interface Unit (SIU) for processing depth below the keel sonar signals from the AN/UQN-4. The DCS monitor can be utilized as a backup to the BWS. The RTS is the primary means for communicating between the various sensors to obtain inputs for the AN/SSN-6 and to provide usable output information to various ships systems. The BWS provides parallel operator control, query, and readout of the DCS.

The Block 3 system is configured as a dual RTS. The current Block 3, Build 2 systems are all dual RTS systems. Figure 4-61 shows a typical NAVSSI system with dual RTSs. A Local Area Network (LAN) links these hardware components via fiber-optic cabling.

The DCS enables the operator to display the ownship's navigation sensor information, control the RTS(s), and display from the Global Positioning System (GPS). GPS data is initially received at the GPS Antenna, then is sent to the Global Positioning System (Versa Module Europa) Receiver Card (GVRC) that is installed in the Versa Modular Europa (VME) chassis of the RTSs. The GPS receiver cards (GVRC) together with the Digital Nautical Charts (DNC) database (supplied via CD-ROM) provide the information that may be displayed on the DCS and BWS monitors. For dual RTS systems, the RTSs exchange data via a reflective memory link. This feature allows the RTSs to share all incoming and outgoing data, thereby improving overall system robustness. In dual RTS configurations, the DCS communicates with each RTS via a Local Area Network (LAN). The BWS provides remote workstation access to the DCS.

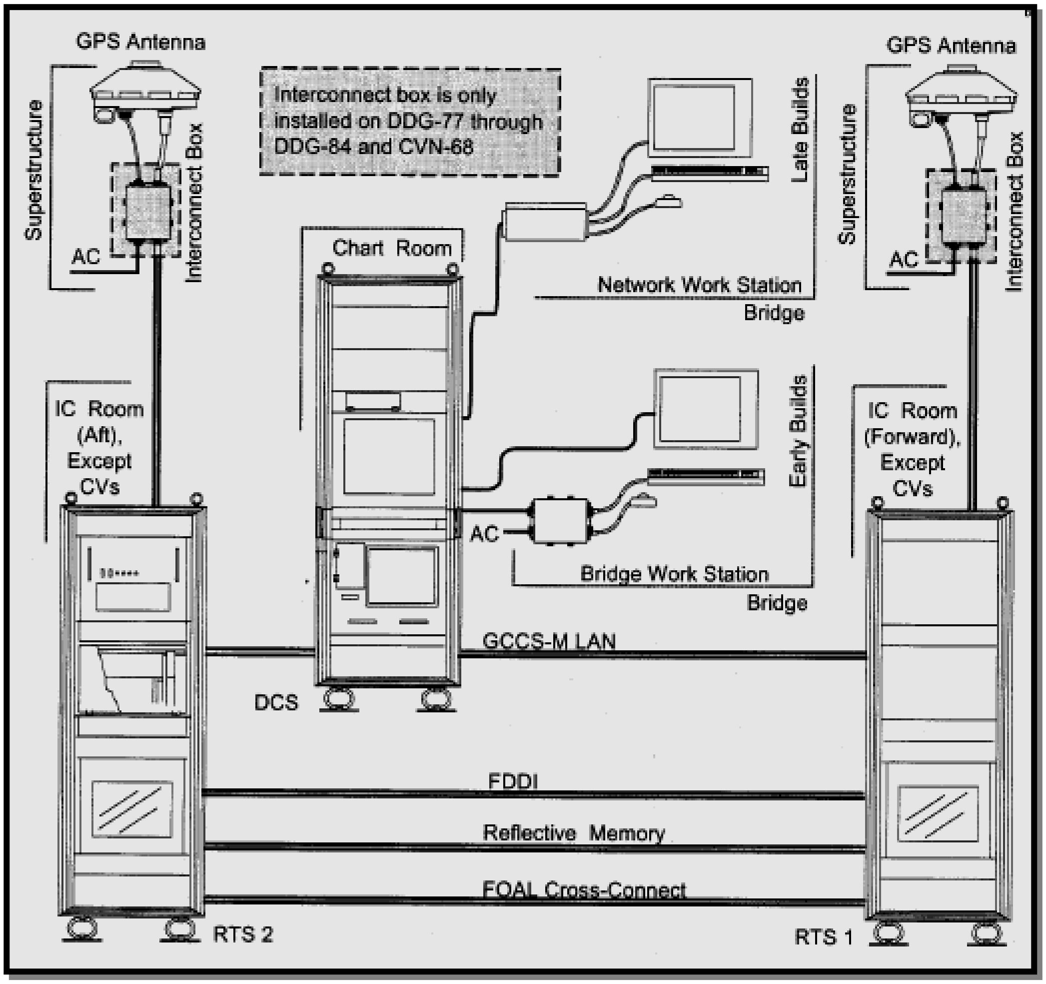


Figure 4-61.— Typical Dual-RTS NAVSSI Block 3 System.

4.12.1 System Capabilities and Interfaces

The primary capabilities and purpose of NAVSSI AN/SSN-6 Block 3 system is to distribute common position, velocity, time, and almanac data to onboard Command & Control and Combat Systems. This is done in real time, with the Global Positioning System (GPS) as the primary source of navigation data.

To elaborate, the system gives users a Human-Machine Interface (HMI) to perform navigation planning, execution, and manipulation of Digital Nautical Charts (DNCs).

The system provides consistent, accurate, timely Position, Velocity, and Time (PVT) data to all navigation dependent shipboard systems. It provides autonomous almanac data to the Tomahawk missile system. It also provides, voyage planning and voyage management functionality, using Digital Nautical Charts (DNCs) and other National Imagery and Mapping Agency (NIMA) products. Users include other navigation systems; Command, Control, Communications and Computer Intelligence, Surveillance, and Reconnaissance systems; weapon systems; and the shipboard navigation teams. This composite PVT enhances the ability of surface ships to perform navigation, ship control, and combat missions. The AN/SSN-6 composite PVT will normally be the most accurate information onboard.

The NAVSSI Block 3 hardware and software marks an improvement over previous versions in several areas:

• It expands the number of sensor and user systems supported.

• It incorporates a Global Positioning System (GPS) receiver capability directly into the NAVSSI system.

• It has refined algorithms that are used to calculate an integrated navigational solution.

• It further expands the navigation tools available to the ship's navigation team.

4.12.2 System Hardware

A typical hardware configuration for the NAVSSI system is show in Figure 4-61. The DCS is normally located in the chart room, and the RTSs are located in the forward and aft Interior Communication (IC) rooms. Most NAVSSI installations include the NAVSSI Bridge Workstation (BWS). The BWS is a fully functional, remote operator, station for the DCS providing NAVSSI display and control capabilities to ship's force on the bridge.

Early versions of the Bridge Work Station do not have computer, with the monitor, trackball and keyboard being interfaced to the DCS. The later versions of the Bridge Work Station, have a computer that interfaces via a LAN to the DCS.

The Block 3, DCS computing platform is based on a TAC-4 computer with a trackball and keyboard. The TAC-4 workstation is a Hewlett Packard computer with a Series 9000-J210 processor providing open system architecture.

The Block 3 RTS computing platform is based on a 20-slot Versa-Modular Europa (VME) chassis. The VME chassis hosts a variety of interface cards and a single board computer or CPU (in slot 0) that is either a Motorola 68000 series processor or a Power PC processor. Some of the significant features of the Block 3 system include the following:

NOTE:
Some of the equipment listed below is not associated with NAVSSI but is simply using available rack space. This is noted, where applicable.

• AN/WSN-7 Ring Laser Gyro *Navigator* (RLGN) inertial interface

• IP-1747/WSN Control Display Unit (CDU) *(none NAVSSI* Equipment)

• Global Positioning System (GPS) Versa Module Europa (VME) *Receiver*, Card (GVRC)

• Doppler Sonar Velocity Log (DSVL) interface

• Integrated Communications and *Advanced* Network (ICAN) interface

• Ship's Self Defense System (SSDS) interface

• *Cooperative* Engagement Capability (CEC) interface

• Battle Force Tactical Trainer (BFTT) interface *(none NAVSSI* equipment)

• Data Multiplexing System (DMS)/Fiber Optic Data Multiplexing System (FODMS) interface

• Aegis Light Exo-atmospheric Projectile Intercept (ALI) Vertical Launch System (VLS) interface

• PTTI precise time and time interval

• AN/SQS-53D (sonar) interface

• AN/KSQ-1 (amphibious assault direction system) interface

• Ship's Data Multiplexing System (SDMS) interface.

4.12.3 System Software

The NAVSSI AN/SSN-6 Block 3 system software uses two Computer Software Configuration Items (CSCls): the DCS CSCI and the RTS CSCI.

The DCS CSCI is the operator interface for the NAVSSI operator's console and the Bridge Workstation. The software resides on the hard *drive* of the TAC-4. It enables NAVSSI operators to do the following:

• Control and monitor RTS operations

• Display navigation sensor data

• Record and *retrieve* navigation information

• Display Digital Nautical Chart (DNC) data

• Provide the capability for route planning

• Route monitoring and *voyage* recording functions

The RTS CSCI is firmware that resides on EPROMs of the CPU module (in slot 0 of the VME chassis) and provides the following:

• Real-time interface, analysis, and selection of incoming navigation data as well as a real-time interface with the shipboard navigation sensors and users

• It can analyze sensor data to select the best source for navigation data users

• Provides Inertial Navigation System (INS) position fix data to the inertial GVRC

• Has the capability to distribute data to the user systems within the required timing constraints.

Each Computer Software Configuration Item (CSCI) is identified with unique names, acronyms and numbers (software Identification). CSCls are assigned a unique identifier composed of SUBSYSTEM DESIGNATOR, BLOCK #, BUILD # RELEASE #, and REVISION of a given release.

Table 4-28 provides an example of the identification system used.

SUBSYSTEM DESIGNATOR	DCS or RTS
BLOCK#	0 to 9
BUILD #	1 to 9
RELEASE #	1 to 9
REVISION	1 to 9

Table 4-28.— System Software Identification.

The charting requirements for NAVSSI Block 3 are met using the Defense Information Infrastructure (DII) Common Operating Environment (COE), and several DII segments including the Coast Guard's Command, Display, and Control (COMDAC) Integrated Bridge Segment (IBS).

Evolutionary Acquisition (EA) enhancements in Block 3 software include the following:

• Compliance with the Defense Information Infrastructure (DII)

• Common Operating Environment (COE) integration standards and software

• Interfacing the DCS Sensor Data Segment (SDS) software with the U. S. Coast Guard DII Segment Command Display and Control (Replacement) (COMDAC-r) software

• Integrated Navigation Segment (INS) software

• U.S. Naval Observatory (USNO) Celestial Navigation program known as System To Estimate Latitude and Longitude Astronomically (STELLA)

• Converting the NAVSSI LAN to a Fiber Distributed Data Interface (FDDI) LAN

• System complies with the Global Command and Control System-Maritime (GCCS-M) integration standards and software

4.12.4 System and Network Interfaces

The main interfaces for the NAVSSI navigational system are the shipboard sensors, weapons, and information systems and the primary source of navigation data used by NAVSSI AN/SSN-6 Block 3 is the GPS satellite system. NAVSSI is the host for the GVRC and provides GPS-unique source data along with the digital navigation charts for use by the navigator. Additionally, NAVSSI supplies a common time source and enables the navigator to monitor navigation data sources and the distribution of data to other shipboard users.

Table 4-29 summarizes typical input data and message rates and the interface criticality for maintaining communications in single and multiple point failures for the sensor/user systems that provide navigation data.

SYSTEM INPUT	DATA RECEIVED
Other RTS	All Sensor, Control, Configuration, Lever Arm Data, etc.
DCS	All Sensor, Control, Configuration, Lever Arm Data, etc.
GVRC	Position, Velocity, Time, Status, Almanac
FOAL Switch	Switch Position
AN/WRN-6	Position, Velocity, Time, Status, Almanac
AN/WSN-1 INS	Position, Velocity, Attitude, Attitude Rate, Speed through Water, System Performance
AN/WSN-5 Channel A	Position, Velocity, Attitude, Attitude Rate, Speed through Water, System Performance
AN/WSN-5 Channel B	Position, Velocity, Attitude, Attitude Rate, Speed through Water, System Performance
AN/WSN-7 INS	Position, Velocity, Attitude, Attitude Rate, Speed through Water, System Performance
AN/WSN-7 Superchannel	Position, Velocity, Attitude, Attitude Rate, Speed through Water, System Performance
Gyrocompass	Synchro Heading
DSVL	Speed through Water or Speed Over Ground
EM Log	Synchro Speed through Water
Digital Speed Log	Speed through Water
Fathometer	Depth beneath the keel
IP-1747/WSN	ANIWSN-7 Control Data
DMS/FODMS	INS, Fathometer, Wind, Propulsion data
ICAN	Wind Speed and Direction
SWAN	TBD

Table 4-29.— Block 3 Data Input Summary.

Table 4-30 summarizes typical data output requirements by system for maintaining communications in single and multiple point failures. The NAVSSI RTS outputs navigation and time data meets the requirements of each user system.

SYSTEM	POSITION ACCURACY (Meters)	ATTITUDE LATENCY (msec)	TIME ACCURACY (msec)
DCS	N/A	N/A	N/A
AN/WRN-6	N/A	100	N/A
AN/WSN-1 (CVNS)	100	N/A	1
AN/WSN-5	100	N/A	1
AN/WSN-7 (RLGN)	100	N/A	1
IP-1747/WSN	N/A	N/A	N/A
DSVL	N/A	Note 1	100
FODMS (RS-422)	100	N/A	N/A
FODMS (STANAG 4156)	20	10	10
ICAN	20	10	10
SWAN	100	N/A	1000
JMCIS TDBM	100	N/A	1000
NTCS-A RS-232 Link	100	N/A	N/A
Outboard (synchro)	100	N/A	N/A
Outboard/ BGPHES/ Combat DF (digital)	100	N/A	N/A
ACDS Blk 0	1000	60	1000
ACDS Blk 1 Lvl 3	20	10 Note 2	10
AN/KSQ-1	100	N/A	1000
AN/SQS-53D	100	N/A	100
SQQ-89 SLR	100	N/A	100
ATWCS/TEPEE	N/A	N/A	N/A
BFTT	N/A	N/A	0.1
CEC	N/A	N/A	0.001
ECS-Havequick	N/A	N/A	1
Mk-86 GFCS	20	N/A	100
ERGM	20	N/A	0.001
SDMS	1000	60	1000
SSDS	20	10 Note 2	10
TAMPS	N/A	N/A	N/A
SLAM	N/A	N/A	N/A
ALI/VLS	20	N/A	0.001
ALI/IWCS	20	N/A	N/A
Expansion Ports: High rate	25	100	100
Expansion Ports: Low rate	25	N/A	100
IP Expansion Ports	100	N/A	1000

Notes:
(1) NAVSSI shall transmit attitude data to DSVL within 30 milliseconds of its receipt from the INS.
(2) This requirement is applicable only to NAVSSI interfaces with the AN/WSN-7. The attitude latency requirement is undefined on AN/WSN-1 and AN/WSN-5 platforms.

Table 4-30.— Block 3 Data Output Summary.

4.12.5 System Hardware Versions

The hardware configurations of individual Block 3 systems vary by ship class and by kits and upgrades that have been installed. The differences are largely in the type of point to point electronic connections.

Because different ships have different combinations of PVT interfacing systems, they need different sets of point to point connections based on these interfacing systems.

The DCS and RTS hardware configurations are build and ship class specific. However, configurations also can vary based on kits and upgrades that have been installed. The various ship classes (or platforms) have different interfaces available to them. NAVSSI system hardware reflects the interfaces that the system has to support. The hardware configuration information is provided in Volume 4 of EE170-AF-OMI-010/SSN-6, Maintenance, identifying the configuration for specific ship classes, in recognition of its impact on maintenance actions.

4.12.6 System Interface Versions

External interfaces supported by the NAVSSI Block 3 system are dependent on the hardware that has been installed on the particular ship. This available hardware will dictate which software functions are available to the NAVSSI system. If the hardware interface is not available, the NAVSSI system software will gray out the applicable (non-functional) features in the operator displays.

4.12.7 System Software Versions

The currently installed NAVSSI, DCS software versions can be determined by accessing the "Help" pull-down menu, as described in Volume 2 of EE170-AF-OMI-010/SSN-6, Program Operation. Since there are substantial platform dependent differences in NAVSSI interface requirements, NAVSSI Block 3 software was developed to run all the different suites of hardware that are available to the NAVSSI system. Each of these suites provides connectivity to the interfaces, particular to those ship classes that the suite supports. NAVSSI software stores the configuration information needed to customize the software to the particular hardware suite in non-volatile memory.

The software has all of the necessary suites to interface the available hardware. If the hardware is not available, that software suite will simply not be functional. All ship classes are provided with the same software.

4.12.8 System Firmware

The NAVSSI, RTS uses firmware in the CPU in Slot 0 of the VME chassis located in the RTS racks. Normally, this is of no consequence to the NAVSSI operator or maintenance technician. However, if the CPU is replaced for any reason, EPROMs on the CPU must be subjected to maintenance action. This requires either replacement EPROMs or the reloading ("or burned-in") of the EPROMs, depending on the type of CPU that installed in the RTS. This is required to maintain the correct firmware for the system.

Refer to Volume 4, Maintenance, and to Volume 3, System Administration of EE170-AF-OMI-010/SSN-6, for the applicable procedural steps.

4.12.9 Equipment Descriptions

The following describes the three major hardware subsystems, they are the Display, Control Subsystem (DCS), the Real Time Subsystem (RTS), and the Bridge Workstation (BWS).

Display Control Subsystem (DCS)

The DCS is the Human-Machine Interface (HMI) subsystem of the AN/SSN-6 system. The DCS is located in the chart room on most ships. The user controls the AN/SSN-6 system by using the DCS video screen, trackball, and keyboard.

The DCS takes the Position, Velocity, and Time (PVT) information from the RTS and then creates the electronic navigation chart to places the PVT in a context that helps the user to navigate the ship. The DCS also acts as an interface to aid in a variety of navigation tasks such as piloting, voyage-planning, voyage-management, and training.

The DCS is mounted in a ruggedized, 19-inch rack with shock isolation intended to minimize the effects of battle damage. It is powered by an Uninterruptible Power Supply (UPS) that provides backup power if primary power fluctuates or there are power interruptions. This feature provides the time needed to perform an orderly system shutdown if there was shipboard power failure.

A typical DCS is shown in Figure 4-62. The DCS provides the overall system control, data processing, storage and the operator interface for the NAVSSI system.

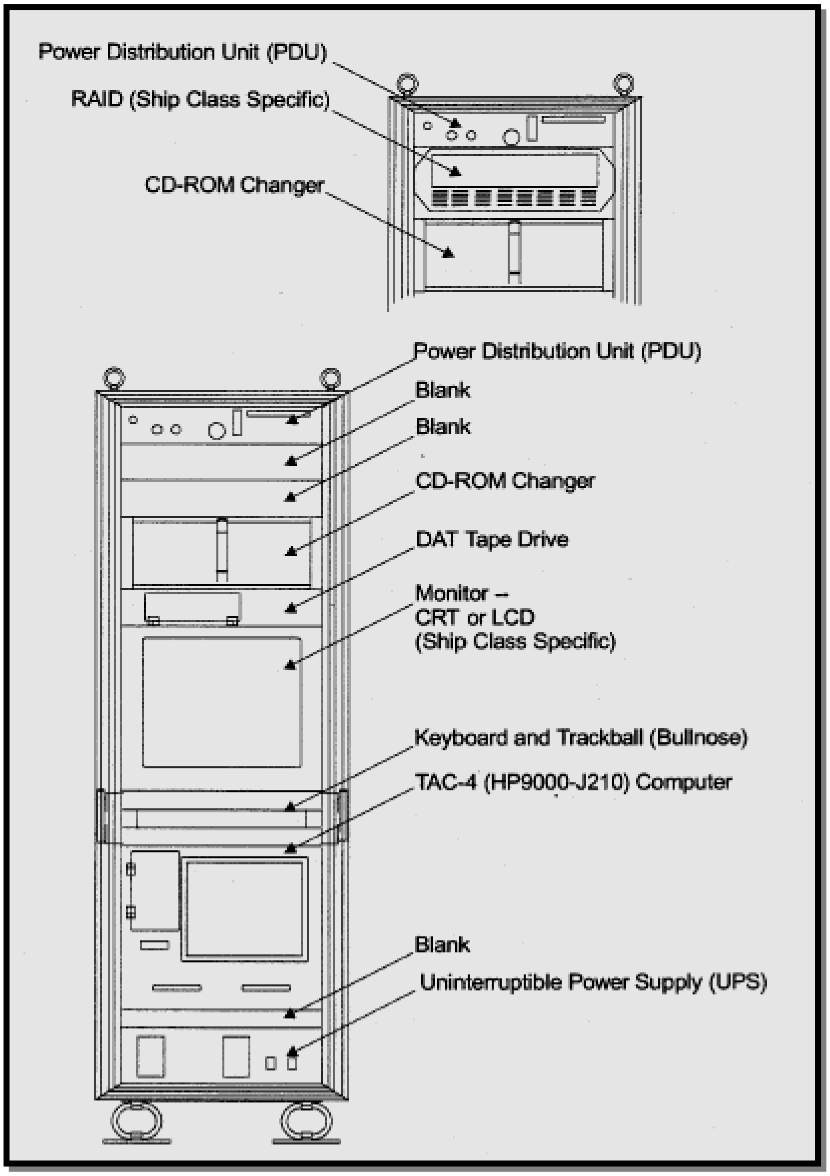


Figure 4-62.— NAVSSI Block 3 Display Control Subsystem (DCS).

Power Distribution Unit (PDU)

Both the RTS and DCS subsystems contain Power Distribution Units (PDUs). The DCS and RTS PDUs are functionally equivalent, except they contain a different EPROM. The EPROMs used in the RTS PDUs are programmed with a power-shed feature. This power-shed feature drops the power on J5 to J8 (outputs) on the RTS PDU, after approximately 55 seconds of power interruption to the PDU. Each component of the RTS and DCS has its own circuit breaker. The circuit breakers provide over-current protection for installed components. In addition, the breakers allow individual components to be electrically isolated for troubleshooting, maintenance, and repair. The total system power can be removed from each subsystem using the UPS power switches.

For safety reasons, the PDU senses and reports abnormally high temperature conditions. The over-temperature LED will light at temperatures exceeding 45° C (113° F). The PDU shuts down in 55 seconds when temperatures exceed 50° C (122° F) after issuing an audible warning. In an emergency battle situation, the BATTLE SHORT switch can be turned on to override the thermal sensors and cause the PDU to continue to distribute power throughout the subsystem.

The PDU operates with an Uninterruptible Power Supply (UPS) by controlling all power supplied to, and taken from the UPS. Specific procedures to remove (or secure) all power in the equipment rack must be followed. All equipment in the racks is provided power through the toggle switches on the PDU which will remove or supply power to all equipment in the rack where the UPS is installed. However, the main power to the rack (ship's input power to the PDU) must be secured prior to performing maintenance. This can be done by securing and tagging ship's power to the equipment rack at the appropriate power panel or switchboard.

RAID

The Random Access, Integrated Drive (RAID) is a mass storage device that uses an array of up to eight half-height drives each having a capacity of up to 18.0 gigabytes. The RAID has a maximum storage capacity of up to 144 gigabytes. These integrated drives provide mass storage for navigational charts for NAVSSI system. Information can be read-from or stored-to the RAID drive like any other hard disk drive.

The RAID drive occupies a storage drawer compartment in the DCS. Some later versions of the NAVSSI system use the RAID drive.

CD-ROM Library (Jukebox)
The CD-ROM is a random access, read-only, mass storage device that uses removable CD-ROM disks.

The jukebox has a capacity of storing up to 240 CD-ROMs. Information can be read from the drive like any other disk drive, except that CD-ROMs cannot be written to. CD-ROM discs are 120mm (4.7 in.) in diameter, and use one data surface with a capacity of over 600 megabytes. Early versions of the systems require the loading of DNC CD-ROMs manually via the TAC-4 computer's CD-ROM drive, as the jukebox is not functional (as no software exists to operate the jukebox). Later versions of the systems may provide functionality of the CD-ROM library Jukebox), whereby, the CD-ROMs are no longer loaded by hand and access to all of the DNC CD-ROMs is provided by software control. But, more then likely, later versions of the systems may not use the jukebox at all and may use the RAID drives instead.

DAT Tape Drive
The Hewlett Packard OAT (Digital-Audio Tape) format tape drive is a 3.5" half-height sequential-access tape drive that can handle multiple capacity removable 4mm DDS data cassettes. The DDS-format tape drive is located on a shelf in the rack of the DCS and is used primarily for re-installation of the NAVSSI and GCCS-M system software. The OAT tape drive is a SCSI device.

Monitor
The DCS monitor in the NAVSSI system provides a color graphical interface to the DCS. The monitor can be either a CRT or LCD depending on ship class. The monitor receives signals from the G-2 Graphics Board in the DCS TAC-4 workstation.

Keyboard and Trackball
The keyboard is a TAC 4-specific keyboard and the trackball provides 4-buttons with the upper-left and lower left having redundant functions, based on operator preference. The Bridge Work Station (BWS) keyboard features back-lighting.

TAC-4 Computer (HP9000-J210)
The NAVSSI AN/SSN-6 Block 3 DCS subsystem is hosted on a TAC-4 workstation (HP 9000 Series J210). The workstation handles all user and peripheral input/output (I/O) as well as system booting. The workstation executes the UNIX operating system that provides an environment for executing application software on the system. The DCS software is run within this environment as a group of UNIX applications. The TAC-4 computer is enclosed in the DCS rack and is equipped with a CD ROM drive, a 3.5" floppy drive and two 4.5-GB hard drives with RAM that is configured with 256 Megabyte.

Uninterruptible Power Supply (UPS)
The RTS and DCS subsystems both contain Uninterruptible Power Supply (UPS) units. The DCS and RTS UPSs are functionally equivalent. The UPS protects the digital circuitry from damage during a sudden power loss or surge. The UPS contains rechargeable batteries that are kept fully charged during normal operation. If power is lost, the batteries in the UPS supply power to operate the system for a short time during power interruptions. This allows for an orderly shutdown of the system.

During normal operation, AC input power from the PDU is brought into the UPS. The UPS provides circuit protection for the electronic equipment in the rack. The noise filter reduces EMI/RFI electrical noise and to provide protection against high voltage transients on the input to the electronics.

When AC input is within limits, the UPS constantly converts the incoming AC power to DC, and then the DC back to AC to power the electrical loads attached to the UPS. The UPS maintains the battery pack in a ready state. When the AC input is outside the limits or has failed. The UPS supplies power from its battery pack (without any interruption of power) to the load. Power status indicators are provided at the UPS.

Real Time Subsystem (RTS 2) – Aft
The forward and aft RTSs are similar subsystems; they however contain different equipment in the racks as noted below. Each RTS is mounted in a 19-inch ruggedized rack with shock isolation and that minimizes the effects of any ship sustained battle damage. It is powered by an uninterruptible power supply (UPS) that provides backup power if primary power fluctuates or there are power interruptions. This ensures continued power and provides the crucial data.

The aft RTS, shown in Figure 4-63, operates independently of the DCS TAC-4. The RTSs communicate directly with navigation data sources and navigation data users. This is done by running real-time software that provides the data processing functions.

The aft RTS communicates with the DCS over the FDDI LAN and in dual-RTS configurations, the RTSs also communicate with each other via the same FDDI LAN. Dual RTS configurations provide reflective memory to each other, whereby current data is always available to the DCS.

The NAVSSI RTS system software resides in the RTS on EPROMs. The currently installed RTS software version may be determined by accessing the DCS "Help" pull-down menu as described in Volume 2 of EE170-AF-OMI-010/SSN-6, Program Operation.

The forward and aft RTSs are essentially the same, except that in most cases, the aft RTS contains the Battle Force Tactical Trainer (BFTT) and the Control Display Unit (CDU) Assembly. The CDU (part of WSN-7 systems) includes a CPU, display, printer and peripheral devices. This equipment is not part of the NAVSSI system, but is housed in the same rack as the NAVSSI equipment. Please refer to separate documentation for information on this equipment.

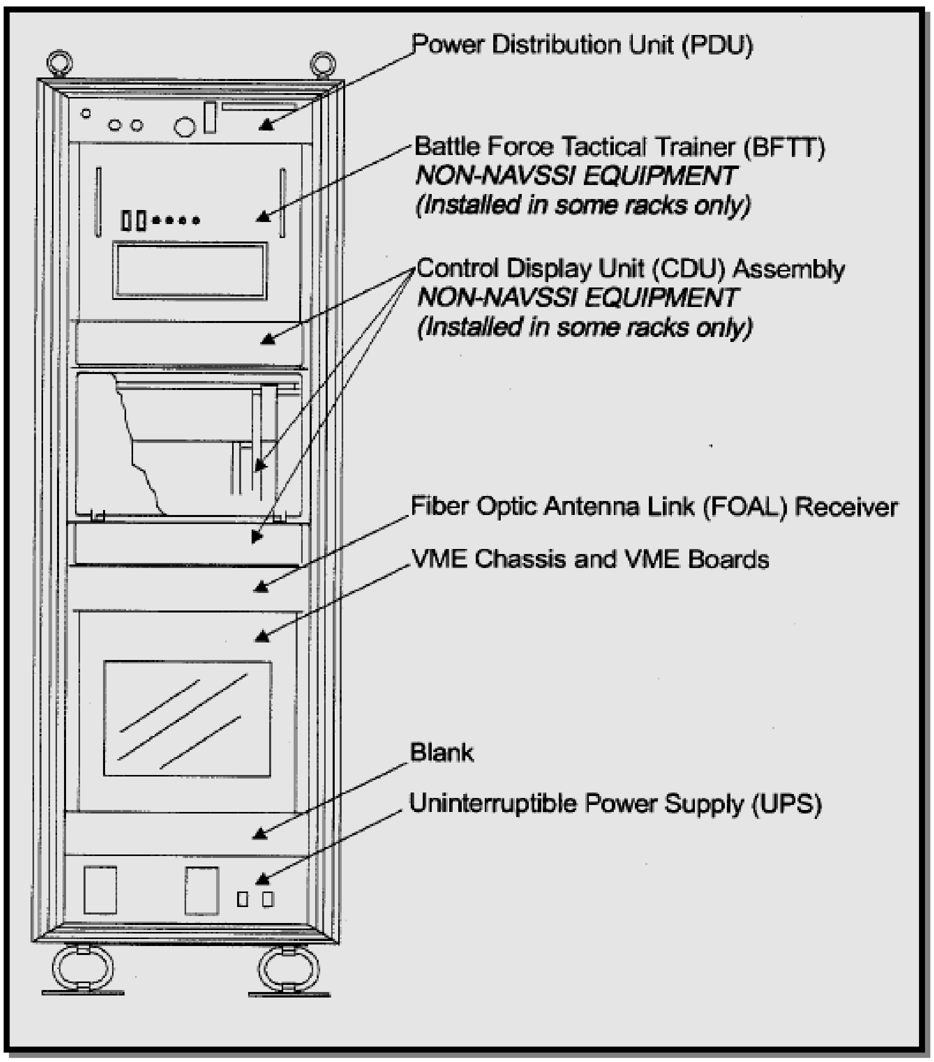


Figure 4-63.— NAVSSI Block 3 RTS 2 (Aft).

Battle Force Tactical Trainer (BFTT) - *NON NAVSSI EQUIPMENT*
This equipment is installed in the NAVSSI racks, but is not part of the navigational equipment.

Control Display Unit (CDU) Assembly - *NON NAVSSI EQUIPMENT*
This equipment is installed in the NAVSSI racks, but is not part of the navigational equipment.

Fiber Optic Antenna Link (FOAL) Receiver
The overall FOAL consists of an antenna conversion module mounted in the GPS antenna and a receiver conversion module mounted in the FOAL unit in the RTS rack. Each RTS is supplied GPS signals from its own GPS antenna, and therefore, each RTS includes a FOAL.

The Fiber Optic Antenna Link (FOAL) provides an optical data transmission link between the RF output of the GPS antenna and the RF input to the GVRC board in the RTS. The GPS signal received at the antenna is routed to the RTS via fiber optic cable to maintain data integrity over the long distances from the antenna at the top of its mast to the RTS rack.

The FOAL provides optical conversion and switching of the GPS signals from the two antennas. The antenna module consists of a RF-to-optical converter to convert the received RF signal to an optical signal. At the RTS end of the fiber optic cable, the FOAL receiver converts the optical signal back to a RF signal for input to the GVRC board.

The FOAL also provides cross-connect switching for the signals from each GPS antenna. If one of the antennas malfunctions, the signal from the single operating antenna is switched to both the forward RTS and the aft RTS.

Real Time Subsystem (RTS 1) – Forward
The forward and aft RTSs are similar in relation to NAVSSI equipment; they however contain different equipment in the racks as noted below. Each RTS is mounted in a 19-inch ruggedized rack with shock isolation designed to counter shock effects from battle, a heavy sea state, or any other source. Each RTS receives operating power from the UPSs to ensure it continues to provide crucial data if there is a problem with shipboard power.

The forward RTS, shown in Figure 4-64, operates independently of the DCS TAC-4. The RTSs communicate directly with navigation data sources and navigation data users. This is done by running real-time software that provides the data processing functions.

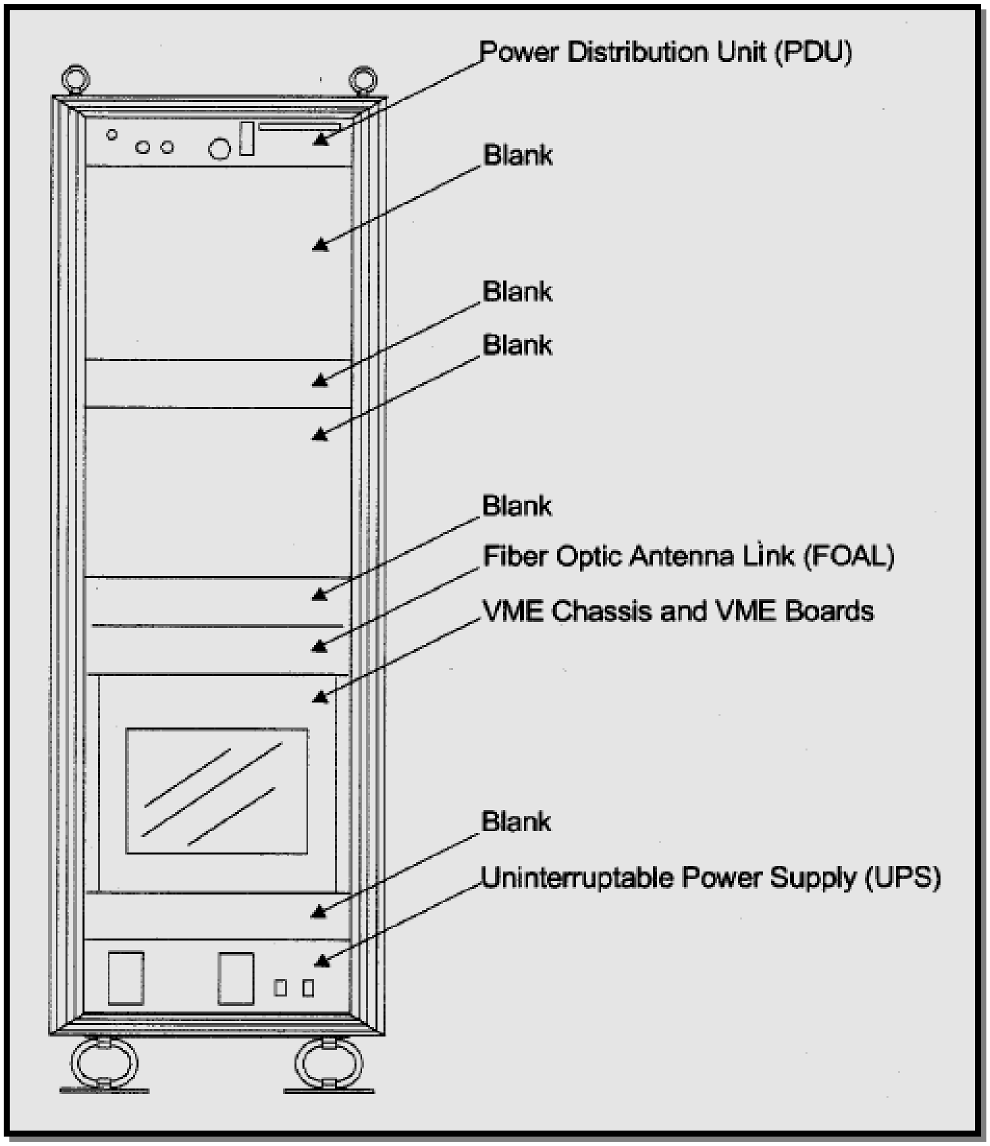


Figure 4-64.— NAVSSI Block 3 RTS 1 (Forward).

Multiple I/O boards are installed in each RTS to format each position and navigation (POS/NAV) output data stream in the format required by the individual user systems. The aft RTS communicates with the DCS over the FDDI LAN, and in dual-RTS configurations, the RTSs also communicate with each other via the same FDDI LAN. Dual RTS configurations provide reflective memory to each other, ensuring that current data is always available to the DCS.

The NAVSSI RTS system software resides in the RTS in EPROM memory. The currently installed RTS software version may be determined by accessing the "Help" pull-down menu as described in Volume 2 of EE170-AF-OMI-010/SSN-6, Program Operation.

The forward and aft RTS are essentially the same, except that the aft RTS contains the Battle Force Tactical Trainer (BFTT) and the Display Control Unit (CDU) Assembly. The CDU (part of WSN-7 systems) includes a CPU, display, printer and peripheral devices. This equipment is not part of the NAVSSI system, but is housed in the same rack as the NAVSSI equipment.

Bridge Workstation

The interactive workstation, located on the bridge, is shown in Figure 4-61. It provides bridge personnel with parallel control, query capability, and a display of NAVSSI system data, as supplied by the DCS.

Monitor

The bridge monitor in the NAVSSI system provides a color graphical interface to the DCS. The monitor can be either a CRT or LCD depending on ship class.

NWS Computer

The upgrade version of the Bridge Workstation, sometimes referred to as the Network Workstation, has a separate computer in lieu of a signal interface to the DCS TAC-4 computer. The pre-upgrade version of the BWS monitor, receive signals from the G-2 Graphics Board in the DCS TAC-4 workstation. The upgrade version of the BWS monitor, interface to DCS TAC-4 workstation via a LAN. This NWS computer controls all video for the BWS.

RTS VME Chassis and Installed Components

The RTS VME chassis, shown in Figure 4-65 contains a backplane with 20 slots, numbered 0 through 19. Slot 0 is at the left of the chassis, as viewed from the front. Each slot provides two, 96-pin connectors labeled J1 and J2. J1 is located in the upper portion of the chassis and J2 is located in the lower portion. The pins of the J2 connector feed through to the back of the VME backplane to connector P2. The outer pin rows of the user defined P2 connector may be used by the card in that slot as an external connection to the VME chassis I/O connectors. The location of each board in the VME Chassis is described below. Each board in the VME chassis requires a unique bus address, even if the boards are identical.

Not all ships have a fully populated VME chassis'. In the cases where one or more of the boards is not included in the ship's configuration, blank panels are inserted in their place. Refer to Volume 4, Maintenance, Chapter 5, System Configuration and Composition of EE170-AF-OM1-01 0/SSN-6, to identify the hardware configuration of your system.

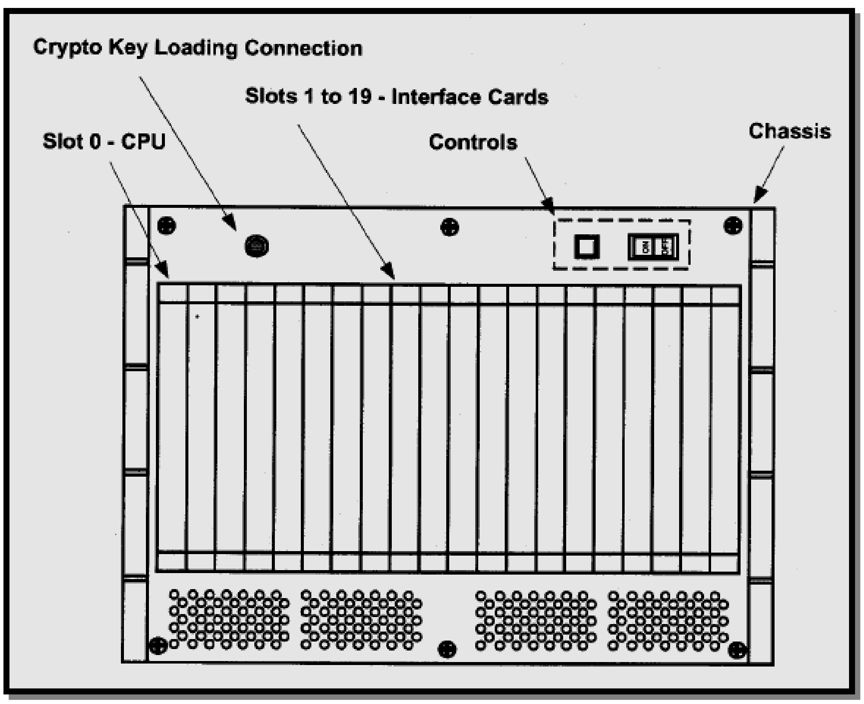


Figure 4-65.— VME Chassis and Installed Components - Typical.

VME Power Supply
The 750-watt VME power supply is mounted behind and below the VME card cage. The unit is powered by 115 VAC and is protected by a fuse located next to the line input (TB1). A detachable AC power cord for the supply is connected to the rear of the VME Chassis. All DC outputs are protected against overload and short circuit and have automatic recovery capability upon removal of fault. There is over-voltage protection for the +5VDC, wherein the trip point is set such that the +5VDC cannot exceed +6.8VDC. Input power to the supply may range from 90 to 132-VAC at 47 to 63 Hz. Output power is +5VDC at 120A and +/- 12VDC at 10A. The -5.2VDC is not used.

Slot 0 - MVME 147 CPU
The MVME 147-023 CPU Board has a MC68030 processor and is the system controller for the VME bus. The processor operates at 32 MHz and has configurable random access memory (RAM). It is responsible for controlling all the boards in the RTS. It directs the interface boards to send/receive data, checks and processes data received, and communicates navigation solutions to the DCS. The CPU communicates with the DCS over the FDDI LAN to transfer information between the RTS and the DCS. It is always installed in the far-left slot (slot 0) to correctly initiate the bus grant daisy chain. The MVME 147-023 CPU board includes an onboard Ethernet communications processor.

Slot 0 - MVME 2700 [Power PC] CPU
Late versions and certain ship classes of the NAVSSI system have an alternate CPU. This is the MVME 2700 CPU Board. It has a PowerPC 750 microprocessor operating at 233 MHz, 266 MHz or 366 MHz. It has either 32 KB or 1 MB cache, and 1 MB flash RAM (or with expansion connector, 4 MB or 8 MB flash RAM). The MVME 2700 CPU is the system controller for the VME bus. The MPC750 processor operates through a 33 MHz 32/64-bit PCI local bus. The CPU is responsible for controlling all the boards in the RTS. It directs the interface boards to send/receive data, checks and processes data received, and communicates navigation solutions to the DCS. The CPU communicates with the DCS over the FDDI LAN to transfer information between the RTS and the DCS. It is always installed in the far-left slot (slot 0) to correctly initiate the bus grant daisy chain.

Slot 1 - VMIVME 5576-210
The VMIVME 5576 reflective memory board serves as the communications link between the two RTSs in a dual RTS system and places data from sensors in both RTSs.

This board allows the user to write any data to any specified location in a specified RTS. The same data will also be written to the same memory location in the other RTS. To execute this operation, the reflective memory board writes the data to the same location in the other RTS.

Slot 2 - Currently Not Used
Current configurations do not use slot 2.

Slot 3 – GVRC
The GPS VME receiver card (GVRC) is a Precise Positioning Service (PPS) receiver that collects and processes GPS satellite signals to derive accurate three-dimensional position, velocity and time. The receiver can also be aided by an auxiliary sensor for increased performance in integrated applications. The GVRC calculates position, velocity and time solutions at a rate of one solution per second.

Slot 4 – PTU
The Pulse Time Unit (VME-Sync Clock 32) is a digital clock that automatically synchronizes to time reference signals. The VME-Sync Clock 32's digital clock provides a resolution of 100 nanoseconds over the host systems "real time" clock. This provides stability and synchronization to universal coordinated time by locking to time reference signals. The time reference signals are standardized to an IRIG-B time code signal, and PTTI signals.

Slot 5 - FDDI 5211
Fiber Distributed Data Interface (FDDI) is a high-performance node processor for 125 Mbps fiber optic networks. The FDDI board performs much of the communications protocol processing and network management function required by FDDI using a Motorola 68EC040 processor and chip set. The FDDI card in this slot is for interface to the LAN.

Slot 6 - FDDI 5211
This board is identical to the FDDI board in slot 5. Refer to slot 5 for a narrative description to the board, except that this FDDI card in this slot is for interface to the ICAN LAN.

Slot 7 - MVCP-16 - SYNC/ASYNC
The Macrolink, VME Communications Processor (MVCP) is a high-speed microprocessor-based board with sixteen independent, synchronous/asynchronous communication ports. 12 ports are RS485 and 4 ports are RS232. Each board supports data transfer rates at up to 2 megabits synchronous and 230 Kbits asynchronous. The board simultaneously supports RS232, RS422 and RS485 interfaces in four (4) line increments. Status, data movement, port arbitration, selection, and protocols are processed on-board, minimizing driver calls and host intervention that maximizes overall system throughput.

Slot 8 - NTDS 1397A1B
The NTDS 1397AB board provides support for communication with military computers and peripherals that support the MIL-STD-1397NB, type A and type B protocol. The board interfaces are software programmable to function as an NTDS computer, peripheral, or inter-computer channel, with an NTDS word size of 8, 16, or 32 bits.

The data is transmitted and received via connector P2. The interface can be configured as either a NTDS Type A (slow) or NTDS Type B (fast). The NTDS card in this slot is for interface to the SDMS and ACDS.

The electrical characteristics for the NTDS MIL-STD-1397AB are a logical "1" = 0 VDC; and logical "0" = -15 VDC at 41,667 words/second. The transmission rate for either ANIWSN-5 or AN/ WRN-6 to the NAVSSI is 4 Hz. The transmission rate for the NAVSSI to either the ANIWSN-5 or ANIWRN-6 is 1 Hz.

Slot 9 - NTDS 1397AlB
This board is identical to the NTDS board in slot 8. Refer to slot 8 for a narrative description to the board, except that this NTDS card in this slot is for interface to the ANIWSN-1, 5, or 7.

Slot 10 - NTDS 1397AlB
This board is identical to the NTDS board in slot 8. Refer to slot 8 for a narrative description to the board, except that this NTDS card in this slot is for interface to the WRN-5 (B), WSN1, CVNS, or LEAP.

NTDS 1397A1B
This board is identical to the NTDS board in slot 8. Refer to slot 8 for a narrative description to the board, except that this NTDS card in this slot is for interface to the MK86 GFCS.

Slot 12 - Currently Not Used
Current configurations do not use slot 12.

Slot 13 - STANAG 4156
This interface adapter allows the user to interface a serial interface system. The board can be configured to operate as a terminal access unit, a user interface device or a direct connection coupler. The board is controlled by an onboard MC6800 microprocessor and a four channel direct memory controller. The DMA controller is used to move data between designated memory buffers areas and the two S4156 ports. The input and output ports can operate in simplified (type A) or complete (type B) protocol modes.

The two ports operate independently and support full duplex transfers. The S4156 interface consists of a set of micro-programmed, sequence logic circuits that control the data transfers between the serial S4156 data ports and the rest of the S4156. The connector for the S4156 input and output ports is mounted on the front of the board. When operating as a user interface device the data rate will automatically operate at the clock speed supplied by the terminal access. When operating as a terminal access unit or a direct connection coupler, a 2.5 MHz data clock is used.

Battery Board
All configurations use this slot to hold a battery pack for the GVRC board. No interface to VME bus.

Slot – 15 NTDS 1397E
The NTDS 1397E board provides support for communication with military computers and peripherals that support the MIL-STD 1397 type E protocol. The data is transmitted and received via two connectors labeled (Receive) and. (Transmit) located on the front panel. The NTDS card in this slot is for interface to the ANIWSN-7 superchannel A.

Slot 16 - NTDS 1397E
This board is identical to the NTDS board in slot 15. Refer to slot 15 for a narrative description to the board, except that this NTDS card in this slot is for interface to the ACDS.

Slot 17 - NTDS 1397E
This board is identical to the NTDS board in slot 15. Refer to slot 15 for a narrative description to the board, except that this NTDS card in this slot is for expansion port 1.

Slot 18 - Currently Not Used
Current configurations do not use slot 12.

Slot 19 – S/D Converter
The Synchro-to-Digital (SID) board provides an interface for analog inputs from the gyrocompass and the EM-LOG (electromagnetic pitometer log). This single slot board incorporates four separate transformer isolated tracking converters that are programmable for either; four single speed or two, two-speed or other combinations adding up to 4 channels. Speed ratios are available from 1:1 to 127:1 with 24-bit resolution with up to 255:1 ratio. Each channel pair has individual transformer isolated reference inputs.

Blank Fascia Spacer

When a slot is not used, a blank fascia spacer is installed in the unused slot position of the VME chassis allowing for proper cooling airflow. The blank fascia spacer physically seals the front of the VME chassis. It provides no interface to the VME bus or addressing for the CPU (in slot one) for the unused position.

BWS J-Box

An outline of the J-box for interconnecting the bridge workstation is shown in Figure 4-66. The J-box contains a power supply and an interactive DB-25 connector that is used to interconnect the TAC-4 computer and the keyboard and trackball of the BWS.

The rose box does not have any physical operator interface. Interconnection is a function of installation and maintenance activities. Please refer to Volume 4 of EE170-AF-OMI-010/SSN-6, Maintenance, for interconnection information.

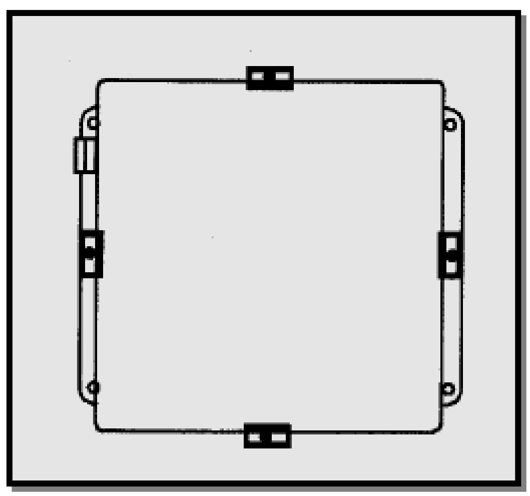


Figure 4-66.— BWS J-Box.

GPS Antenna

Signals received through the Global Positioning System (GPS) antenna module, transmitted by Navstar Global Positioning System (GPS) satellites, enables the computation of accurate position coordinates, elevation, speed, and time information. GPS navigation is based on satellite ranging that involves measuring the time it takes the satellite signal to travel to from the satellites to the navigation user. By ranging three satellites, a three-dimensional position can be determined that accurately pinpoints where the signals intersect on the earth surface.

Antenna Module

The GPS antenna is shown in Figure 4-67. This figure shows both types of antennas that could be used. The type of antenna used is base on the type of receiver module or FOAL (and its interconnection) used in the NAVSSI system.

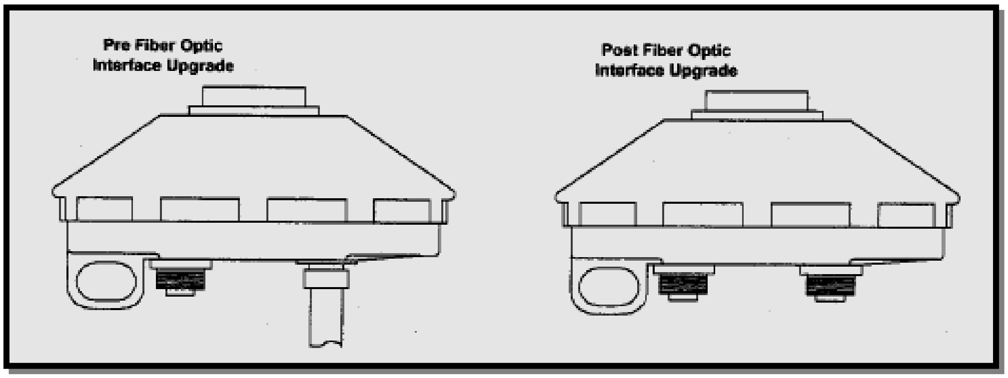


Figure 4-67.— GPS Antenna Module.

Antenna Interface and Interconnection

The GPS antenna does not have any physical operator interface. Interconnection is a function of installation and maintenance activities. Please refer to Volume 4 of EE170-AF-OMI-010/SSN-6, Maintenance, for interconnection information.

Fiber Optic Interconnect Box

An outline of fiber optic interconnect box is shown in Figure 4-68. The fiber optic interconnect box contains an isolation transformer and is used to interconnect the GPS antenna and Fiber Optic Antenna Link (FOAL) receiver in the RTS.

NOTE:

Interconnect box is only installed on DDG-77 through DDG84 and CVN-68.

The fiber optic interconnect box does not have any physical operator interface. Interconnection is a function of installation and maintenance activities. Please refer to Volume 4 of EE170-AF-OMI-010/SSN-6, Maintenance, for interconnection information.

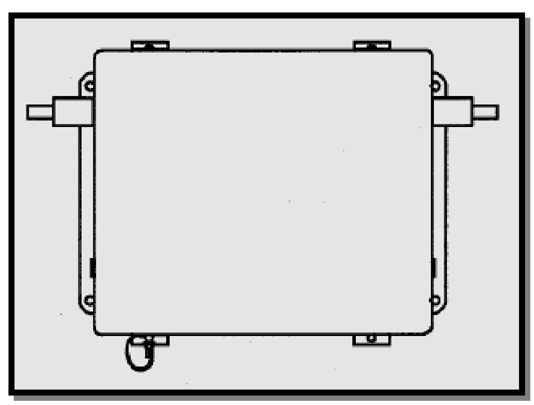


Figure 4-68.— Fiber Optic Interconnect Box.

4.13.0 SHIP'S COURSE INDICATORS (REPEATERS)

The trend to transistorized equipment has resulted in gyro installations being equipped with highly reliable transistorized ship's course indicators, or repeaters as they are commonly called. Ship's course indicators are used to visually display gyrocompass heading data for navigational purposes. They are installed at the helm, on the bridge wings, in the after steering room, and other remote locations aboard ship. Figure 4-69 is a breakdown of the various types of ship's course indicators used with gyrocompass systems.

TYPE	FREQUENCY	SPEED	DRIVE	DIAL	MOUNT
A	400	1	Servo	Single	Bulkhead
B	400	1X + 36X	Servo	Single	Pelorus Bulkhead
E	400	1X + 36X	Servo	Dual	Bulkhead
F	400	1X + 36X	Servo	Dual	Console
G*	60	1	Servo	Dual	Bulkhead
H*	60	1	Servo	Dual	Bulkhead
L	400	1	Synchro	Single	Console Bulkhead

Figure 4-69.—Gyrocompass repeaters by letter designation.

The several variations of mounting dials, data transmission systems, and power requirements for ship's course indicators will be discussed in the following paragraphs.

Units may be designated as single-speed or 1 and 36 speed. Single-speed units contain one synchro control transformer in larger units and one synchro receiver in miniature units. The 1 and 36 speed units provide greater accuracy in reading and contain two control transformers. In the 1 and 36 speed, coarse control is 1 speed and fine control is 36 speed.

Units also may be divided by power requirements with some using 60 Hz and others using 400 Hz.

An additional feature is the low noise and normal (nonlow) noise characteristic of several repeaters. In the nonlow noise variety, the servo and dial assembly mount directly to the cast housing. In the low noise variety, the mounting is on vibration isolators similar to rubber shock mounts.

Figure 4-70 shows a type E repeater minus terminal block and cord. The inner dial is single speed and the blocked out outer dial is 36 speed. These repeaters are generally located in enclosed spaces, such as the OOD's repeater on the bridge.

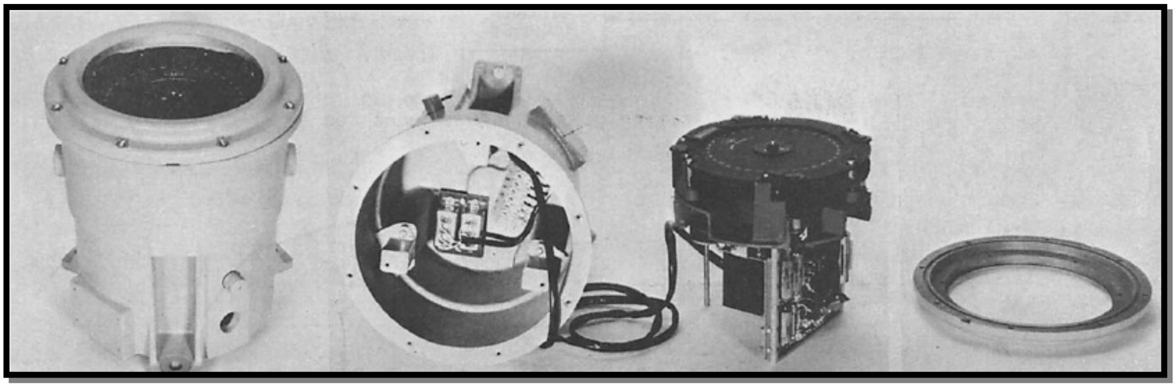


Figure 4-70.— Type E ship's course indicator (designed for bulkhead mounting).

The basic block diagrams of the various repeaters are shown in figure 4-71. View A shows the type L repeater synchro drive. View B displays the type A servo drive single speed. In view C, types B, E, and F are depicted, and view D shows the G and H course-to-steer repeaters.

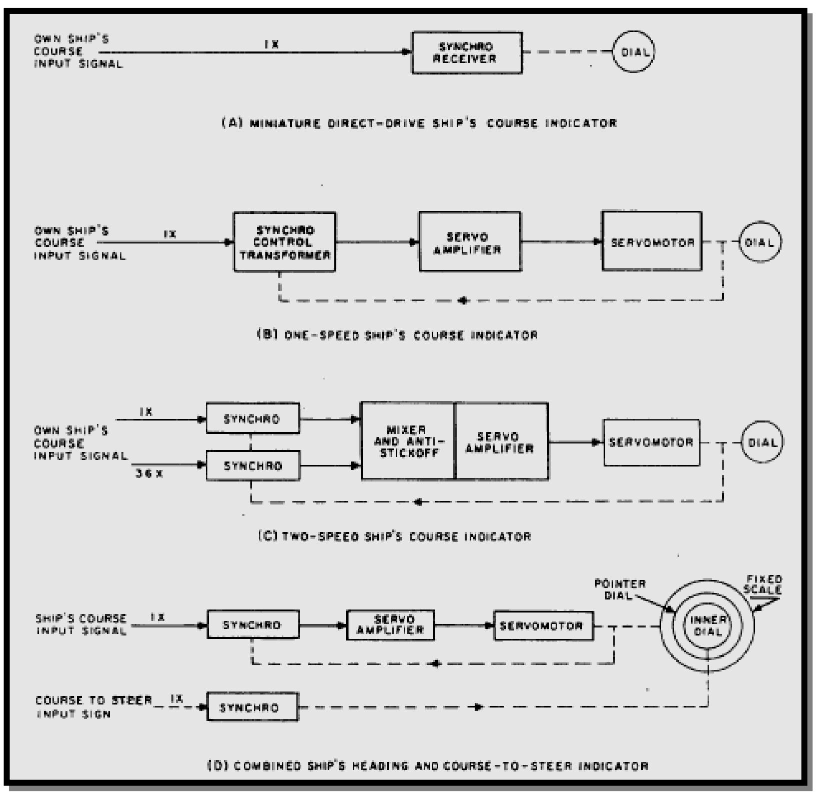


Figure 4-71.— Block diagram of ship's course indicators.

The operation of the components is standard; however, and explanation of the mixer and anti-stick off voltage may be of assistance.

The 36X synchro control transformer determines the accuracy of the indicator, but because this synchro has 36 null positions for one revolution of the indicator dial, the 1X synchro sets the proper null. The two synchro rotors are connected in shunt through a mixing network consisting of pairs of diodes and two resistors. The mixing network performs three functions. First, it effectively opens the 1X synchro signal circuit whenever the indicator dial is within 2.5° of null. Second, it limits or attenuates the 36X synchro signal whenever the 36X synchro is more then ±2.5° from its null. Third, it keeps synchro loading to its minimum allowable level.

The use of the mixing network eliminates every false null except the one at the 180° point of the indicator dial. This null is eliminated by adding a 2.5- volt, 400-Hz, anti-stick off voltage in series with the 1X synchro rotor voltage, and shifting the phase of the 1X synchro voltage by 2.5° to bring the indicator null back to a true reading. This procedure converts the 180° point to an unstable (or re-centering) null. If the coarse (1X) and fine (36X) control transformers were installed (adjusted to the same electrical zero as the electrical zero position of the compass transmitters), there would be a position of the coarse control transformer shaft 180° out of correspondence with the compass transmitter, at which the rotor volt ages of both the coarse and fine control transformers would again both equal zero. Thus, the coarse synchro system provides two null points in a complete cycle. Regarding the coarse control transformer (1XCT), it's null at the 180° point is an unstable null, because if the shaft were on either side of that point, by an infinitesimal angle, the servo would drive toward the correct null, 180° away. The fine synchro has 72 null positions or 36 times as many as the coarse synchro system. If only the fine control transformer (36XCT) were connected in the system, there would be 36 positions of the transmitter shaft that would produce a stable null error voltage. Only one of these 36 positions is desired, that position being the point where the 1XCT also provides a stable null.

The mixing network switches the fine error signal into the servoamplifier when the error is small (output of the coarse synchro is small) and introduces the coarse error signal to the amplifier when the error is large (output of the coarse synchro is large).

The coarse error signal can be small enough at the 180° point to result in the tine error signal being fed into the servo, through the action of the mixing network. If only the 1X error voltage were applied at the 180° point, the servo would drive away from this false null; but, because the 36X voltage has control, it drives the servo toward this 180° point. The 36X error voltage (negative between 175° and 180°) tends to drive the servo to an increased angle (180°). The 36X voltage is positive between 180° and 185°, and tends to drive the servo to a decreased angle (180°), the same point. In other words, if this condition were tolerated, the servo would lock in at a false null.

To remove this condition (false null), an anti-stick off voltage of 2.5 volts is obtained from a transformer in the amplifier unit and applied to the coarse error voltage. This voltage is applied either in phase or 180° out of phase with the 1X error voltage and is sufficient to shift the IX error signal null points 2.5°. The resultant voltage does not pass through the zero reference position of the 36XCT voltage. To restore the resultant voltage to the zero reference position, the 1XCT stator is shifted 2.5° in its housing. Thus, the resultant 1X error voltage is shifted a total of 5°, which corresponds to 180° rotation (36 x 1X) of the 36X synchro.

With anti-stick off bias, the false null at the 180° point cannot be attained by virtue of the 36X or 1X error signal on either side of this point, both being of such polarity as to drive in the same direction to the real null at zero degrees. The 36X error signal drives 2.5° toward the correct null and then the mixing network switching to the 1X error signal, which drives to 2.5° of the zero degree null position.

As the 2.5° point is reached, the mixing circuit automatically shifts the amplifier input signal from the 1X synchro to the 36X synchro. This signal, with amplifier output and motor torque reacting accordingly, is reduced as the servo approaches null. The final null position is reached at the point of minimum 36X synchro rotor voltage. Because these synchro voltages are very low, the amplifier output and motor torque are reduced substantially to zero.

Mixing networks and anti-stick off voltages are unnecessary in 1-speed systems. Although synchro voltage and thus motor torque go to zero at the 180° point, this point is an unstable (de-centering) null. If the servo approaches this false null with slight overshoot, the servo will not come to rest at the null. Instead, the servo will continue to rotate toward the true null, where it will come to final rest.

4.13.1 Features

- Ship's Course Indicators (SCI) function as remote repeaters to indicate the ship's heading or course-to-steer. These devices may be installed at any desired location on the ship and oriented at the location in any convenient direction.

- A number of types are available. Each is designated by a type number and by mark and modification numbers.

- Types A, B, E, F and M indicators are servo-driven. Types L and N are synchro-driven. A servo-driven version of Type L is available. Types G and H have a servo-driven course-to steer dial and a synchro-driven heading dial.

- All indicators receive synchro heading data from the ship' gyrocompass or other synchro transmitting equipment. The gyrocompass signals and the reference power from the ship's supply actuate the indicators to position graduated dials which show the ship's heading.

- There are two basic types: one-speed and two-speed (1X and 36X) units. Two-speed indicators provide greater accuracy because lX synchro only provides coarse control of the dial and the 36X synchro provides fine control.

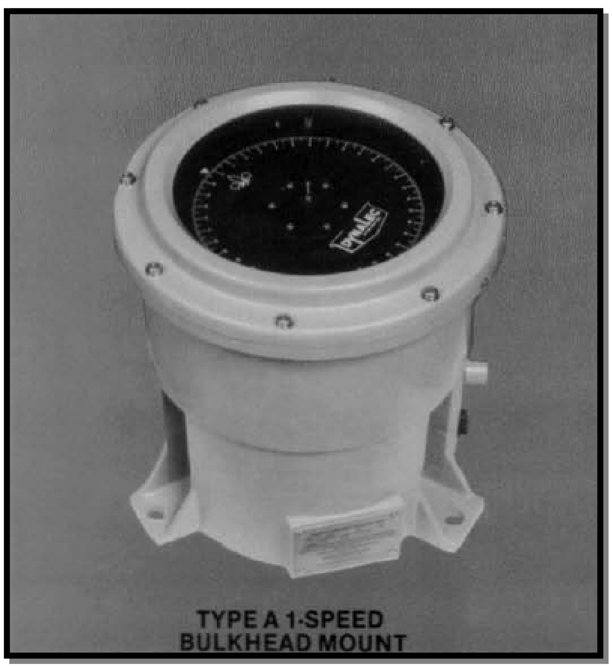


Figure 4-72.— Type A 1-Speed Bulkhead Mount.

- Types E and F may have two dials geared together 10 be read as a mechanical vernier. Types G and H have two independent concentric dials, one displaying ship's heading and the other dial displaying course-to-steer.

- Any SCI is available in either low or non-low noise variations. In the non-low noise variation, the servo and dial assembly mount directly to the cast housing. In the low-noise variation, the servo and dial mount on vibration isolators inside the cast housing.

- All types, except F and H, have integral dimmer rheostats for dial illumination control. Types F and H require a remote dimmer rheostat. Type l can be used with either an integral dimmer control or remote rheostat.

- Each Ship's Course Indicator is complete unit with facilities or mounting and for external electrical connections. (Figure 4-73).

Figure 4-73.— Ship's Course Indicator Types.

4.13.2 Indicator Types

TYPE A, Mark 3 Mod 6, is a400 Hz, one-speed single dial servo-driven Ship's Course Indicator. Available for bulkhead mounting.

TYPE B, Mark 2 Mod 6, is a 400 Hz, two-speed single dial SCI. Housing mounts in a gimbal which is supported by a bracket, mounted on a shelf or on a pelorus stand for bearing determination.

TYPE E, Mark 1 Mod 6, is a 400 Hz, two-speed vernier dial servo SCI for steering. Available for bulkhead mounting.

TYPE F, Mark 1 Mod 6A, is a 400 Hz, two-speed vernier dial servo SCI for steering. Housing mounts to the sub-plate of a console panel.

TYPE G, Mark 6 Mod 6, is a 60 *Hz,* one-speed dual dial unit. The outer dial contains only a solitary diamond-shaped mark which indicates course-to steer. It is driven through a servo. The inner dial indicates heading and is directly gear-driven by a receiver synchro. The drive mechanisms and dials mount as a single assembly inside the cast housing. The housing, in turn, mounts to a bulkhead.

TYPE H, Mark 6 Mod 6A, is identical to the Type G, except for the housing which mounts to the sub-plate of a control panel.

TYPE L, Mark 7 Mod 6, is a one-speed, single dial synchro motor-driven miniature SCI. Mod 6 is a400 Hz unit and Mod 6A is 60 Hz. The servo-driven Type L uses a special servo built into a standard BuOrd Size 23 configuration. It can be used on either60 or 400 Hz. Housing for all variations mounts either to a bulkhead or to a panel.

TYPE M, Mark 9 Mod 6, is a 400 Hz, one-speed, single dial servo SCI for bulkhead mounting. Its large dial makes it suitable for distant viewing.

4.13.3 Accessories

GIMBAL RING and BRACKET (SURFACE) PART 1878032 - provide mechanical mounting for Types Band N, usually on a Pelorus Stand.

PELORUS STAND PART 1675676 - is a deck mounting stand. It contains a terminal board which serves as a junction between ship's wiring and the SCI. A Gimbal Ring and Bracket can be bolted on top of the stand.

GIMBAL RING and BRACKET (SUBMARINES) PART 1880789 - provide for mounting of Type N SCI for use on submarines. The indicator and ring are quickly removable from the bracket; and the bracket is, in turn, removable from the mounting plate.

SINUOUS CLOCK ADAPTER RING PART 1677075 - provides for the use of a clock with Types E and F SCI's by replacing the bezel with an adapter ring.

PART	TYPE	MK	MOD	VOLTS	SERVO POWER	LIGHTS (WATTS)	FREQ	OVERALL SIZE			
								WIDTH	HEIGHT	DEPTH	WEIGHT (POUNDS)
1878094·1	A	3	6	115VAC	7	7	400Hz	10	10	10.75	22
1878091-1	B	2	6	115VAC	7	7	400Hz	10	10	10.75	28
1878089-1	E	1	6	115VAC	7	7	400Hz	10	10	10.875	24
1878088·1	F	1	6A	115VAC	7	7	400Hz	8.875	8.875	10.875	20
1878086·1	G	6	6	115VAC	8	7	60Hz	10	10	10.875	32
1878085·1	H	6	6A	115VAC	8	7	60Hz	8.875	8.875	10.875	30
1878158·1	L	7	6	115VAC	4	6	400Hz	6	6	6	9
1878158-2a	L	7	6A	115VAC	4	6	60Hz	6	6	6	9
1878158·2b	L	-	-	115VAC	6	6	60/400Hz	6	6	6	9
1880160·1	M	9	6	115VAC	7	4	400Hz	15.5625	16.5625	10.4375	33
1880787	N	10	6	115VAC	4	7	400Hz	10	10	7.5	13

Table 4-31.— Part Numbers, Power Requirements, and Physical Characteristics.

4.13.4 Mounting Information

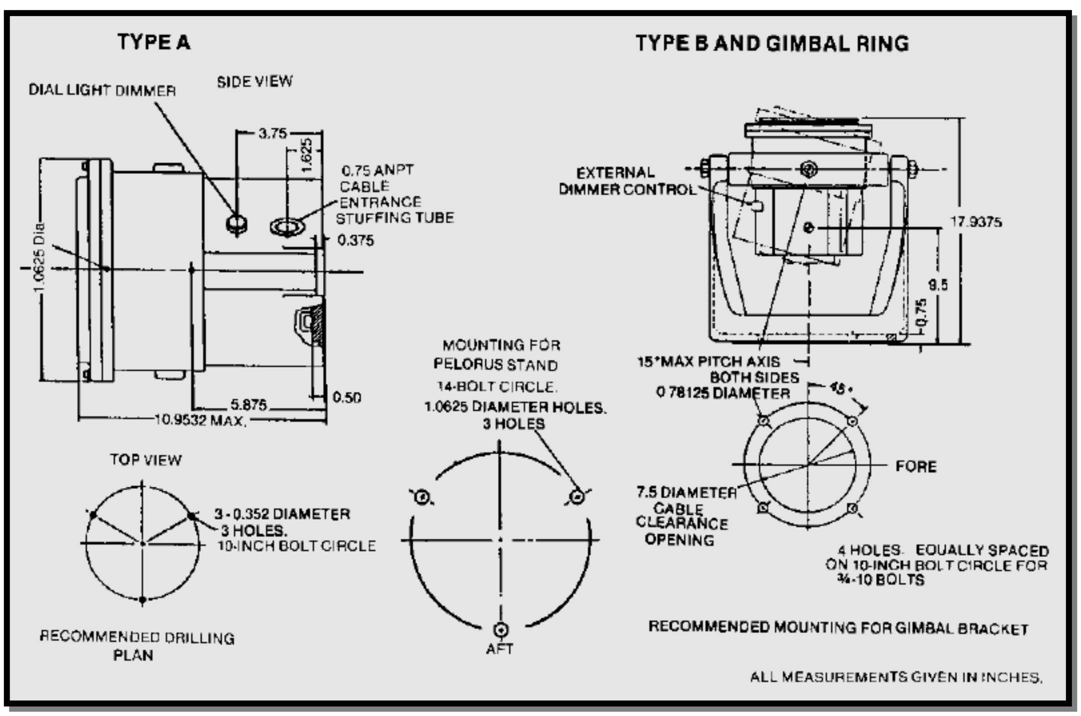


Figure 4-74.— Recommended Mounting Information.

4.14.0 DIGITAL INDICATORS

Figure 4-75.— Integrated Digital Indicator Panel.

4.14.1 Features

- Microprocessor-controlled unit.
- Operates on 115VAC, 60Hz input power via MS3406DJ14S-2S connector.
- 2 simultaneous interfaces and decoding data independently for each indicator). Interfaces with shipboard DMS system's RS-422 interface via MS3406DJ18-1S data connector (capable of supporting 2 simultaneous interfaces and decoding data independently for each indicator).
- Separate adjustable panel (dial and legends) and digital display dimmer controls (dimmable to a full off position).

- "TEST" button to test digital display segments and zero-reading indication.
- Electro-mechanically driven analog dial.
- Available in Single, Dual, and Quad configurations (see Related Equipment List below). (Table 4-32).

AVAILABLE CONFIGURATIONS	
DESCRIPTION	**PART NUMBER**
Single Dual Rudder Angle Indicator	62416-000
Single Wind Speed and Wind Direction Indicator	62416-100
Single Ship's Course and Ship's Speed Indicator	62416-300
Dual Ship's Course/Speed & Wind Speed/Direction Panel	62416-400
Dual Ship's Course/Speed & Dual Rudder Angle Panel	62416-500
Dual Speed/RPM/Pitch & Dual Rudder Panel	62416-600
Quad Indicator Panel (includes the following:)	62416-700
• Ship's Course and Ship's Speed Indicator • Dual Rudder Angle Indicator • Wind Speed and Wind Direction Indicator • Ship's Speed, Dual RPM, and Dual Pitch Indicator	
ELECTRICAL CHARACTERISTICS	
CONTROL UNIT:	
INPUT POWER	115 VAC, 60Hz, Single Phase
HEAT DISSIPATION	51 BTU/HR, max (15 Watts)
ENVIRONMENTAL CHARACTERISTICS	
OPERATING TEMPERATURE	-20 Degrees C TO 65 Degrees C
HUMIDITY	95% RH, Maximum
WATERTIGHT	MIL-STD-810E, SECT 512, METHOD 512.3
SHOCK	MIL-S-901C
VIBRATION	MIL-STD-167-1
EMI	MIL-STD-461C

Table 4-32.— Digital Indicator Configurations.

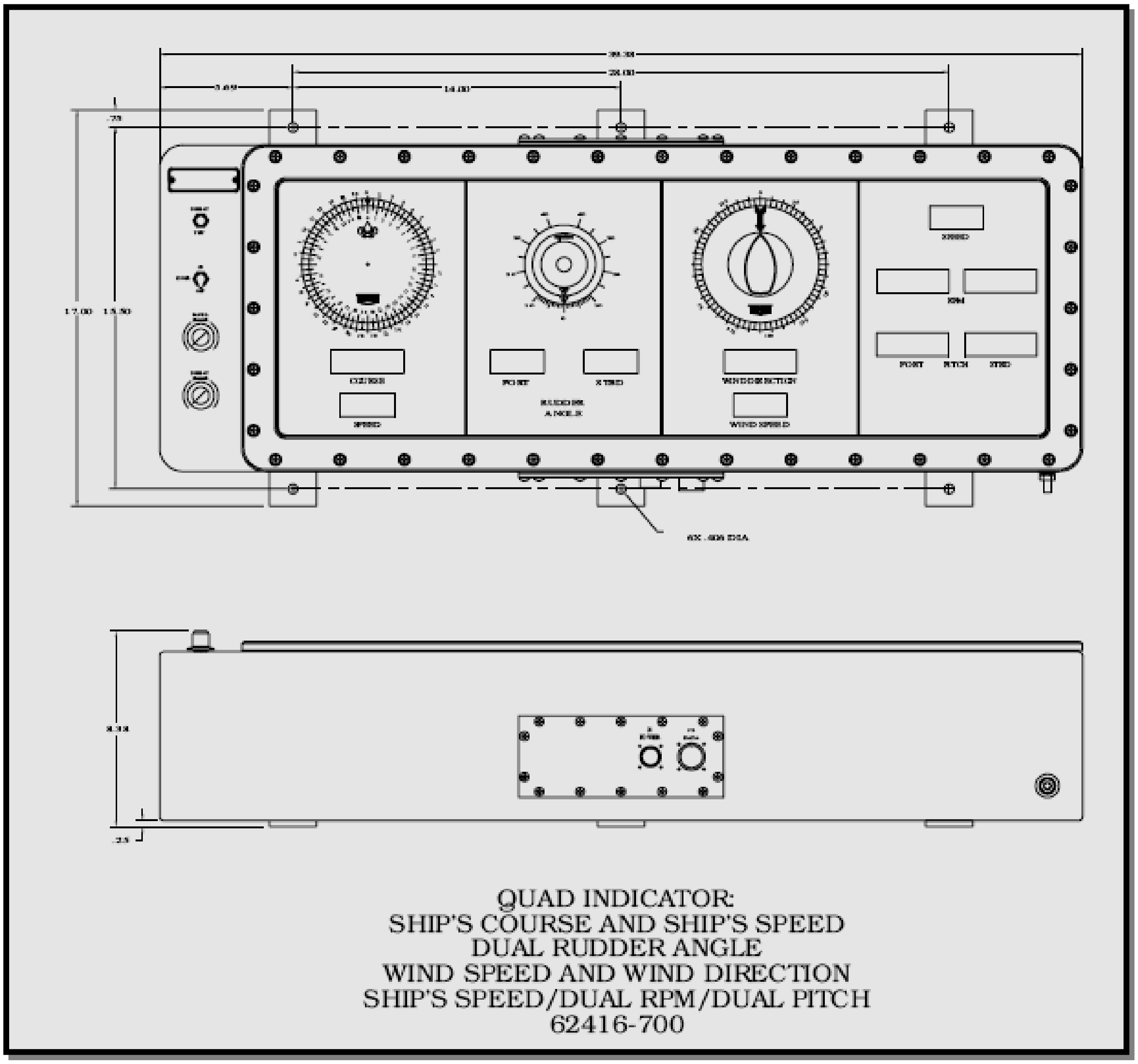


Figure 4-76.— Quad Indicator.

4.15.0 SUMMARY

In this chapter, we have discussed basic gyroscopic principles and the making of the gyroscope into a gyrocompass. We have identified and discussed the major components of some of the most common gyrocompass systems installed on board Navy ships today and described the procedures for starting, standing watch on, and securing these gyrocompasses. We have also described the purpose of the synchro signal amplifiers and ship's course indicators used with the various gyrocompass systems.

5 SOUND-POWERED TELEPHONE SYSTEM

Upon completion of this chapter, you will be able to do the following:

- Describe the purpose of the sound-powered telephone system installed on Navy ships.
- Identify the sound-powered telephone circuits, as to type and classification.
- Describe the proper procedures for paralleling sound-powered telephone circuits.
- Describe the X40J casualty communication circuit.
- Describe the phone/distance and station-to-station lines used during replenishment at sea.
- Describe the preventive maintenance procedures for sound-powered telephone circuits.
- Identify the equipment used with the sound-powered telephone system, to include handsets, headset-chestsets, sound-powered amplifiers, amplifier control switches, circuit selector switches, soundproof booths, and the plotters transfer switchboard.
- Explain how to operate and maintain the equipment used with the sound-powered telephone system.
- Identify the call and signal circuits and associated equipment used with the sound-powered telephone system.
- Describe the AN/WTC-2(V) sound-powered telephone system, including identification and operation of the major units used with the system.

5.0.0 INTRODUCTION

The sound-powered telephone system provides the most reliable means of voice communication within a ship. The sound-powered telephone system is used aboard ship for two-way voice communication between various sound-powered telephone stations. The system provides a rapid means of transmitting and receiving verbal orders and information. The system is easy to maintain and is not easily susceptible to damage during battle. The system includes sound-powered telephone circuits, sound-powered telephone equipment, and sound-powered call and signal circuits. As an IC Electrician third class, you will indoctrinate personnel in the uses and capabilities of the sound-powered telephone system. This chapter will be an aid in that indoctrination. Table 5-1 is a glossary of terms for the sound-powered telephone system. The *Sound-Powered Telephone Talkers Manual*, NAVEDTRA 14005-A, contains the proper operating procedures for sound-powered handsets and headset-chestsets.

GLOSSARY OF TERMS	
BUS	The common connection between a group of line cutout switches. It may be in a single section or divided; it maybe connected to a jack outlet or be free.
CIRCUIT	A quantity of telephone jackboxes connected by one or more lines, either directly or through switchboards and switchboxes, to provide a means of communication between personnel at various stations.
JACKBOX	A weatherproof enclosure mounted in any convenient location and connected to a sound-powered telephone line. Jackboxes can be single-gang, double-gang, or four-gang types. Gang is a term used for the number of jack outlets in the jackbox.
JACKPLUG	The plug connected to the end of the cable on a sound-powered telephone headset-chestset. When plugged into a jackbox, it connects the set to a sound-powered telephone circuit.
LINE	The smallest portion of a circuit that can be electrically isolated by operation of switches at a central point. For example, in the switchboard or switchbox types of circuits, a line is the pair of wires between the line cutout switch on a switchboard (or switchbox) and a telephone jackbox; in string circuits, a line is a pair of wires interconnecting the various jackboxes in the circuit.
PARALLELING	Cross connecting two or more sound-powered circuits.
STATION	The location of a jackbox where a sound-powered telephone operator mans a sound-powered telephone.
TIE LINE	A line between two switchboards, two switchboxes, or a switchboard and a switchbox. It connects two circuits and is terminated by a switch at each end.
TIE SWITCH	A switch at one end of a tie line, usually the end connected to an auxiliary circuit. It is normally open unless the ship's doctrine requires that it be closed.
TIE PLUS SWITCH	A normally closed switch at the opposite end of a tie line from the tie switch. It may be opened to clear a damaged circuit.

Table 5-1.—Glossary of Terms

5.1.1 S/P TELEPHONE TALKER PROCEDURES

The purpose of having standard sound-powered telephone procedures is to provide uniformity of expression, enabling messages to be understood more clearly over the phones. In every CIC in the fleet, day in and day out, IC Electricians deal over and over with the same type of information. Personnel can handle information with speed, accuracy, and reliability when they have a system that is simple, easily understood, and readily usable. They can then place every transmission into a brief and clear form that will be understood instantly and is ready for use when received.

A system that satisfies these requirements is the standard sound-powered-telephone procedure and phraseology. The system is simple. Speed is not achieved by transmitting rapidly and biting off words or running them together. Speed is gained by using standard procedure and terminology with every transmission.

5.1.2 GENERAL RULES

The following is a list of some general rules for sound-powered-phone talkers.

1. Be alert. Pay attention to what is said over the phones. If possible, maintain a written log of the activities of other stations on the circuit. Pay attention to the officer or petty officer in charge of the station.
2. Repeat or relay all messages <u>word for word</u>. **DO <u>NOT</u> REPHRASE ANY MESSAGE**. Changing a single word may change the meaning of the entire message.
3. Do not engage in idle conversation on the phone. Keep your mind on your assigned duty.
4. Speak into the transmitter in a loud, clear tone; do not shout or whisper. Shouting results in mushy, slurred noises. A whisper cannot be heard. Speak distinctly. Pronounce every syllable. Restrict your dialect or accent.
5. When using a headset, hold the button down when talking, but do not touch it when listening. When using a handset, hold the button down both to speak and listen.
6. Hold the headset transmitter about 1/2 inch from your mouth when talking.
7. Do not use alphabetic letters as references. This practice can lead to confusion and errors that may result in a considerable loss of time and can prevent needed action that might have been taken had the message been received correctly. Use words in the phonetic alphabet, such as **ALFA, GOLF, PAPA,** and **XRAY**.
8. To be an important member of any team, you must become familiar with all the duties of the team.

As an IC Electrician, strive to be the best talkers on the circuit.

5.1.3 Basic Message Format

The basic format for transmitting a message by sound-powered telephone consists of the standard shipboard names for the station called and the station calling, followed by the text (what is to be said) in clear, concise language. In the example below, Combat is passing information about a surface contact to the bridge.

Message from Combat: “Bridge, Combat. Surface contact—TOO SIX ZE-RO—TWEN-TY TOW-ZAND

Response from the bridge: “Bridge—Aye, Aye “

NOTE:
Do not call a station and wait for word to go ahead. Every time you have information to transmit, call the station(s) concerned, identify your station, and send the message. If you do not get a response, repeat your message.

5.1.4 S/P Phraseology

If all called stations could receive and entirely understand every transmission on the first transmission, there would be no need for anything more than the procedure mentioned above. Unfortunately, not all transmissions are received perfectly. Operators sometimes make errors during transmissions; communication is difficult at times. To help prevent errors, standardized words or phrases come in handy. Using them helps eliminate transmission errors and misunderstandings. Some of the common terms and their meaning follow.

SILENCE ON THE LINE—Use this term only in emergencies. When a transmission in progress on the circuit is interrupted by a message of extreme importance, the person on the circuit must cease talking to permit the cut-in to send the important message.

AYE, AYE — Use this standard response to all transmissions you receive completely. It means “I have received all of your transmission and will deliver it exactly as received.” Never use this response if you are uncertain that you received all of the transmission. Also, do NOT use it simply as an affirmative answer to a question. After you give an AYE, AYE to a message, either use the information the message contains if you are the “action” addressee or pass the message on to the person responsible for taking action.

SAY AGAIN—With this term, you signify that you did not receive the message. The proper response to the term by the sender is a complete retransmission of the message.

CHANGING PHONES; BACK ON THE LINE — Use the term CHANGING PHONES when you remove the telephone headset to give it to another talker. CHANGING PHONES signifies that your station will temporarily be unable to receive messages. The new talker should report BACK ON THE LINE when he or she is ready to resume normal operations. This process should take very little time to complete.

CORRECTION — The word CORRECTION preceded and followed by a pause during a transmission indicates that the sender made an error and is correcting it. Examples of errors are a mispronounced word, an omitted word or phrase in the text, or the incorrect information. If you make an error, make the correction to the message clearly and distinctly. To correct an error, pause, speak the word CORRECTION, pause, retransmit the last word or phrase that you transmitted correctly, transmit the corrected word or phrase, and then transmit the rest of the message. This procedure is particularly important when you are transmitting a series of numerals.

REPEAT BACK — When you want to be sure the receiving talker has understood your message correctly you may ask him or her to repeat it back to you by saying “Repeat back.”

THAT IS CORRECT (or WRONG) — If you direct another talker to REPEAT BACK a message that you send, you must acknowledge the repeat with either THAT IS CORRECT (or WRONG) —do not use the phrase AYE, AYE.

a. Say “THAT IS CORRECT” if the receiver repeats the message correctly.

b. Say “WRONG” if the receiver repeats the message incorrectly. Then give the correction.

BELAY MY LAST — Sometimes, as you are transmitting a message, but before you complete the transmission, you may realize that you made an error that you can correct only by stating the message over. Or, you may realize that you shouldn’t have sent the message. In such instances, use the phrase BELAY MY LAST. Do not use this phrase to cancel a message that you have completely transmitted and had receipted.

WAIT—Use the word WAIT when you need to make a pause of short duration (several seconds) during a transmission. You can also use it when someone requests information that you do not have immediately available.

5.1.5 Numeral Pronunciation

Although it is impossible to completely standardize the phraseology used in the text of a sound-powered-telephone message, numerals can be and are standardized. You should learn from the beginning to treat numerals with the care they deserve.

Personnel cannot afford to make errors in the information they handle, because in many instances it is vital to ship control. Numerical errors when passed on to the command, could prove disastrous in wartime. Even in peacetime, numerical errors on tactical maneuvering or navigational data may cause a disaster.

For an example of how numerals can be misunderstood, say the following numbers aloud: 7, 11, 17, 70 (seven, eleven, seventeen, seventy). Notice that the sounds are similar. If they are slurred or are pronounced indistinctly, there is room for error. A carelessly pronounced “seventeen” may sound like “seventy”. If range (in miles) is the subject, mistaking “seventeen” for “seventy” will introduce an error of 53 miles. You can avoid making such an error by following the well-established communications rules listed below.

5.1.5.1Basic Digits

Ten basic digits make up the numerical system. Each digit must be pronounced distinctly so that it will be understood. Learn to pronounce them as they are written in the accompanying list.

Number Spoken as	Number Spoken as
0 ZE-RO	5 FIFE
1 WUN	6 SIX
2 TOO	7 SEV-EN
3 TREE	8 AIT
4 FOW-ER	9 NIN-ER

5.1.5.2 Rules for Pronouncing Numerals

If the basic digits were the only consideration in using numerals, there would be little problem. Unfortunately, numerals may form an indefinite number of combinations, and the combinations may be spoken in several different ways.

The following rules apply to the pronunciation and expression of numerals. Situations may arise, however, in which these rules are inapplicable. In these cases, try the pronunciation and expression that best fit the situation.

- Always speak the numeral 0 (written ø) as ZE-RO, never as *oh.*
- Speak decimal points as DAY SEE MAL.

5.2.0 SOUND-POWERED TELEPHONE CIRCUITS

The sound-powered telephone system consists of individual sound-powered telephone circuits, each of which operates without any external source of electrical power. The number of particular circuits installed on each individual ship depends on the operational requirements of the ship.

5.2.1 Types of Circuits

There are three types of sound-powered telephone circuits: switchboard, switchbox, and string.

Switchboard Circuit

A switchboard circuit originates from a sound-powered telephone switchboard. Figure 5-1, view A, is an illustration of a type IC/A sound-powered telephone switchboard. Figure 5-1, view B, shows a section from the sound-powered telephone switchboard. Each telephone station jackbox (fig. 5-2) in the circuit is connected to a switchjack on the switchboard. The switchjack (fig. 5-3) is a combination line cutout switch and telephone jack.

The line cutout switch portion of the switchjack either connects or disconnects a telephone station jackbox from its circuit. The jack portion of the switchjack either parallels the telephone station associated with a particular switchjack to another circuit or parallels two entire circuits. This method of paralleling is accomplished by a patching cord. A patching cord is a short length of portable cord having a jackplug at each end. The lines and tie switches are also installed to allow paralleling with circuits on other switchboards or switchboxes.

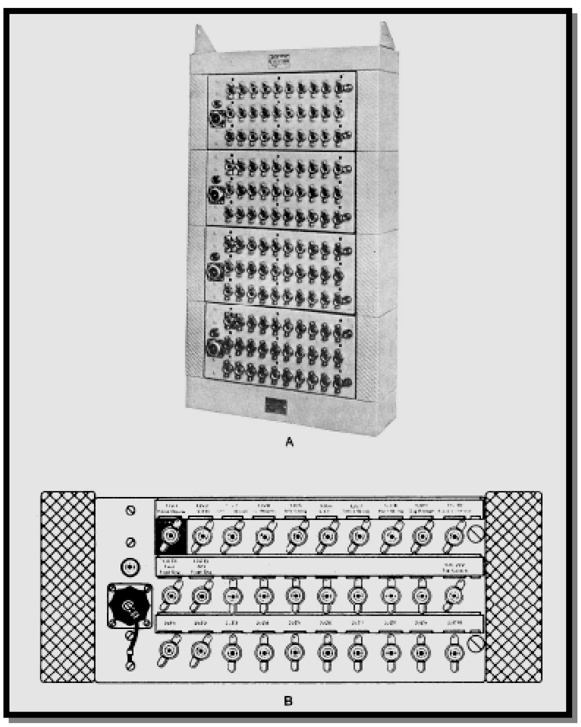


Figure 5-1.—Type IC/A sound-powered telephone switchboard.

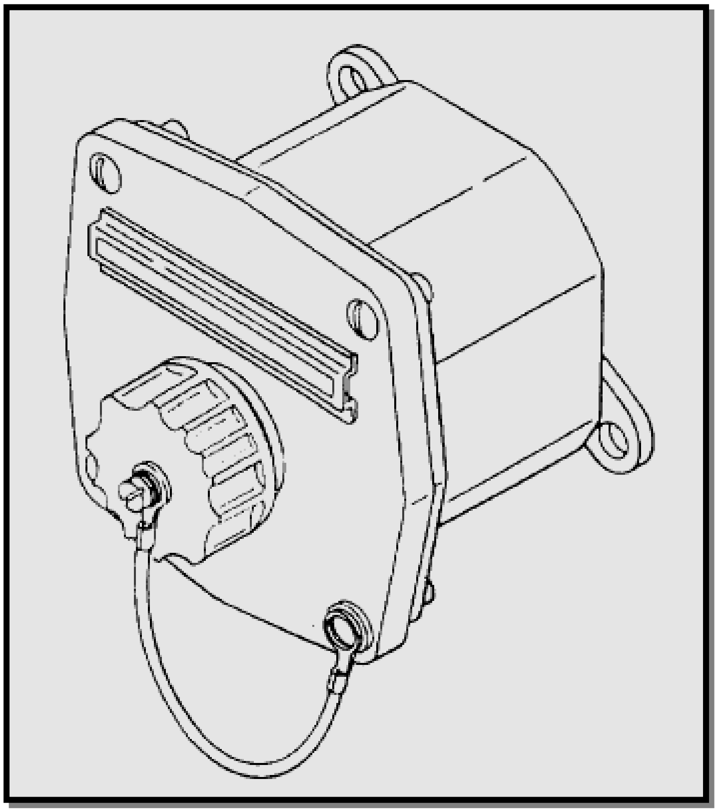


Figure 5-2.—Single-gang sound-powered telephone jackbox.

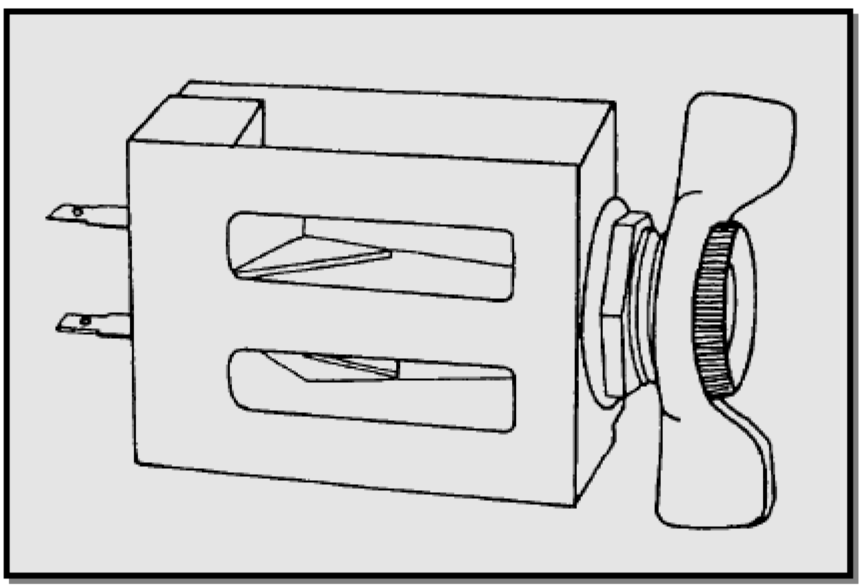


Figure 5-3.—A switchjack.

Most large combatant ships have several sound-powered telephone switchboards installed in different centrally located and protected control stations. Each switchboard facilitates and controls several sound-powered telephone circuits.

Switchbox Circuit

A switchbox circuit originates from a sound-powered switchbox. Figure 5-4 is an illustration of a type A-17A sound-powered telephone switchbox. Each telephone station jackbox in the circuit connects to a line cutout switch in the switchbox. The line cutout switch either connects or disconnects an individual telephone station jackbox from its circuit. There are also tie lines and tie switches installed to allow paralleling with circuits in other switchboxes or switchboards.

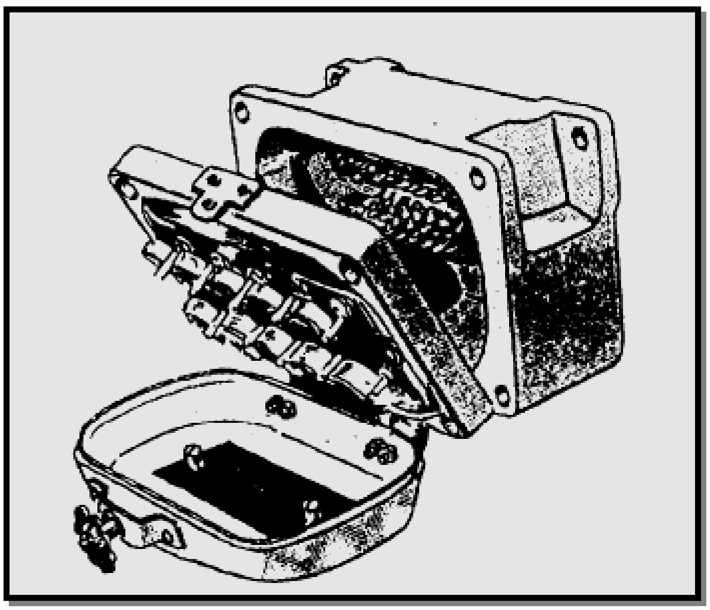


Figure 5-4—-Sound-powered telephone switchbox.

Switchboxes contain either 10 or 20 switches and function primarily as small action cutout (ACO) switchboards. Switchboxes are normally located at the station having operational control over the circuit or circuits concerned. Usually, there is only one circuit in a switchbox.

String Circuit

A string circuit consists of a series of telephone station jackboxes connected in parallel to a common line. There are no line cutout switches provided for cutting out individual stations. However, some string circuits are connected to communication consoles, selector switches, and plotter transfer switchboards. These will be discussed later in this chapter.

5.2.2 Classification of Circuits

Sound-powered telephone circuits are classified to their usage. Circuits are classified as primary, auxiliary, or supplementary. Table 5-2 is a list of all sound-powered telephone circuits used on Navy ships.

Primary Circuits

Primary circuits provide communication for as primary control and operating functions associated with ship control, weapons control, aircraft control, engineering control, and damage control. Primary circuits are designated JA through JZ.

Auxiliary Circuits

Auxiliary circuits duplicate certain principal primary circuits as an alternate means of communication in case of damage to the primary circuit. The wiring of the auxiliary circuits is separated as much as practicable from the wiring of the corresponding primary circuits to lessen the possibility of damage to both circuits. Auxiliary circuits are designated XJA through XJZ.

Supplementary Circuits

Supplementary circuits provide the means of communication for various subordinate control, operating, and service functions. Supplementary circuits are designated X1J through X61J and are normally string circuits.

PRIMARY CIRCUITS

Circuit	Title
JA	Captain' battle circuit
JC	Weapon's control circuit
10JC	Missile battery control circuit
JD	Target detectors circuit
JF	Flag officer's circuit
1JG	Aircraft control circuit
2JG	Aircraft information circuit
2JG1	Aircraft strike coordination circuit
2JG2	Aircraft strike requirement and reporting circuit
2JG3	Aircraft information circuit CATTCC direct line
3JG	Aircraft service circuit
4JG1	Aviation fuel and vehicular control circuit
4JG2	Aviation fueling circuit forward
4JG3	Aviation fueling circuit aft
5JG1	Aviation ordnance circuit
5JG2	Aviation missile circuit
6JG	Arresting gear and barricade control circuit
9JG	Aircraft handling circuit
10JG	Airborne aircraft information
11JG	Optical landing system control circuit
JH	Switchboard cross-connecting circuit
JL	Lookouts circuits
JK	Double-purpose fuse circuit
JM	Mine control circuit
JN	Illumination control circuit
JO	Switchboard operators' circuit
2JP	Dual-purpose battery control circuit
4JP	Heavy machine gun control circuit
5JP	Light machine gun control circuit
6JP	Torpedo control circuit
8JP	ASW weapon control circuit
9JP	Rocket battery control circuit
10JP	Guided missile launcher control circuit
10JP1	Starboard launcher circuit
10JP2	Port launcher circuit
11JP	FBM checkout and control circuit
JQ	Double-purpose sight setters circuit

PRIMARY CIRCUITS

Circuit	Title
JR	Debarkation control circuit
JS	Plotters' transfer switchboard circuit
1JS	CIC information circuit
2JS	NTDS coordinating circuit No. 1
3JS	NTDS coordinating circuit No. 2
20JS1	Evaluated radar information circuit
20JS2	Evaluator's circuit
20JS3	Radar control officer's circuit
20JS4	Weapons liaison officer's circuit
21JS	Surface search radar circuit
22JS	Long range air search radar circuit
23JS	Medium range air search radar circuit
24JS	Range height finder radar circuit
25JS	AEW radar circuit
26JS	Radar information circuit
31JS	Trank analyzer No. 1 air radar information check
32JS	Trank analyzer No. 2 air radar information check
33JS	Trank analyzer No. 3 air radar information check
34JS	Trank analyzer No. 4 air radar information check
35JS	Raid air radar information circuit
36JS	Combat air patrol air radar information circuit
61JS	Sonar information circuit
80JS	ECM plotter's circuit
81JS	EMC information circuit
82JS	Supplementary radio circuit
JT	Target designation control circuit
1JV	Maneuvering and docking circuit
2JV	Engineer's circuit (engines)
3JV	Engineer's circuit (boiler)
4JV	Engineer's circuit (fuel and stability)
5JV	Engineer's circuit (electrical)
6JV	Ballast control circuit
11JV	Waste control circuit
JW	Ship control bearing circuit
JX	Radio and signals circuit

Table 5-2.—Sound-Powered Telephone Circuits

PRIMARY CIRCUITS - CONTINUED	
Circuit	**Title**
2JZ	Damage and stability control
3JZ	Main deck repair circuit
4JZ	Forward repair circuit
5JZ	After repair circuit
6JZ	Midship repair circuit
7JZ	Engineer’s repair circuit
8JZ	Flight deck repair circuit
9JZ	Magazine sprinkling and ordnance repair circuit forward
10JZ	Magazine sprinkling and ordnance repair circuit aft
11JZ	Gallery deck and island repair circuit
	Auxiliary Circuits
XJA	Auxiliary captain’s battle circuit
X1JG	Auxiliary aircraft control circuit
X1JV	Auxiliary maneuvering and docking circuit
XJX	Auxiliary radio and signal circuit
X2JZ	Auxiliary damage and stability control circuit
	Supplementary Circuits
X1J	Ship administration circuit
X2J	Leadsman and anchor control circuit
X3J	Engineer watch officer’s circuit
X4J	Degaussing control circuit
X5J	Machinery room control circuit
X6J1	Electronic service circuit
X6J7	ECM service circuit
X7J	Radiosonde information circuit
X8J	Replenishment-at-sea circuit
X9J	Radar trainer circuit

SUPPLEMENTARY CIRCUITS - CONTINUED	
Circuit	**Title**
X10J	Cargo transfer control circuit
X10J1	Cargo transfer circuit–low decks
X10J10	Cargo transfer circuit–upper decks
X11J	Captain’s and admiral’s cruising circuit
X12J	Capstan control circuit
X13J	Aircraft crane control circuits
X14J	Missile handling and nuclear trunk crane circuit
X15J	SINS information circuit
X16J	Aircraft elevator circuit
X17J	5-inch ammunition hoist circuit
X18J	Machine gun ammunition hoist circuit
X19J	Missile component elevator circuit
X20J	Weapons elevator circuit
X21J	Catapult circuit
X22J	Catapult steam control circuit
X23J	Stores conveyor circuit
X24J	Cargo elevator circuit
X25J	Sonar service circuit
X26J	Jet engine test circuit
X28J	Dumbwaiter circuit
X29J	Timing and recording circuit
X34J	Alignment cart service circuit
X40J	Casualty communication circuit
X41J	Special weapons shop service circuit
X42J	Missile assembly and handling circuit
X43J	Weapons system service circuit
X44J	ASROC service circuit
X45J	Special weapons security circuit
X50J	Fog foam circuit
X61J	Nuclear support facilities operations and handling

Table 5-2(Cont’d).—Sound-Powered Telephone Circuits

5.2.3 Paralleling of Circuits

When two or more circuits are tied together, the result is to parallel as many sound-powered telephones as there are manned stations.

All primary circuits are provided with a tie line between their respective switchboard or switchbox for cross-connection with their auxiliary circuits. The tie lines are fitted with a tie switch at one end and a tie + (tie plus) switch at the other end. The tie switch is normally open and is closed only to parallel two circuits. The tie + switch is normally closed and is opened only in the event of casualty, to disconnect the defective circuit or tie line.

When the patch cord method of paralleling is used, the following conditions may be obtained:

1. When the line cutout switches of both lines are open, the two lines will be connected together, but will not be tied in with any other station of either circuit. Figure 5-5 is an illustration of line cutout switches in the open and closed positions.

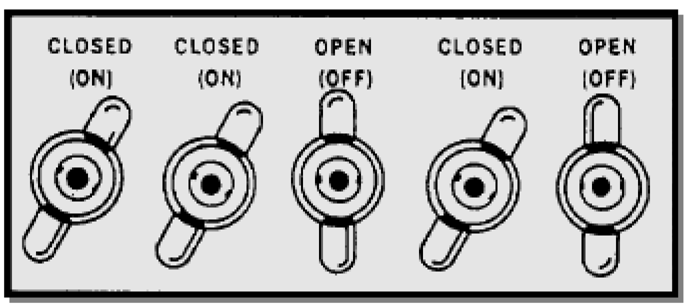


Figure 5-5.—Line cutout switches in the open and closed positions.

2. When the line cutout switch of only one line is closed, the two lines will be tied together and also connected to the other stations on the circuit of which the line cutout switch is closed.

3. When the line cutout switches of both lines are closed, all lines of the two circuits will be tied together.

Thus, by manipulating patch cords and individual line cutout switches, you can connect any pair of lines together and any line to any circuit or combination of circuits on the switchboard.

Circuits connected to switches on the communication consoles in the combat information center (CIC) may also be paralleled by the console operators.

In an extensive sound-powered telephone system, paralleling of circuits has both advantages and disadvantages. One advantage is that it allows a controlling station to extend supervision over several different stations, using fewer talkers. Another advantage is that if communications is lost to one of the primary stations, the talker can easily reestablish communications with the control station by unplugging the headset from the primary jackbox and plugging it into the auxiliary jackbox.

One disadvantage of paralleling circuits is overloading transmitters. Each sound-powered telephone receiver unit consumes electrical energy when converting transmitted electrical signals to audible signals. As receiver units are added, the demand for electrical energy may exceed the capability of the transmitter unit, resulting in the transmitter becoming overloaded. An overload condition reduces the input electrical energy available to each receiver unit, with a corresponding reduction in receiver output volume. The reduced audio output may render the circuit ineffective. The number of receivers it takes to overload a circuit varies; therefore, the controlling station should be alert to garbled messages or frequent requests for repeats, indicating the circuit is overloaded.

A second disadvantage of paralleling circuits is that as the number of stations on a circuit increases, conversations may increase, resulting in confusion. This can be remedied by all stations exercising good circuit discipline.

Under normal operating conditions, circuits are usually paralleled to reduce the number of talkers required. As conditions of greater readiness are set, more talkers are assigned and fewer circuits are paralleled. Few, if any, primary circuits are paralleled under the highest condition of readiness.

5.2.4 Casualty Communications

Circuit X40J is designated the casualty communication circuit. This supplementary string circuit provides a means of rigging emergency communication lines between vital stations after a casualty has occurred. This circuit applies to combatant ships and auxiliary ships, 200 feet and over in length, fitted with weapons.

Permanent vertical riser cables are installed between single telephone jackboxes located port and starboard in vital below-deck stations and corresponding four-gang jackboxes located port and starboard on the first weather deck directly above each below-deck station (hangar deck on aircraft carriers).

Each single jackbox installed in the below-deck stations contains a nameplate that indicates the circuit identification X40J. Below-deck stations include steering gear rooms, engine rooms, emergency generator rooms, central control stations, firerooms, auxiliary machinery rooms, and IC rooms.

The jackbox outlets in each four-gang jackbox are connected in parallel, and each box contains a nameplate that identifies the associated below-deck station and circuit identification X40J.

On aircraft carriers, four-gang jackboxes are installed port and starboard on the forward and after sides at each hangar division door. The respective forward and after jackboxes are permanently connected and are used to facilitate patching when the doors are closed.

Each repair party locker on the ship is equipped with four 200-foot lengths of type MRID-1 (commonly called salt and pepper) portable cable. Each cable has a telephone jackplug fitted at both ends and is stowed on a reel. Each repair locker also contains two sound-powered telephone headset-chestsets and eight double-gang jackboxes (with jackbox outlets connected in parallel).

Some ships have portable cables with jackbox outlets built into the cable ends. On these ships, the eight double-gang jackboxes are not provided in each repair locker.

If normal sound-powered telephone service is disrupted, the permanently installed jackboxes and risers, portable patching cables, jackboxes, and headset-chestsets maybe used to connect the casualty communication circuit over a wide variety of routes to suit any casualty condition that may occur.

5.2.5 Phone/Distance and Station-to-Station Lines

IC Electricians are responsible for maintaining the sound-powered telephone portion of the bridge-to-bridge phone/distance and station-to-station lines. The lines are made of 1 1/2-inch round, 3-strand, lightweight polypropylene. Each strand of the line has one electrical wire interwoven in it. Sound-powered telephone jackboxes are attached to both ends of each line; the boxes are labeled either BRIDGE-TOBRIDGE or STA.-TO-STA.

The bridge-to-bridge phone/distance line is used between the delivery and receiving ships for ship-to-ship coordination during replenishment-at-sea operations. The line is made up and kept by the ship’s deck division. Distance markers are attached to the line at 20-foot intervals.

These markers consist of colored cloth squares for daytime use and red flashlights for nighttime use.

The station-to-station line is used for communications between the delivery and receiving cargo transfer stations on each ship. This line is also made up and kept by the ship's deck division. The line is identical to the bridge-to-bridge line, except it doesn't have any distance markers attached to it.

After the ship's deck division makes up a new line, the IC Electricians make the sound-powered telephone connections, which must be as secure as possible and watertight.

5.2.6 Maintenance of Circuits

Preventive maintenance for sound-powered telephone circuits consists of routine tests, inspections, and cleaning, which should be conducted according to current PMS requirements. Cleanliness is essential to the proper operation of sound-powered equipment because of the low voltages and currents involved. Dirt and dust between closely spaced contacts in the sound-powered switchboards and switchboxes can cause cross talk.

When conducting insulation tests on sound-powered circuits, open all tie switches connected to the circuit. Close all line cutout switches on associated switchboards or switchboxes. Disconnect all sound-powered telephone headsets from the circuit. Be sure the push button on all handsets connected to the circuit are open. Remove all sound-powered telephone amplifiers associated with the circuit from their cases.

Insulation tests should be made using an approved megohmmeter. You should measure from each conductor to ground and between each pair of conductors. Each reading should be a minimum of 50,000 ohms of resistance; lower readings indicate a potential source of failure. Short cable runs should have a minimum resistance well above 50,000 ohms. A separate insulation test should be made for each circuit.

5.3.0 SOUND-POWERED TELEPHONE EQUIPMENT

In addition to switchboards, switchboxes, and jackboxes, sound-powered telephone equipment includes telephone handsets and headset-chestsets, telephone amplifiers, amplifier control switches, selector switches, soundproof booths, and a plotter's transfer switchboard.

5.3.1 Sound-powered Telephone Handsets and Headset-Chestsets

The sound-powered telephone system is comparatively reliable because external electrical power is not required. The sound waves produced by the transmitter's (talker's) voice is the only energy necessary for the reproduction of the voice at the receiver's telephone. The acoustic energy of the talker's voice is converted into electrical energy in the sound-powered telephone transmitter unit and transmitted, via connecting wires, to the receiving sound-powered telephone. The receiving sound-powered telephone receiver unit reconverts the electrical energy into acoustic energy. The types of sound-powered telephones used in the sound-powered system are the handset and the headset-chestset.

Sound-Powered Handsets

Sound-powered telephone handsets are designed for general use on a line with other handsets or headset-chestsets. Figure 5-6 is an illustration of a type H-203/U sound-powered telephone handset and handset holder. This type of handset has a non-kinking retractable cord. Another type of handset is the H-203/U (modified). This handset is identical to the type H-203/U except that the handset cord is straight and contains no less than two conductors in a single shield. The H-203/U (modified) is modified to meet security requirements of the ship's communication center.

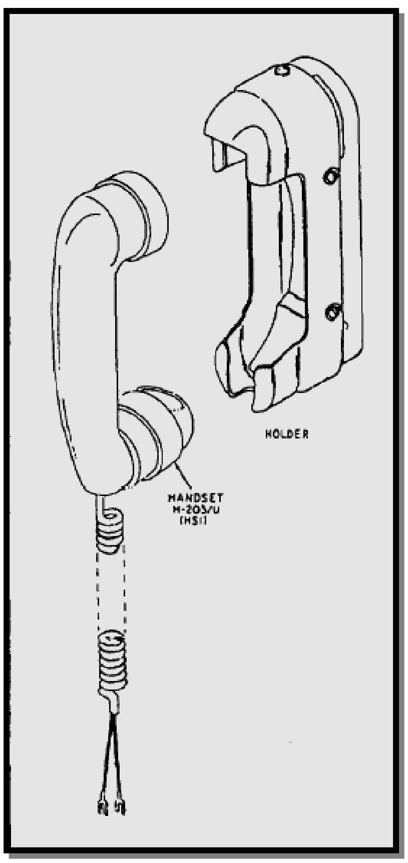


Figure 5-6.—The H-203/U sound-powered telephone handset

Sound-powered handsets are hard-wired into sound-powered jackboxes, selector switches, and magneto call stations. For stowage of the handsets, handset holders are installed in enclosed spaces, and handset stowage cabinets are installed at stations exposed to the weather.

Figure 5-7 is a wiring diagram of a type H-203/U sound-powered telephone handset. The non-locking, normally open, spring return, push switch, S1, disconnects the sound-powered transmitter and receiver units from the line in the open position, and connects the units to the line in the closed (depressed) position.

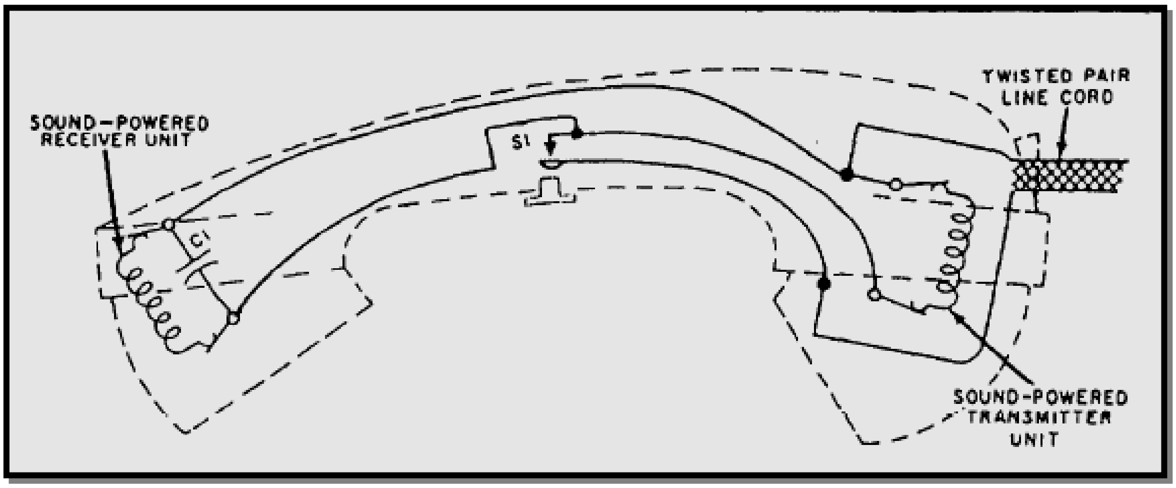


Figure 5-7.—Wiring diagram of the H-203/U sound-powered telephone handset and handset holder.

Capacitor C1 is connected in parallel with the sound-powered units for tone compensation. When using the sound-powered handset, switch S1 must be depressed for both transmitting and receiving.

SOUND-POWERED UNITS.— The sound-powered transmitter (microphone) and receiver units in a sound-powered handset are identical and interchangeable. As illustrated in figure 5-8, views A, B, and C, a unit consists of two permanent magnets, two pole pieces, an armature, a driving rod, a diaphragm, and a coil. The armature is located between four pole tips, one pair at each end of the armature. The spacing between the pole tips at each end is such that an air space remains after the armature is inserted between them. This air space has an intense magnetic field, supplied by the two magnets that are held in contact with the pole tips.

The armature is clamped rigidly at one end near one of the pairs of poles and is connected to the other end to the diaphragm by the drive rod. Therefore, any movement of the diaphragm causes the free end of the armature to move toward one of the pole pieces. The armature passes through the exact center of a coil of wire that is placed between the pole pieces in the magnetic field.

Principles of Operation of the Transmitter Unit.— Sound waves are vibrations that cause compressions and rarefaction in the atmosphere in which they travel. In sound-powered telephones, the sound waves created by a speaker's voice cause the diaphragm in the transmitter unit to vibrate in unison with the sound wave vibrations. Figure 5-8, view A, shows the armature of a transmitter unit when there are no sound waves striking the diaphragm. Note that the armature is centered between the pole pieces with the magnetic lines of force passing from the north to the south pole and that there are no lines of force passing lengthwise through the armature.

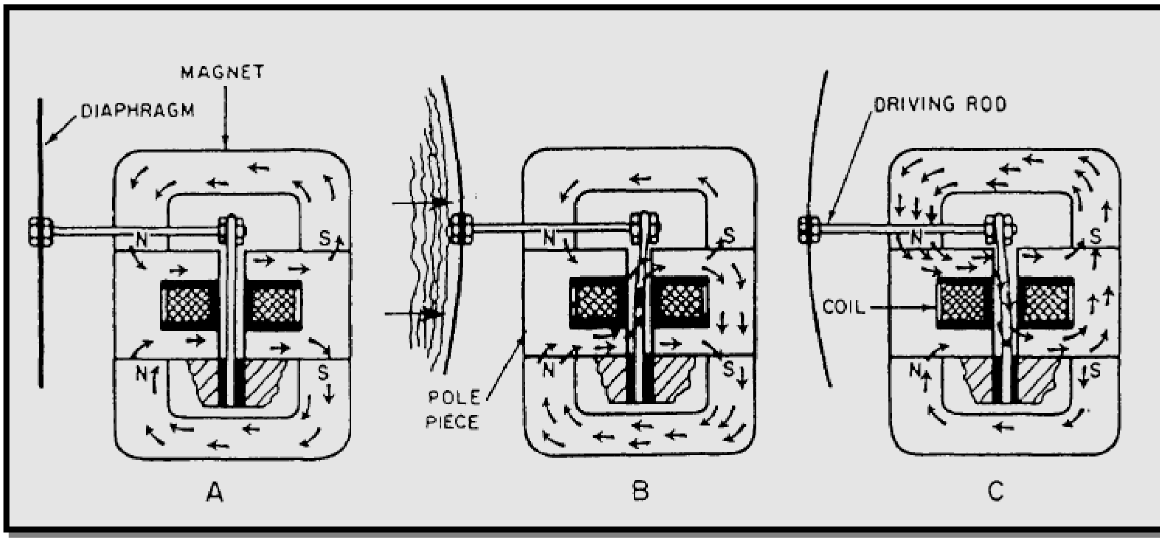


Figure 5-8.—Sound-powered transmitter receiver unit.

Figure 5-8, views B and C, show sound waves striking the diaphragm and causing the diaphragm to vibrate. The vibrations are impressed upon the armature by the drive rod. During the compression part of the wave (fig. 5-8, view B) this action causes the armature to bend and reduce the air gap at the upper south pole. The reduction of the air gap decreases the reluctance between the upper South Pole and the armature, while increasing the reluctance between the armature and the upper North Pole. This action reduces the lines of force that travel between the two upper pole pieces. There is no large change in the reluctance at the lower poles; however, the armature has less reluctance than the lower air gap and a large number of magnetic lines of force will follow the armature to the upper South Pole.

When the sound wave rarefaction reaches the diaphragm (fig. 5-8, view C), it recoils, causing the armature to bend in the opposite direction. This action reduces the air gap between the armature and the North Pole. The reluctance between the armature and the upper North Pole is decreased and the lines of force are reestablished through the armature, this time in the opposite direction.

As the sound waves strike the diaphragm, they cause the diaphragm to vibrate back and forth. The armature bends first to one side and then to the other, causing an alternating polarizing flux to pass through it, first in one direction and then the other. These lines of force passing through the armature will vary in strength and direction, depending upon the vibrations of the diaphragm. This action induces an electromotive force (emf) of varying direction and magnitude; that is, an alternating voltage in the coil. This alternating voltage has a frequency and waveform of the sound wave striking the diaphragm.

Principles of Operation of the Receiver Unit.— The sound-powered receiver unit reverses the transmission process. The alternating voltage generated in a transmitter unit is impressed upon the receiver coil, which surrounds the armature of the receiver unit. The resultant current through the coil magnetizes the armature with alternating polarity. An induced voltage in the coil of the transmitter unit (fig. 5-9, view A) causes a current to flow in the coil of the receiver unit (fig. 5-9, vie w B), magnetizing the free end of the armature arbitrarily with north polarity. The free end of the armature is repelled by the North Pole and attracted by the South Pole. As the direction of the current in the receiver reverses, the polarity of the armature reverses. The position of the armature in the air gap reverses, forcing the diaphragm inward. The diaphragm of the receiver unit vibrates in unison with the diaphragm of the transmitter unit and generates corresponding sound waves in the receiver unit.

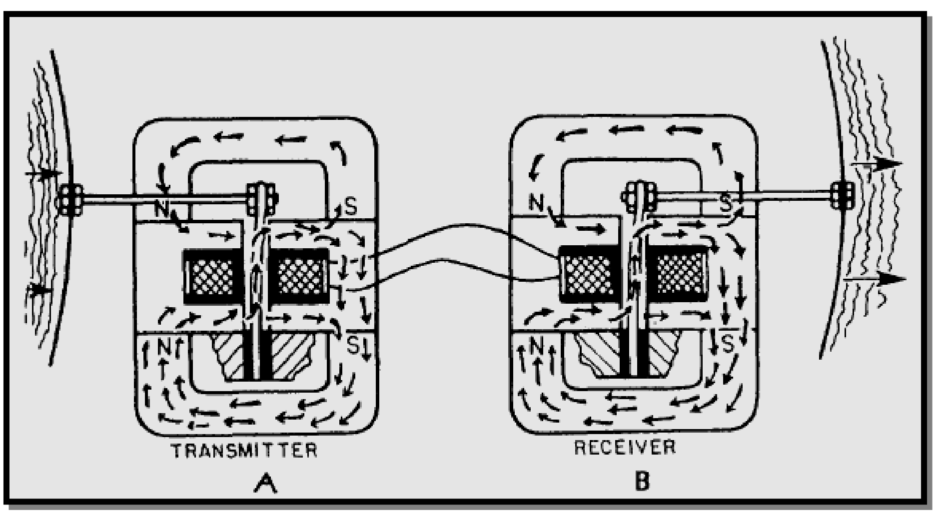


Figure 5-9.—Operation of sound-powered units.

LOADING HANDSET.— Handsets are designed to give maximum operating efficiency when used in a 1-to-1 ratio. The number of handsets operating in parallel should in no case exceed four. Where more than four are deemed necessary from an operational standpoint, the communication should be by sound-powered headset-chestsets. To maintain the overall efficiency of the circuit, handset buttons should not be taped down for convenience, as this may overload the lines. When using the handset, you should speak in a loud, clear voice. The power of the transmitter is generated by the voice, and while shouting is not necessary, the louder the speech, the louder the message is heard in the distant handset. When a handset is not in use, it should be stowed in its holder or stowage cabinet.

Sound-Powered Headset-Chestsets

Sound-powered headset-chestsets are designed for general use and for use with sound-powered telephone amplifiers. Figure 5-10 is an illustration of a type H-200/U sound-powered telephone headset-chestset. This head-set-chestset consists of two sound-powered receiver units with protective shells and ear cushions, one sound-powered transmitter unit with protective shell and a push switch, one mouthpiece, one chestplate assembly with junction box provided with capacitors and terminal facilities, one headband assembly and neck strap, and one cord assembly and plug. The receivers are mounted on the headband; the transmitter is mounted on the chestplate.

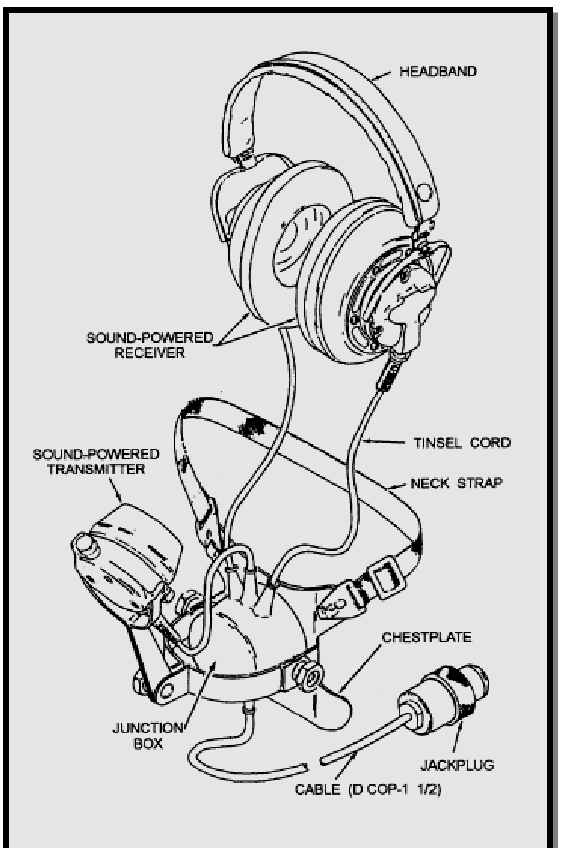


Figure 5-10.—The H-200/U sound-powered telephone headset-chestset.

Figure 5-11 is a wiring diagram of a type H-200/U sound-powered telephone headset-chestset. Closing the press-to-talk switch, S1, connects the sound-powered transmitter unit across the line. The receiver units are permanently connected across the line when the set is plugged in.

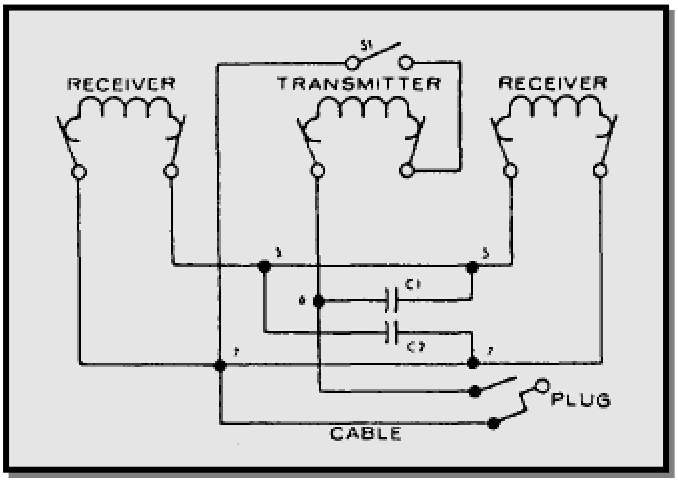


Figure 5-11.—Simplified sound-powered telephone headset-chestset schematic.

Capacitor C1 is in the circuit to prevent the flow of direct current through the receiver units when the set is used on the output side of a sound-powered telephone amplifier. When the set is used on the output side of the amplifier, a small dc voltage is placed across the set to form an amplifier squelching circuit to avoid acoustical feedback when the local set is transmitting. When the press-to-talk switch, S1, is depressed, direct current flows through the transmitter unit, causing a relay in the amplifier to operate and activate the squelching circuit.

Capacitor C2 provides for power-factor correction and improves the acoustical quality of the set.

The H-200/U can also be modified to meet security requirements for use in the ship's communication center. The headset-chestset cord must contain not less than two conductors in a single shield.

There are two other types of headset-chestsets used with the sound-powered telephone system. They are the H-201/U and the H-202/U.

The H-201/U is designed for use by plotters and console operators. This set features a transmitter suspended from the headband on an adjustable boom. The normally open, spring-loaded, press-to-talk switch, S1, is in a junction box clipped to the talker's belt.

The H-202/U is a specially designed set for use in high noise level areas. The receiver units are housed in noise-attenuating shells consisting of plastic caps lined with sound-absorbing material.

SOUND-POWERED UNITS.— The sound-powered transmitter and receiver units used in sound-powered telephone headset-chestsets are not interchangeable. The units differ physically; however, the principle of operation is the same for both.

Sound-powered telephone headset-chestset receiver units will transmit as well as receive. In the event the transmitter becomes defective, and the set cannot be repaired at once, communication can still be maintained. Remove either one of the receiving units from the headband and use it as a transmitter. Since the receivers are connected in parallel, either one can be used as the transmitter.

HANDLING HEADSET-CHESTSETS.— Sound-powered telephone headset-chestsets should be handled with care so they will be working properly in the event of an emergency. When not in use they should be correctly made up and stowed in their proper place.

The sets are made as waterproof as possible, but they should not be exposed unnecessarily to the weather. The cords should not be dragged over sharp edges, pulled too hard, or allowed to kink. When unplugging the cord from a jack, always pull on the body of the plug and never on the cord. If it becomes necessary to remove the set from the talker's head, hang the set by the headband and neck strap, and never by the connecting wires.

DONNING HEADSET-CHESTSETS.— When donning the headset-chestset, you should use the following procedure:

1. Remove the set from the stowage hook or stowage box.

2. Hold the set and coiled cord in one hand.

3. Unhook the neck strap and unwind the coiled cord. Do not allow the set to dangle by its connecting wires; this could cause open leads.

4. Put the neck strap around the neck and secure it to the chestplate.

5. Put on the receivers and adjust the ear cushions for maximum comfort and exclusion of noise.

6. Straighten out any kinks in the connecting wires.

7. Test the headset for satisfactory operation by blowing into the transmitter with S1 depressed. A hissing noise should be heard in both receivers.

8. Remove the jack cover and connect the plug to the jack.

LOADING HEADSET-CHESTSETS.— Sound-powered telephone headset-chestsets are designed to operate with 10 sets in parallel without any noticeable effect in response. However, it is possible to parallel up to 20 sets before overall line level response is considered critical. To maintain the overall efficiency of the circuit, do not tape down the transmitter button for convenience, as this may overload the circuit. When using the headset-chestset, hold the press-to-talk switch down firmly to ensure good contact, and talk directly into the transmitter. When listening, be sure to release the press-to-talk switch to eliminate the pickup of extraneous sounds and also the loss in receiver signal strength due to the low impedance transmitter shunted across the line.

REMOVING HEADSET-CHESTSETS.— When removing a sound-powered telephone headset-chestset, you should use the following procedure:

1. Remove the headband and hang it over the yoke of the transmitter.

2. Remove the plug from the jackbox and replace the jack cover on the jackbox to keep out moisture and dirt.

3. Lay the cord out on the deck and remove any kinks.

4. Coil up the cord, starting from the end that attaches to the chestplate. Coil with the right hand, making the loops in a clockwise direction. The loops should be about 10 inches across.

5. After the cord is coiled, remove the headband from the transmitter yoke and hold the headband in the same hand with the cord.

6. Fold the transmitter yoke flat so that the mouthpiece lays flush against the chestplate connection box, using care not to pinch the transmitter cord.

7. Hold the headband and cord in the left hand and unhook one end of the neck strap from the chestplate.

8. Bring the top of the chestplate level with the headband and cord. Secure the chestplate in this position by winding the neck strap around the headband and coiled cord just enough times so that there will be a short end left over. Twist this end once and refasten it to the chestplate. The set is now made up and ready for stowing, Figure 5-12 shows a properly made up sound-powered telephone headset-chestset.

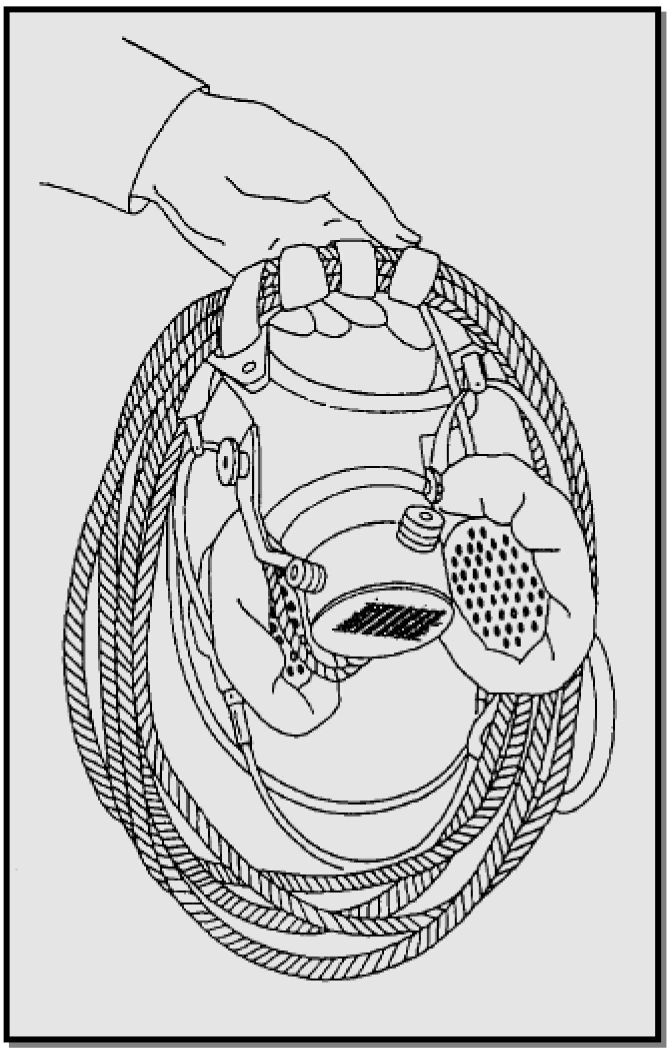


Figure 5-12.—A properly made-up sound-powered telephone headset-chestset.

STOWING HEADSET-CHESTSETS.— In enclosed spaces, you should stow headset-chestsets on hooks. In machinery spaces and on weather decks, you should stow these sets in stowage boxes, which are designed for stowing one set or up to six sets.

A properly made-up set should fit into its stowage box without forcing. Never allow a loose cord to hang out of the box because it maybe damaged when the lid is closed. Never use the stowage box for storing cleaning gear or tools because rags give off moisture and soap powder gives off fumes that will cause the aluminum diaphragms to rapidly oxidize. Tools and other loose gear may damage the set(s) or may prevent you from getting a set out quickly in an emergency situation.

<u>Sound-Powered Telephone Maintenance</u>

As an IC Electrician, you will be required to service sound-powered telephones. Because a great deal of time is devoted to the repair of these sets, you should become thoroughly familiar with the proper methods of testing and repairing them. Many of the larger ships in the fleet have a telephone shop devoted entirely to the repair of sound-powered telephones.

Sound-powered handsets are usually repaired on location because they are permanently connected. When trouble develops in a sound-powered headset-chestset, the usual procedure is for the operator to bring it to the IC shop and exchange it for a good one. This procedure provides each station with properly operating sets at all times. The IC shop should maintain a log of all sets turned in; this will aid in locating faulty circuits or identifying operators who continually abuse their sets.

PRECAUTIONS.— When repairing sound-powered telephones, you should observe the following precautions:

- Do not repair telephones on a dirty workbench.
  The magnets in the units may attract iron filings, which are difficult to remove.
- Before disassembling a set, make a wiring diagram showing the color coding, polarity, or terminal numbers of the lead connections.
- Never alter the internal wiring of sets.
- Always replace parts exactly as they were before disassembly.

INSPECTION.— You should make a routine inspection of sets before you begin to repair the sets to determine whether you should replace physically defective parts. Many troubles may be located by inspecting the set for damaged cord or insulation; cord pulled out of units; loose units; defective or broken pushbuttons; and broken or damaged parts, such as unit covers, neck strap, chestplate, junction box, plug, and headband.

TRANSMITTER AND RECEIVER UNITS.— Transmitter and receiver units are not repairable. If these units become defective, they must be replaced. Both of these items are standard stock items.

OPEN AND SHORT CIRCUITS.— When testing the units for open and short circuits, you should use a low-voltage ohmmeter to avoid damage to the sound-powered transmitter and receiving units. Continuity tests may be made from the chestplate junction box on sound-powered headset-chestsets. Figure 5-13 is an illustration of the transmitter circuit of a sound-powered telephone headset-chestset. Figure 5-14 is an illustration of the receiver circuits. When testing the plug cable or tinsel cords of a sound-powered headset-chestset, you should disconnect them from the junction box. The normal dc resistances of the sound-powered transmitter and receiver units are 10 ohms and 62 ohms respectively. If the plug cable and tinsel cords test out satisfactorily, then you should check the capacitors.

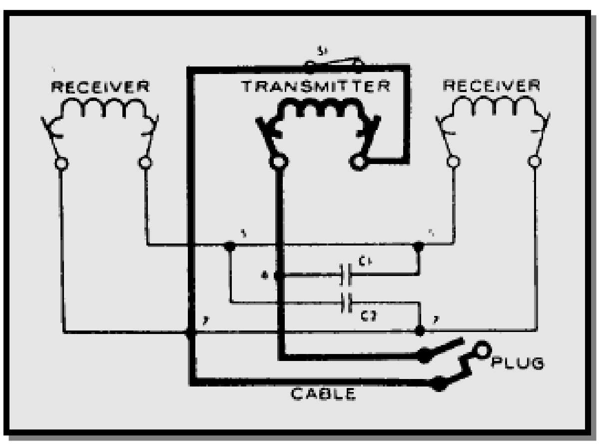


Figure 5-13.—Sound-powered telephone head set-chestset transmitter circuit.

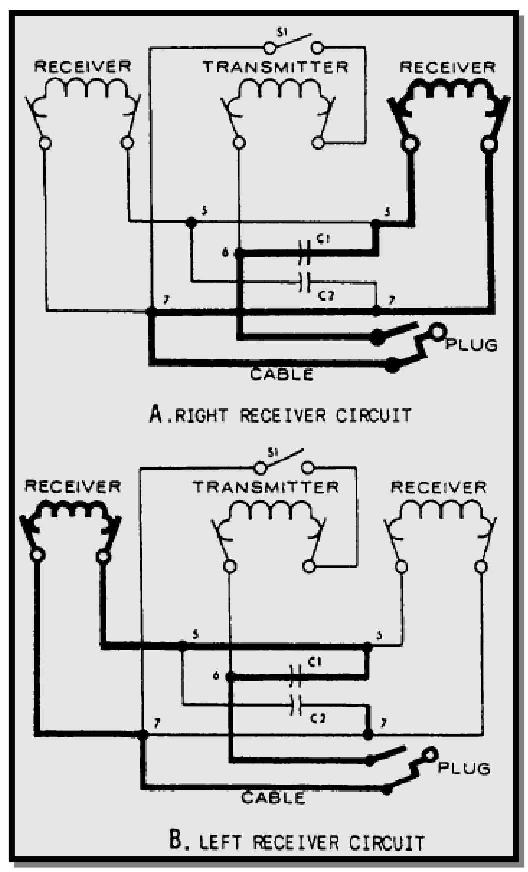


Figure 5-14.—Sound-powered telephone headset-chestset

A short circuit in a single sound-powered transmitter or receiver unit will render an entire circuit inoperative because all sound-powered telephones on the circuit are connected in parallel. Operation of switchboard or switchbox line cutout switches will allow isolation of a faulty unit. For string circuits, you should disconnect each set in sequence to isolate the faulty unit.

LOSS OF SENSITIVITY.— Loss of sensitivity, or weakening of the transmission sound, is a gradual process and seldom is reported until the set becomes practically inoperative. When a sound-powered telephone is in good condition electrically yet the sound is weak you should replace the transmitter unit. If this procedure does not remedy the trouble, then you should replace the receiver units.

To test a headset for loss of sensitivity, you should depress the talk switch and blow into the transmitter. If the set is operating properly, you will hear a hissing noise in the receiver units. You should listen to one receiver unit and then the other. In most cases, the loss in sensitivity is in the transmitter unit and might be caused by a displacement of the armature from the exact center of the air gap between the pole pieces.

To test a handset for loss of sensitivity, you should blow air into the transmitter. It is not necessary to press the talk switch because the transmitter and receiver are permanently connected in parallel. If no sound is heard, either the transmitter or the receiver is defective. The easiest method to determine which unit is defective is to have someone talk into another phone on the circuit while you listen to both the transmitter and receiver of the handset. If the talker’s voice is heard on one of the units but not the other, you should replace the unit on which the voice is not heard because it is defective. If the talker’s voice cannot be heard on either unit, and the telephone circuit being used is known to be good, the fault may be traced to the line cord, switch, or internal handset circuits.

REPLACING CORDS.— When replacing cords, you should always use prepared cords, if possible. Handset cords fitted with terminals at both ends are available through standard stock. Tinsel cord cut to the proper lengths and fitted with terminals for use with the various types of headset-chestset transmitter and receiver units are also standard stock items. DCOP 1 ½ cord is used between the junction box and the plug on a sound-powered headset-chestset.

Replacing Handset Cords.— To replace the cord on a sound-powered handset, you should use the following procedure:

1. Remove the faulty cord by unscrewing the bushing and disconnecting the wires from the terminals.

2. Place the threaded bushing, washer, and grommet on the new cord.

3. Insert the cord into the handset and connect the wires to the terminals.

4. Screw the bushing into the handset tightly to secure the cable.

5. Test the set for proper operation.

Replacing Tinsel Cords.— To replace a tinsel cord on a sound-powered telephone headset-chestset, you should use the following procedure:

1. Open each unit connected to the cord that is to be replaced.

2. Before disconnecting the cord, make a diagram showing the color coding of the wires.

3. Disconnect both ends of the cord.

4. Remove the screw that holds the tie cord, or untie the cord if it is secured to an eyelet.

5. Unscrew the entrance bushing, if provided, and pull the cord through the port.

6. Place the threaded entrance bushing, metal washer, and rubber gasket on the new cord and insert the cord into the entrance port. The cord should be long enough to allow slack after it is connected.

7. Secure the tie cord so that it takes all the strain off the connections; otherwise the wires might be pulled from their terminals.

8. Connect the wires to the terminals.

9. Screw the entrance bushing on the entrance port, drawing the bushing up tightly to secure the cable and to seal the port.

10. Close the unit after all connections have been visually checked.

11. Test the set for proper operation.

If prepared cords are not available for repairing headset-chestsets, you can make them from bulk tinsel cord using the following procedure:

1. Strip about 2 inches of the outer layer of insulation from one end of the cord.

2. Remove about one-fourth of an inch of insulation from the ends of the conductors, exercising caution not to damage the tinsel wire.

3. Wind a single layer of 32-gauge tinned copper wire over the tinsel wire, and extend the tinned copper wire about one-eighth of an inch over the rubber insulation.

4. Dip these whipped conductors into melted solder and flatten them slightly when they are cool.

5. Solder the whipped conductor to a lug or cord tip, as required.

Replacing DCOPl l/2 Cord.- To replace the cord between the junction box and the plug on a sound-powered headset-chestset, you should use the following procedure:

1. Prepare one end of the cord for use in the junction box.

2. Follow steps 1 through 10 for tinsel cord replacement for the junction box end of the cord.

3. Prepare the cord for use with the plug end.

4. Place the threaded bushing, washers, and rubber grommet on the plug end of the cord.

5. Insert the cord into the insulated sleeve and solder the wires to the connector strips.

6. Insert the insulated sleeve, grommet, and washers into the plug, and screw the bushing into the plug, drawing up tightly to secure the cable and to seal the plug.

7. Test the set for proper operation.

5.4.0 SOUND-POWERED TELEPHONE AMPLIFIERS

In high noise level areas it is often difficult, if not impossible, to hear conversations, even over the best maintained sound-powered telephone circuits. Thus, the sound-powered telephone amplifier was developed to assist communications in these vital areas. Sound-powered telephone amplifiers are installed in machinery rooms, gun mounts, missile checkout areas, flight and hangar decks, helicopter landing platforms, and other large noisy spaces. They are also installed in spaces where it is desirable to monitor incoming signals via a loudspeaker, without the use of a sound-powered telephone.

Sound-powered telephone amplifiers amplify one-way communications in a two-way sound-powered telephone system using existing sound-powered headset-chestsets; that is, amplify the voice to the high noise level area but not the voice from it. The amplifiers accept one incoming circuit for amplification and are capable of transmitting the amplified signal to as many as six headset-chest sets and two loudspeakers.

5.4.1 Sound-Powered Amplifier AM-2210N/WTC and AM-2210G/WTC

The transistorized AM-22l0N/WTC and AM-2210G/WTC sound powered amplifiers (fig. 5-15) are two of the most common types presently in wide use throughout the fleet and are the ones that will be discussed in this training manual. Electrically, the units consist of an audio amplifier, a switching circuit, and a power supply. The incorporation of transistors in the audio and switching circuits and silicon junction diodes in the power supply creates a highly reliable static condition. The AM-2210N/WTC will replace the AM-2210G/WTC Sound Powered Amplifier.

Figure 5-15.—AM-2210N/WTC Sound Powered Amplifier.

Figure 5-16 is a functional diagram of the AM-2210N/WTC. One relay (K1) is used in the switching circuit.

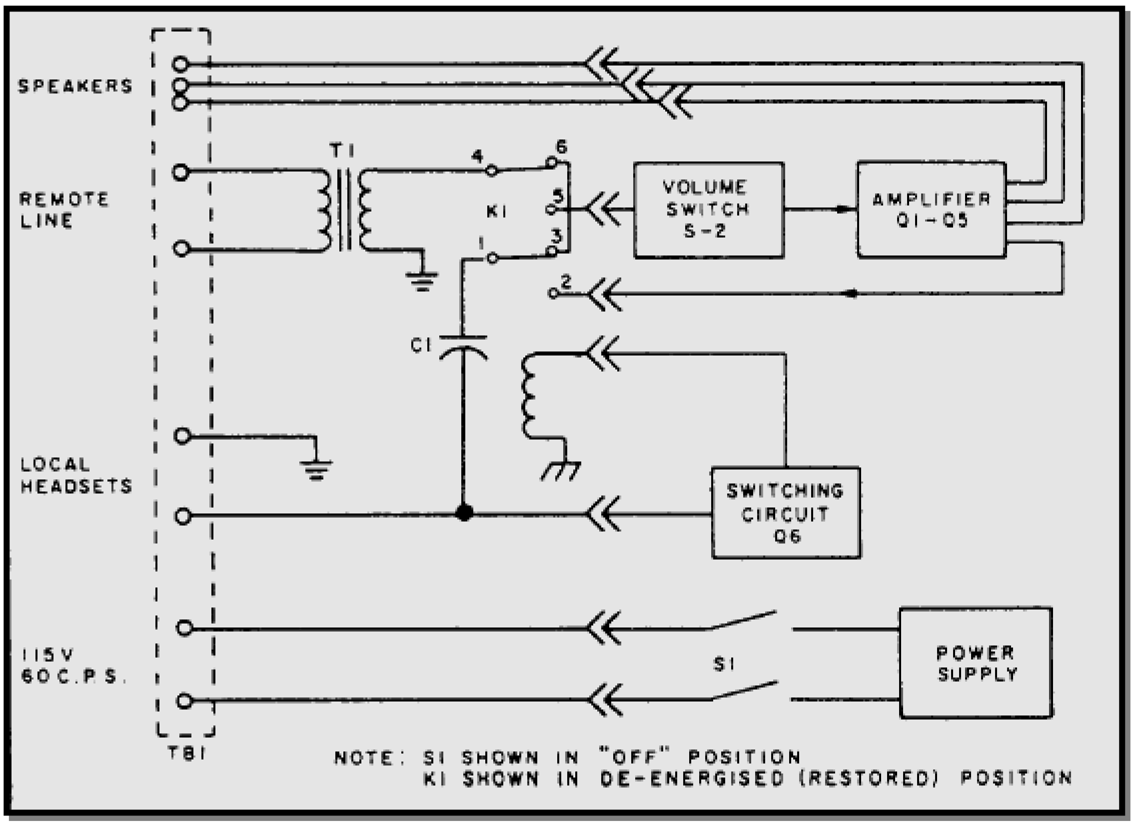


Figure 5-16.—Functional diagram of AM-2210/WTC.

AUDIO AMPLIFIER.— The audio amplifier (fig. 5-16) consists of a low-level, three-transistor amplifier (Q1 through Q3) and a power amplifier (Q4 and Q5), with negative feedback employed throughout. The output transformer (T3, not shown) has two secondaries: the first is used with the loudspeakers and the latter, a tapped winding, is used for as many as six sound-powered telephone outlets. The amplifier provides a 10-watt output.

SWITCHING CIRCUIT.— Figure 5-17 is a functional representation of the K1 switching circuit, showing K1 in an energized and operated condition. The receiver element of the local headset-chestset is in series with a dc blocking capacitor, thereby presenting a high resistance when the talk switch is open. Closing the talk switch connects the headset across the line, giving the headset a dc resistance of approximately 4.8 ohms. It is the function of the switching circuit to sense this change from high impedance to low resistance that takes place with the depression of one of the six headset-chestset talk switches.

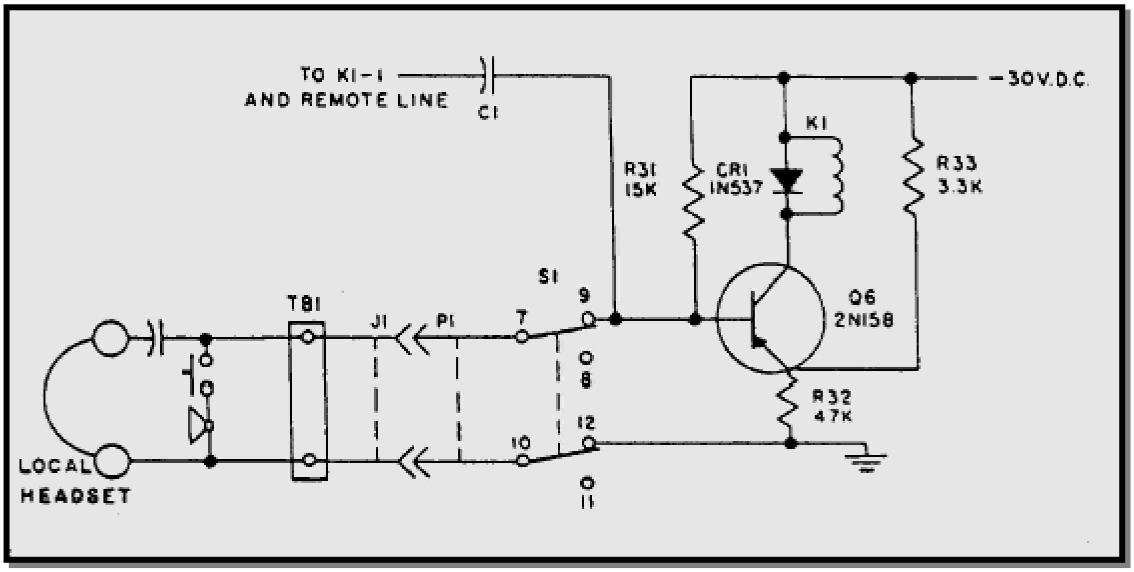


Figure 5-17.—Switching circuit of AM-2210/WTC.

The switching circuit is activated when the amplifier is energized. With power available and neither local nor remote talk switches closed, the relay (K1) is operated. When operated, the depression of a remote talk switch will have no effect upon K1; that is, it will remain operated. However, when one of the six local talk switches is depressed, the circuit to K1 is changed and K1 restores.

Resistor R31 provides a bias to the base of Q6, which normally holds Q6 in a saturated state, maintaining K1 in an operated condition. When the local talk switch is closed, the base of Q6 is connected to ground through the 4.8 ohms of the mouthpiece. Presently the voltage across Q6 from base to ground becomes less than the emitter bias voltage provided by voltage divider network R32 and R33; therefore, the transistor becomes reverse biased and Q6 becomes nonconductive, de-energizing and restoring K1.

The incoming and outgoing voice signals are coupled through capacitor C1 of the amplifier. CR1 is in the circuit to protect Q6 from surges while it is in the cutoff state.

The restoration of K1 will result in normal communications at sound-powered level between all stations. The amplifier is effectively bypassed. The advantage of this circuitry is that any casualty, such as loss of power, will allow normal sound-powered communications to continue.

POWER SUPPLY.— The power supply is basically a full-wave rectifier receiving its power through switch S1 (fig. 5-16) and the fuses on the face of the amplifier. A neon glow lamp and a volume control potentiometer are also located on the face of the amplifier. The amplifier operates on 115-volt, 60-Hz, single-phase power, which is normally supplied by the ship's local lighting panels.

AMPLIFIER OPERATION.— Incoming signals are amplified and delivered to local headset-chestsets and loudspeakers. The volume control knob located on the face of the amplifier is used to adjust the desired headset-chestset receiver output volume. The output volume for the associated loudspeakers is adjusted locally at the loudspeakers. The circuit associated with the telephone amplifier operates under the three following conditions:

1. When the amplifier is de-energized, direct two-way communication between local and remote stations takes place at the normal sound-powered level.

2. When the amplifier is energized, incoming signals from the remote line are amplified and transmitted to the local stations and associated loudspeakers.

3. When the amplifier is energized and the talk switch of any local station is closed, the amplifier is cut out and communications between any of the local and remote stations takes place at the normal sound-powered level.

5.4.2 Amplifier Maintenance

Although by no means trouble free, the AM-2210N/WTC is a highly reliable piece of equipment. When trouble does occur, it is often caused by improper operating procedures or by a failure in external circuitry. Often personnel who operate the amplifier are not aware of its operational capabilities, and a brief indoctrination will clear up an apparent trouble.

One procedure that has caused some failures in the amplifier is the practice of taping closed the talk button of one of the local headset-chestsets. This violation of circuit integrity will result in K1 being continually restored, resulting in no amplification of incoming signals.

You should accomplish preventive maintenance using the applicable maintenance requirement cards (MRCs). You should accomplish corrective maintenance according to the applicable technical manual.

5.5.0 AMPLIFIER CONTROL SWITCHES

At stations where it is desired to maintain two-way communication for all circuits serving the station, an amplifier control switch is installed. This switch provides the operator with a means of selecting anyone of several circuits to be amplified while retaining two-way communications at normal sound-powered level for other circuits not selected to be amplified. These switches are multiple rotary-type S-3R and are provided with dial illumination for darkened-ship condition areas.

The incoming sound-powered telephone circuits are connected to the sound-powered telephone amplifier via this switch.

5.6.0 SELECTOR SWITCHES

Type A-26A sound-powered telephone selector switches (fig. 5-18) are located throughout the ship at control and operating stations served by more than one sound-powered telephone circuit. The selector switch enables the operator to connect the sound-powered telephone to any one of several circuits brought to the switch without having to change from one jackbox to another.

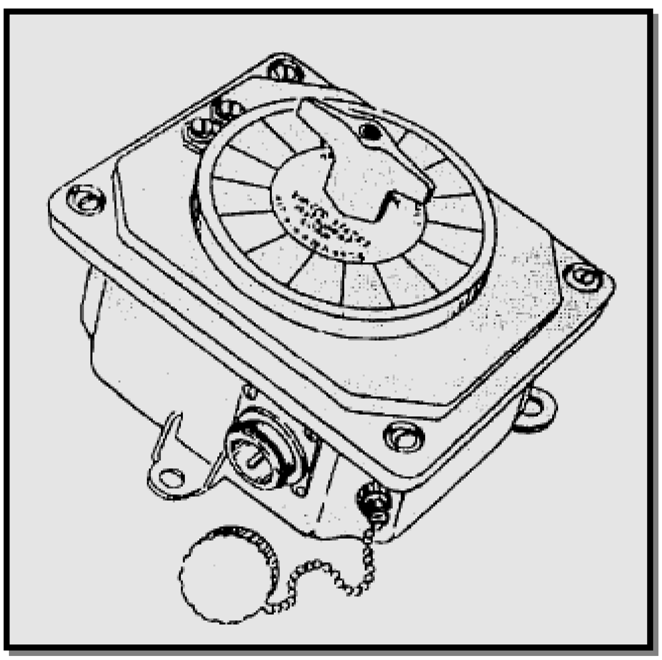


Figure 5-18.—Type A-26A selector switch.

The selector switch is a multiple rotary switch designed for use in connection with sound-powered telephone systems. The switch is constructed with 2 sections and has 16 stationary contacts for incoming lines on each section. The rotor has a movable contact and is driven directly from the shaft attached to the handle, which has an indexing mechanism for selecting the desired circuit. The switch has a built-in jack outlet connected to the rotor contacts.

Most of the switches are installed with a sound-powered telephone handset permanently connected to the rotor contacts. Where a handset is not provided, the switch operator must insert a sound-powered telephone headset-chestset plug into the jack outlet. Switches located in normally darkened-ship condition areas are provided with dial illumination.

At stations where only two circuits are involved, a double-throw lever or double-throw rotary snap-type selector switch is used rather than the larger rotary type.

5.7.0 SOUNDPROOF BOOTHS

In spaces where the ambient noise level at the handset location is 90 dB or more during any condition of operation, soundproof booths are installed for use with sound-powered telephone handsets. Wherever practicable, the telephone booths are installed so that the front faces away from the direction of maximum noise. The deck area under the booth will be solid or walkway grating. Only handset(s) with holder(s) and an illumination fixture are mounted inside the booth; all other associated sound-powered equipment is mounted on the outside of the booth.

5.8.0 PLOTTERS TRANSFER SWITCHBOARDS

Plotters transfer switchboards are found in areas aboard ship, such as the CIC, where the tactical situation governs the sound-powered circuit to which the plotters are to be connected. For instance, the situation may require that the CIC plotters connected to jackboxes JS1 through JS5 be connected to circuit 21JS, while the plotters connected to jackboxes JS6 through JS10 be connected to circuit 22JS. Another situation may call for an entirely different arrangement.

The switchboards consist of one or more SB-82/SRR panels (fig. 5-19, view A). Each panel consists of five vertical rows of 10 double-pole, single-throw switches. Each row on the panel is connected to a sound-powered circuit, and each switch on the panel is connected to a sound-powered jackbox. The switches are continuously rotatable in either direction. Several different sound-powered jackboxes and circuits are connected to these switchboards, thus permitting the plotters to be shifted from one circuit to another quickly and efficiently as the situation dictates and eliminates the necessity of installing multiple-circuit phone boxes at each station.

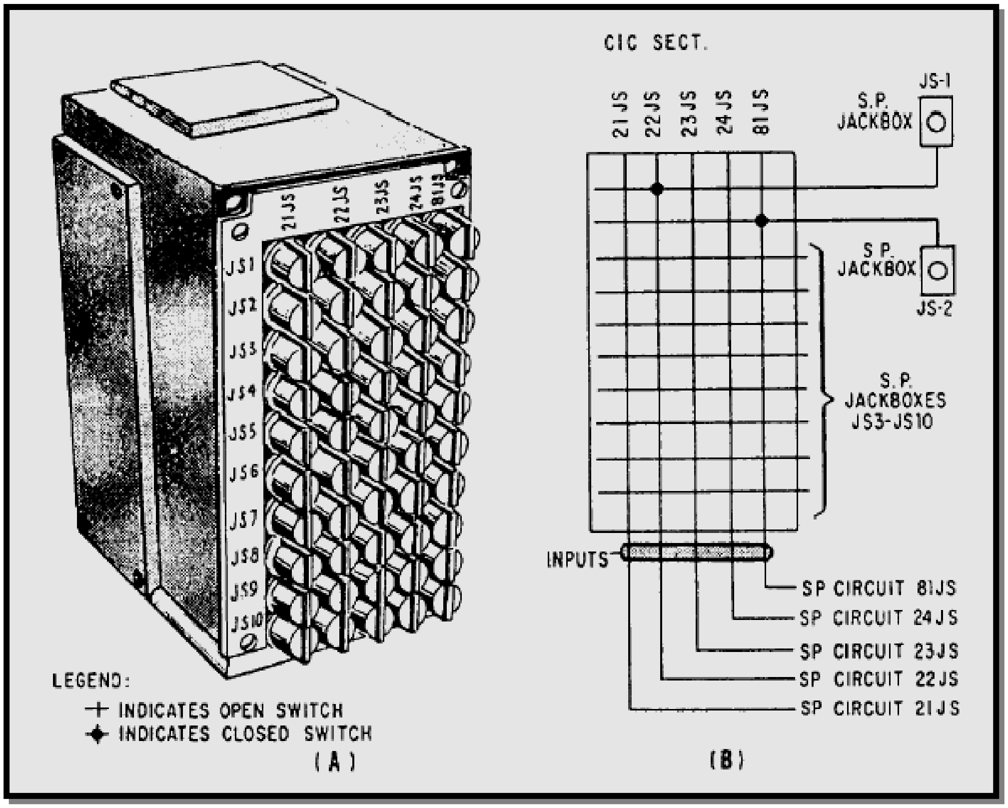


Figure 5-19.—Plotters transfer switchboard.

As shown in figure 5-19, view B, the closing of any one of the five switches associated with each jackbox permits the jackbox to be connected to one of the sound-powered circuits. In the figure, jackbox JS 1 is shown connected to sound-powered circuit 22JS, and jackbox JS2 is shown connected to sound-powered circuit 81JS. Any of the remaining jackboxes, JS3 through JS10, may be connected to one of the five sound-powered circuits by simply closing the associated switch.

5.9.0 CALL AND SIGNAL CIRCUITS

Call and signal circuits used in conjunction with a ship’s sound-powered telephone system provide the means of calling and signaling between stations of the various sound-powered telephone circuits. The call and signal circuits are designated E, EM, and MJ.

5.9.1 Circuit E – Sound-Powered Telephone Call Circuit

Circuit E provides a means of signaling between sound-powered telephone stations, where not more than six stations are to be called by the calling station. The circuit operates on 120-volt, 60-Hz, single-phase power, which is usually supplied by the main IC switchboard. Watertight and non-watertight push buttons and lever-operated spring return or spring return rotary switches are provided at all calling stations. Buzzers, horns, bells, and drop-type annunciators are installed at the associated called stations. Buzzers are used in low noise level spaces. Horns are used in high noise level spaces, and bells are used in other spaces. Annunciators are provided at all stations where two or more similar audible signals are required.

To use the circuit, the caller operates a switch at the calling station, which in turn energizes the audible and/or visual signal devices located at the called station.

Circuit E is divided into the following functional circuits:

1E-Cruising and miscellaneous

2E—Ship control

3E—Engineering

4E—Aircraft control

5E—Weapons control

A simplified call circuit is shown in figure 5-20. The upper branch circuit, with one bell and one push button in series with each other, is used to call a single station from one remote location.

The center branch circuit, with two push buttons in parallel with each other and in series with the bell, is used to call a single station from two remote locations.

The lower branch circuit, with two bells in parallel with each other and in series with one push button, is used to call two stations from one remote location.

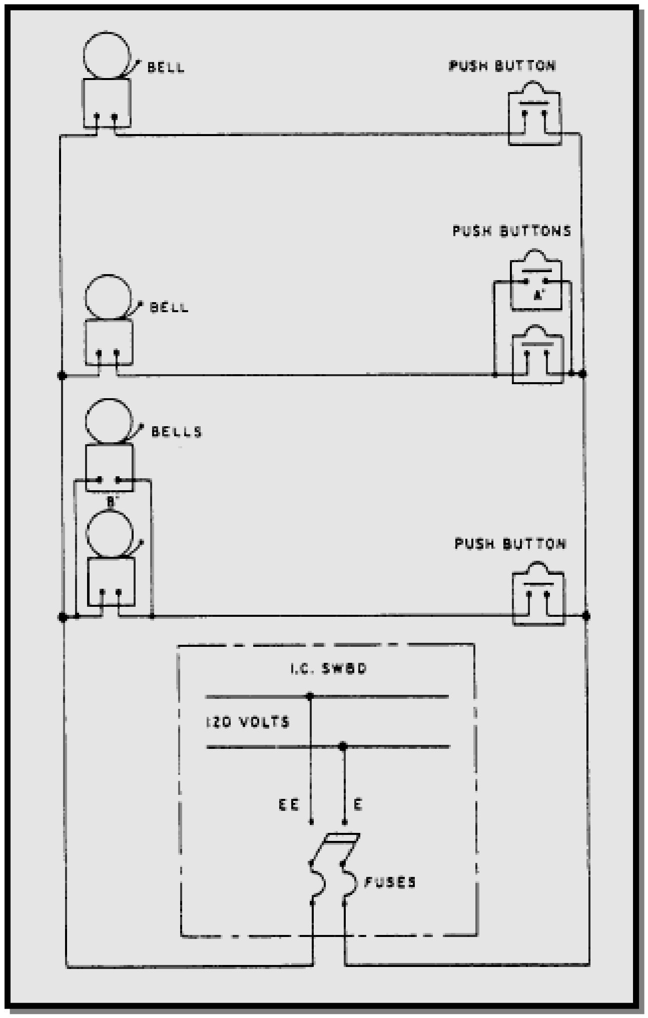


Figure 5-20.—Simple call-bell system.

Note that the bells or signaling devices are connected to the side of the lines bearing the negative designation EE. This arrangement is used on ac circuits that have no polarity, but in which one side of the line arbitrarily is designated as EE for convenience.

5.9.2 Circuit EM – Sound-Powered Telephone Signal Circuit

Circuit EM provides a means of signaling between sound-powered telephone stations, where more than six stations are to be called by the calling station. Circuit EM is divided into the same functional circuits as circuit E except that 1EM through 5EM is used. Circuit EM uses type IC/D call signal stations, which require no external power, and provides the operator with selective calling of up to 16 individual stations.

The associated sound-powered telephone circuit is independent of the signal circuit and provides the voice communication facilities between stations. Each sound-powered telephone circuit can accommodate only one conversation over its facilities. The IC/D call signal station (fig. 5-21, views A and B), normally called a growler or a howler, uses a magneto generator to transmit a non-interrupted or interrupted signal to a selected station.

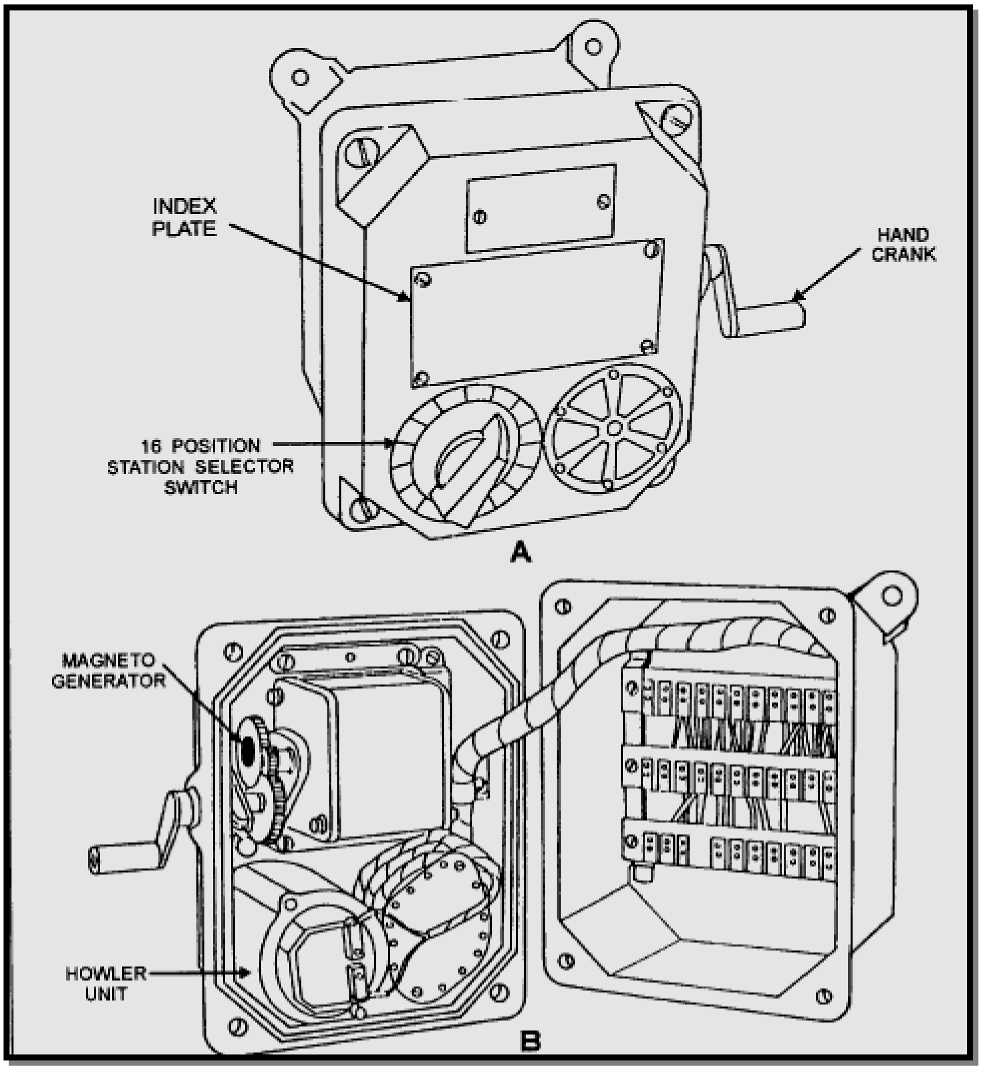


Figure 5-21.—IC/D call signal station. A. External view. B. Internal view.

IC/D Noninterrupted Call Signal Station

The IC/D noninterrupted call signal station is made of cast aluminum, with all of the equipment mounted on the cover except for the terminal board and a sound-powered jack outlet. Equipment mounted on the cover include a 16-position rotary selector switch, an index plate, a hand-operated magneto generator, a howler unit, and an attenuator. The associated sound-powered telephone circuit may be either the string or the switchboard type.

To operate the station, you simply turn the rotary selector switch to the station to be called and crank the magneto generator handle. The howler (a modified sound-powered telephone receiver unit) at the selected station will produce a high distinctive howl. The howl will continue for as long as the calling station generator is cranked. The attenuator is used to control the volume of the individual howler at its respective station. Each EM circuit station is equipped with an IC/D call signal station. Figure 5-22 is an elementary wiring diagram of the 2EM (ship control) circuit.

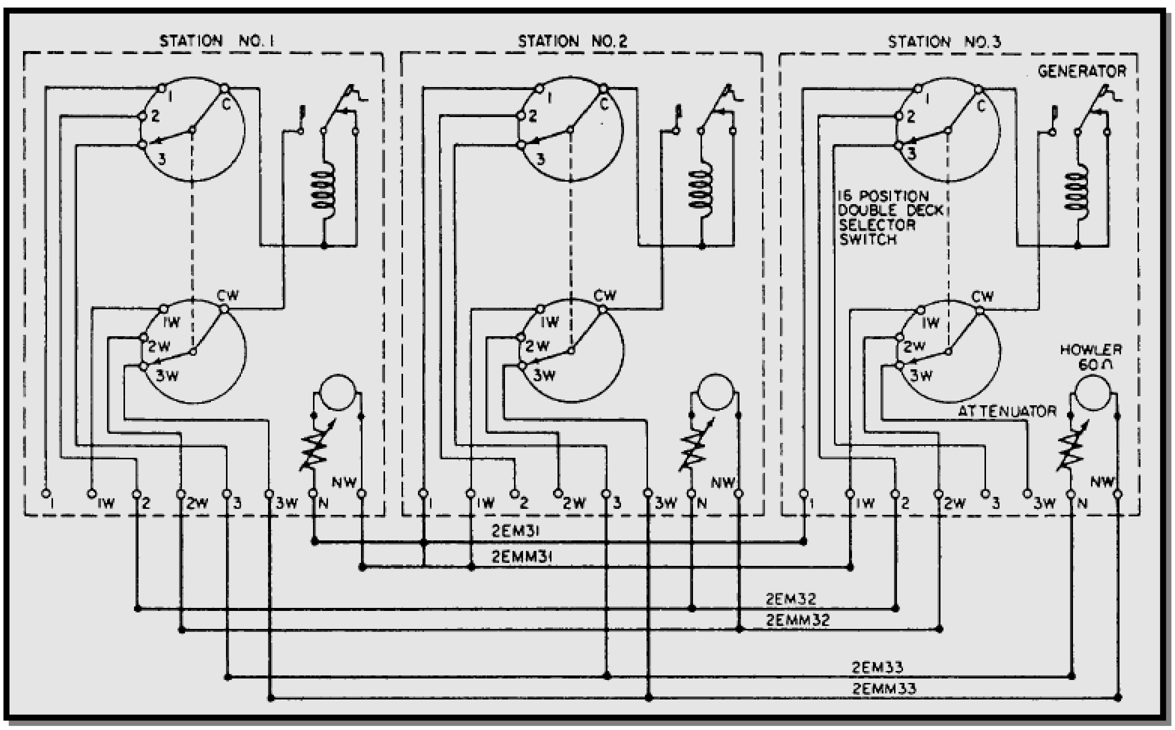


Figure 5-22.—Sound-powered magneto call circuit 2EM.

The call signal stations located in noisy spaces may include a visual indicator lamp to alert personnel of an incoming call. A relay box nippled to an indicator lamp is installed adjacent to each call signal station. The relay coil is connected to the howler circuit of the station. The relay contacts are connected to the nearest emergency lighting circuit. When the station howler is activated, the relay coil is energized and the relay contacts operate to complete the circuit from the lighting system to energize the indicator lamp.

IC/D Interrupted Call Signal Station

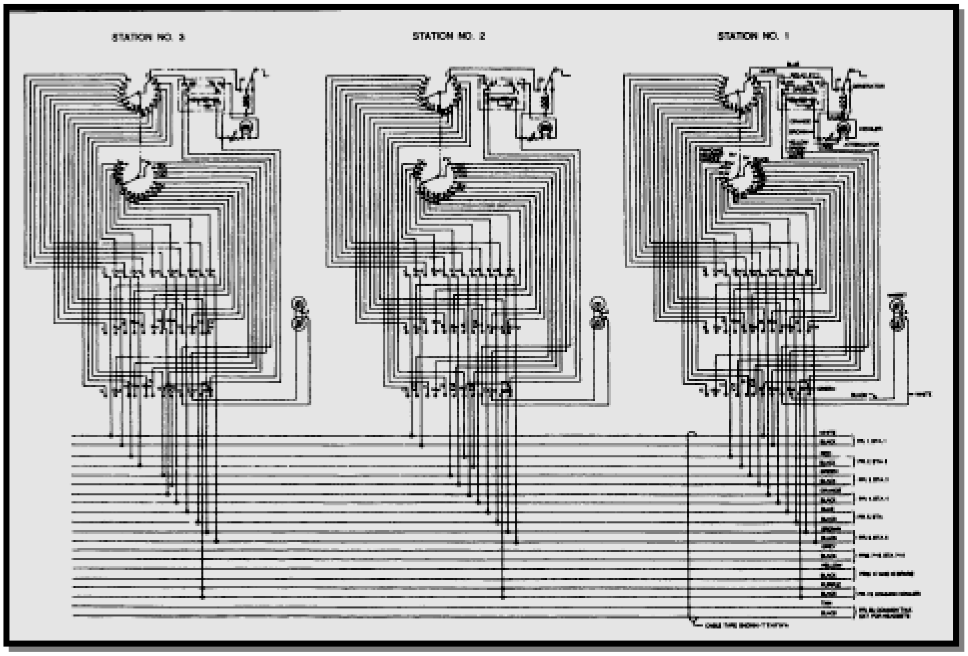
This station is identical to the noninterrupted station, except the hand-operated magneto generator has been modified to generate a pulsating voltage. When the generator handle is cranked, the pulsating voltage produced will provide an interrupted howl at the selected station.

This call signal station is used along with the noninterrupted call signal station in a space where two different circuits are required; thus providing different audible signals to alert personnel as to which station is being called.

5.9.3 Circuit MJ – Multiple-Talking and Selective Ringing Circuit

Circuit MJ provides a means of communication with more than one conversation on the circuit simultaneously, as well as providing selective ringing at each station. In addition, the sound-powered telephone and ringing circuits are combined to provide one common talking circuit between all stations. Up to eight separate conversations are possible at one time. The circuit may be used with any particular sound-powered circuit where its capabilities would be advantageous.

IC/D call signal stations are used with circuit MJ. The internal wiring of each call signal station is revised and a relay and diode assembly is mounted on the selector switch of each call signal station. When the relay is de-energized, its contacts complete the circuit to the local handsets at all call signal stations on the circuit. When a caller cranks the hand-operated magneto generator at the calling station, it energizes the coil of the relay at the called station. The contacts of the relay then close to complete the circuit to the howler at the called station. At some call signal stations on the circuit, extension handsets are provided for convenience in answering incoming calls. The extension handsets are connected to the “home station” circuit MJ wires to avoid the need of setting the station selector switch to the ANSWER position, which is required to use the local call signal station handset. Figure 5-23 is an elementary wiring diagram of an MJ circuit.



Representative example, see appropriate Technical Manual for use in trouble shooting.

Figure 5-23.—Modification of IC/D call signal station, for multiple talking and selective ringing.

5.9.4 Call and Signal Circuits Maintenance

You should accomplish preventive maintenance of call and signal circuits according to the applicable MRCs. Corrective maintenance will usually consist of isolating shorts, grounds, and opens in the circuits and repairing or replacing the audible and visual signal devices used with the circuits.

5.10.0 SOUND-POWERED TELEPHONE SYSTEM AN/WTC-2(V)

The AN/WTC-2(V) sound-powered telephone system is installed on some naval ships. This system replaces the existing EM and MJ call and signal circuits. The system is designed for interior shipboard use and, along with the sound-powered telephone circuits discussed earlier, provides two-way voice communication between shipboard terminal stations. You can signal and talk on the same cable. The system uses a variable number of 8 separate major units and may contain up to 144 terminal stations.

5.10.1 Physical Description and Purpose of Units

The eight major units of the AN/WTC-2(V) sound-powered telephone system are as follows:

1. Unit 1—TA-974/WTC-2(V) sound-powered telephone set
2. Unit 2—TA-975/WTC-2(V) sound-powered telephone set
3. Unit 3—TA-976/WTC-2(V) sound-powered telephone set
4. Unit 4—G-15/A sound-powered telephone jackbox
5. Unit 5—H-200/U headset-chestset
6. Unit 6—J-3523/WTC-2(V) distribution box
7. Unit 7—TS-3687/WTC-2(V) telephone test set
8. Unit 8—BZ-240/WTC-2(V) audible alarm

Units 1, 2, and 3

The terminal stations are units 1, 2, and 3. These terminal stations provide the means of selecting and calling other stations in the system.

UNIT 1.— Unit 1 (fig. 5-24) is a bulkhead-mounted terminal station consisting of three separate components: call-signal station A1, handset HS1, and handset holder MP1.

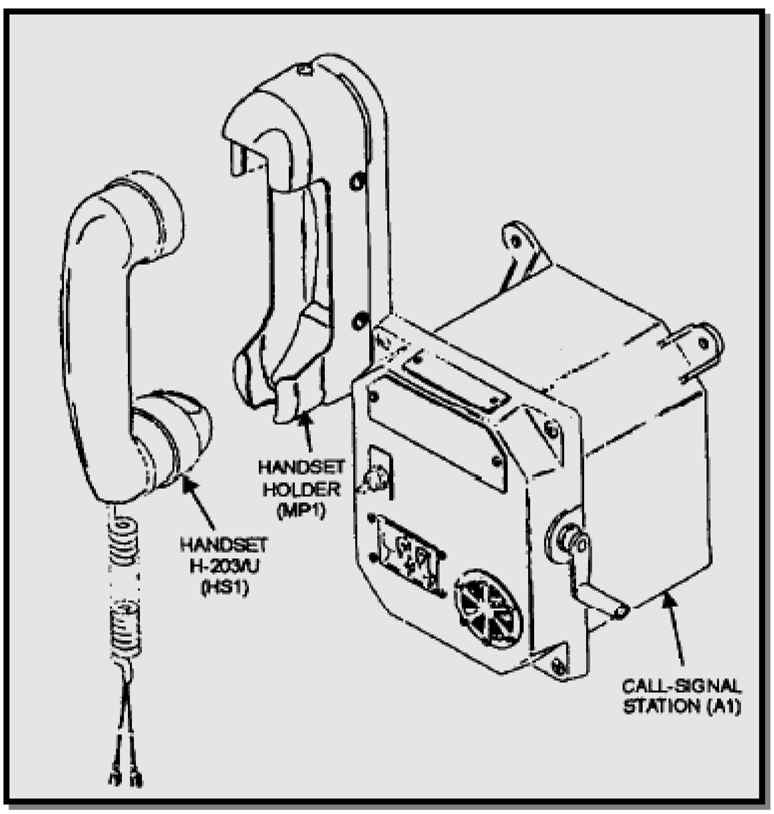


Figure 5-24.— The TA-974/WTC-2(V) sound-powered telephone set, unit 1.

Call-signal station A1 consists of a cover assembly and a case assembly. The cover assembly (fig. 5-25) contains two single-pole, 12-position thumbwheel station selection switches, a PLACE CALL/ANSWER toggle switch, a side-crank dc hand-ringing generator with related electronics, and an attenuator to adjust the ring signal audio level. The case assembly is the housing for the cover assembly and contains the necessary terminal board and multi-pin connector to mate with the plug on the cover assembly. The case assembly also provides the means of connecting the handset.

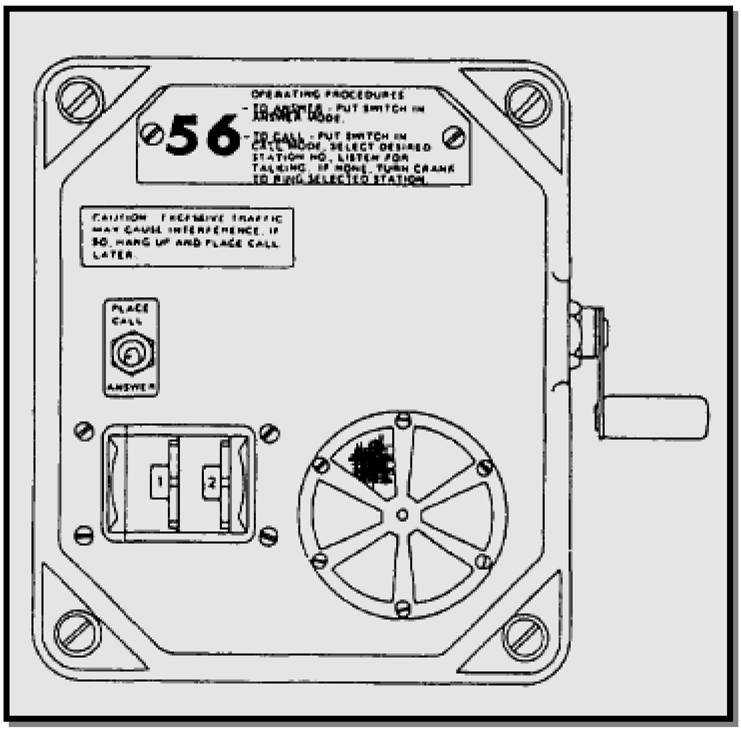


Figure 5-25.— Call signal station A-1.

Handset HS1 is a standard H-203/U sound-powered telephone handset.

Handset holder MP 1 is a standard holder for the H-203/U sound-powered telephone handset. The holder is mounted near call-signal station A1.

UNIT 2.— Unit 2 (fig. 5-26) is similar to unit 1 except that the call-signal station has a front-crank hand ringing generator instead of a side-crank hand ringing generator.

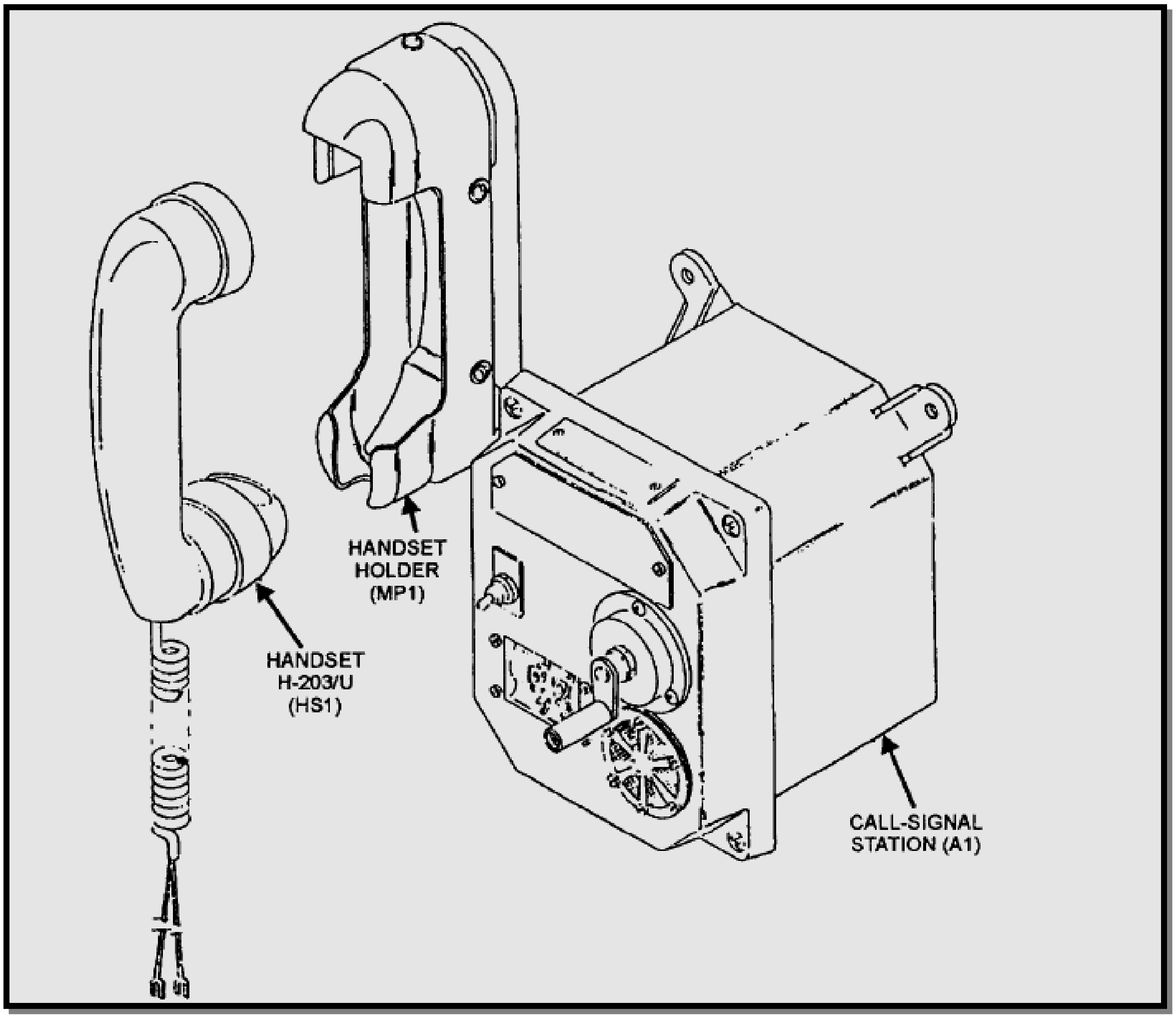


Figure 5-26.—The TA-975/WTC-2(V) sound-powered telephone set, unit 2.

UNIT 3.— Unit 3 (fig. 5-27) is a console-mounted terminal station consisting of four separate components: BCP console 3A1, hand-ringing generator 3A2, audible alarm BZ-240/WTC-2(V), and handset HS1. BCP console 3A1 and hand ringing generator 3A2 serve the same purpose as the cover assembly in unit 1. The audible alarm component houses an electrical horn for remote audible signaling.

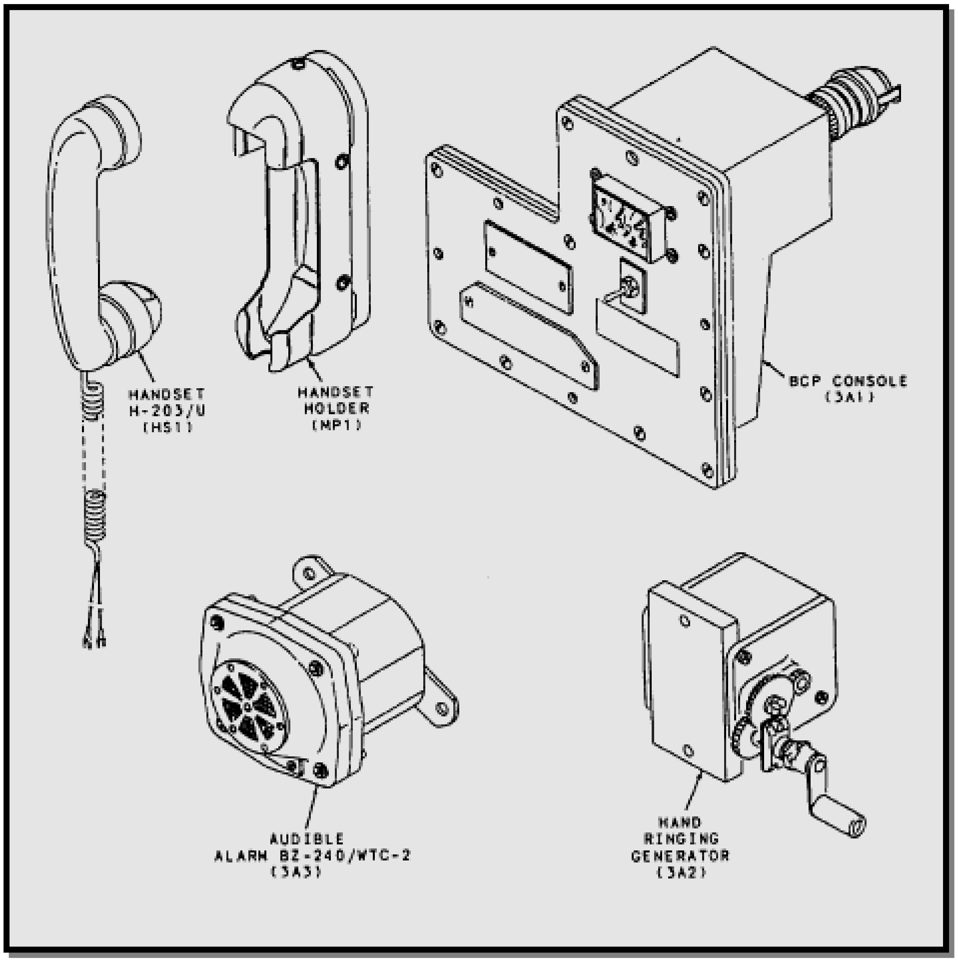


Figure 5-27.—The TA-975/WTC-2(V) sound-powered telephone set, unit 3.

UNIT 4.— Unit 4 is a standard sound-powered telephone single-gang jackbox.

UNIT 5.— Unit 5 is a standard H-200/U sound-powered telephone headset-chestset. Unit 5 is used with unit 4 and may also be connected to a terminal station equipped with a jack.

UNIT 6.— Unit 6 (fig. 5-28) provides a means of connecting an extension visual signal device to ship's power in areas where such a device is required. Unit 6 is comprised of a relay assembly mounted inside an enclosure assembly. The dc voltage from a calling terminal station activates the relay, which connects the 115-volt power circuits to as many as three extension visual signal devices.

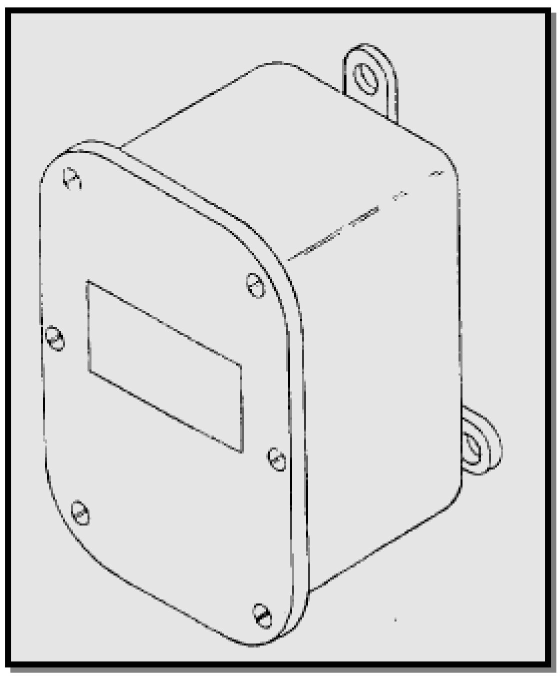


Figure 5-28.—The 6J-3523/WTC-2(V) distribution box, unit 6.

The extension visual signal device (fig. 5-29) provides a visual signal to a location remote from a terminal station when additional signaling is required due to high noise levels or physical barriers to sound near a station. The extension visual signal device uses a 50-watt incandescent lamp.

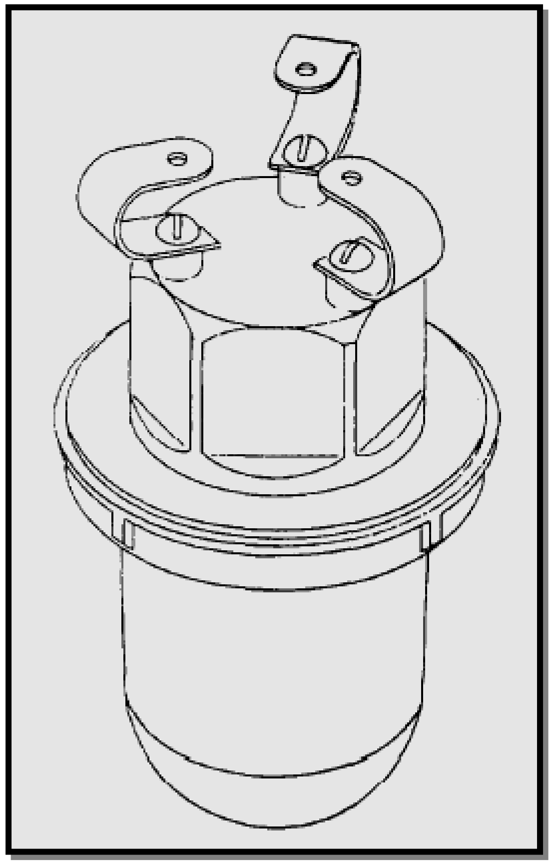


Figure 5-29.—Extension visual signal device.

UNIT 7.— Unit 7 (fig. 5-30) is used to test the terminal stations, it has the capability of testing the continuity of the station selector switches and associated wiring of the terminal stations. The test set is a portable bench top unit that mainly consists of an ON/OFF toggle switch, a transformer, and 24 light emitting diodes to test the continuity of the two station selector switches on the terminal stations.

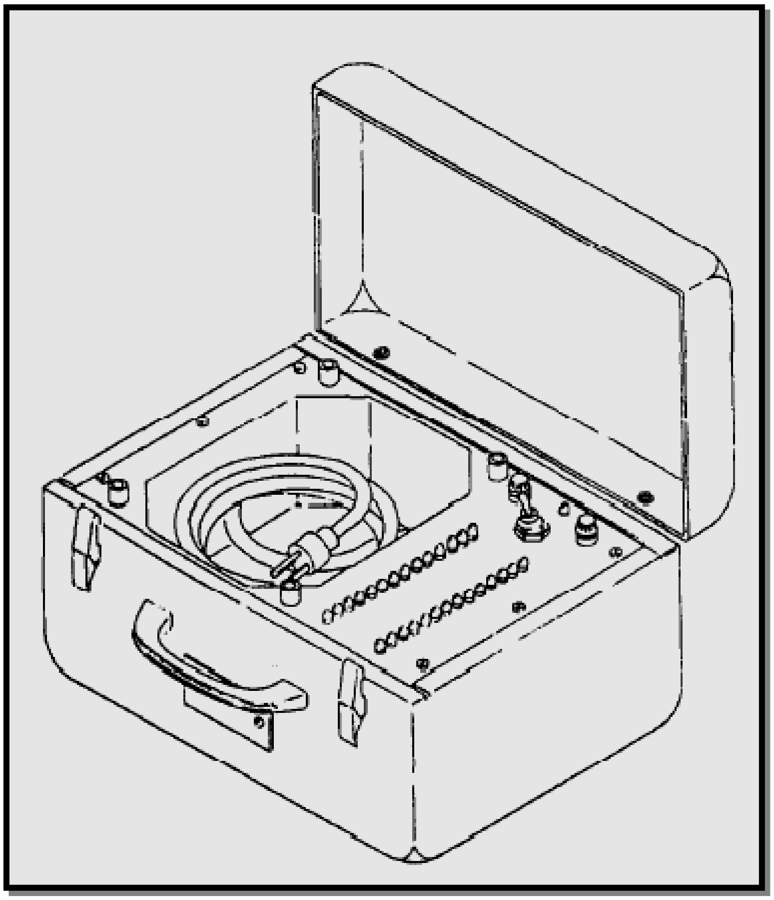


Figure 5-30.—The TS-3687/WTC-2(V) telephone test set unit 7.

UNIT 8.— Unit 8 (fig. 5-31) provides an audible signal to a location remote from a terminal station when additional audible signaling is required due to high noise levels or physical barriers to sound near a terminal station. The audible alarm consists of an electrical horn mounted within the component. The audible alarm is also supplied as one of the components for unit 3.

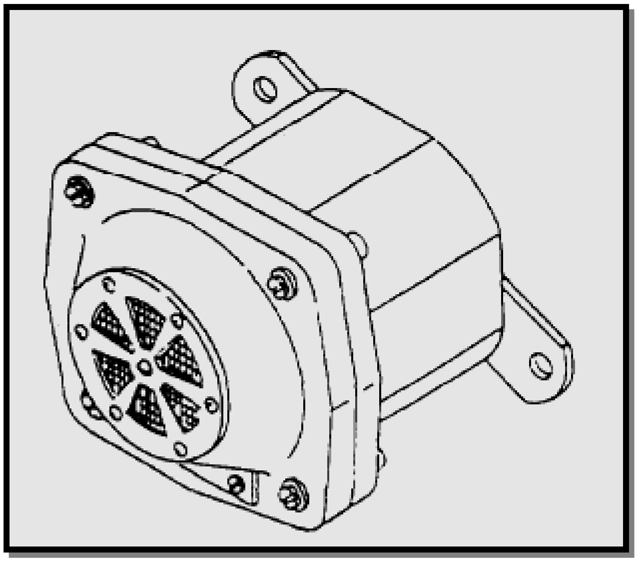


Figure 5-31.—The BZ-240/WTC-2 (V) audible alarm, unit 8.

5.10.2 System Operation

The system can be used to make point-to-point (station-to-station) calls and conference calls. The system also provides net access, call holding, and executive override functions.

Point-to-Point Calls

Point-to-point calls can be made from any terminal station to any other terminal station. To initiate a point-to-point call, you should perform the following procedures:

1. Set the PLACE CALL/ANSWER switch to the PLACE CALL position.

2. Select the desired station number on the thumbwheel switches.

3. Remove the handset from its holder, depress the handset press-to-talk switch, and listen for talking on the line. If the line is clear, continue to step 4. If the line is not clear (busy), return the handset to its holder, and set the PLACE CALL/ANSWER switch in the ANSWER position.

4. Turn the crank several times to ring the desired station.

5. Talk to the desired station. After the call is completed, return the handset to its holder, and set the PLACE CALL/ANSWER switch to the ANSWER position.

To answer an incoming point-to-point call, you should perform the following procedure:

1. Set the PLACE CALL/ANSWER switch to the ANSWER position (the switch should already be in the ANSWER position).

2. Remove the handset from its holder and depress the handset press-to-talk switch and acknowledge the call.

3. When the call is completed, return the handset to its holder.

Conference Calls

A conference call involves the sharing of the same line among a number of terminal stations. The number of participants (stations) involved in a conference call should be limited to five, as each additional station will cause a drop in the audio-signal level. To initiate a conference call, you should perform the following procedure:

1. Place a point-to-point call to the first desired station.

2. Inform the called station that a conference call is being established, and give the called station your station number.

3. Repeat steps 1 and 2 for each terminal station you desire to participate in the conference call.

4. After each station has been contacted, rotate the thumbwheel switches to your own terminal station number and begin the conference.

5. When the conference call is completed, return the handset to its holder, and set the PLACE CALL/ANSWER switch to the ANSWER position.

To answer an incoming conference call, you should use the following procedure:

1. Answer the same as you would for a point-to-point call.

2. When the caller informs you that it is a conference call, set the thumbwheel switches to the caller's station number and wait for the conference to begin.

3. When the conference call is completed, return the handset to its holder.

Net Access

The AN/WTC-2(V) system is an integrated point-to-point and net communications system. When the system is installed aboard ship, certain interconnecting wire pairs and their associated station numbers are reserved for net (string circuits) use. A net consists of designated stations and their associated units, and only the stations in a net have access to that particular net. The system contains several nets so certain stations may operate as a string circuit during particular conditions, such as general quarters. Ringing is not possible in a net; stations must already be manned to accomplish the desired communications.

Net access can be obtained through the use of either the terminal station handset or a headset-chestset plugged into either the station jack or an associated jackbox. To access a net using the terminal station handset, you should perform the following procedure:

1. Select the predetermined net station number on the thumbwheel switches.

2. Set the PLACE CALL/ANSWER switch to the PLACE CALL position. Do not turn the crank.

3. Depress the press-to-talk switch on the handset to establish communications with the net.

4. When finished, return the handset to its holder and set the PLACE CALL/ANSWER switch to the ANSWER position.

To access a net using the headset-chestset, you should perform the following procedure:

1. Connect the headset-chestset to either the jack on the terminal station or to the associated jackbox.

2. Depress the press-to-talk switch to establish communications on the net.

3. When finished, disconnect the headset-chestset from the jack or jackbox and stow it.

Call Hold

The call hold function is used by a terminal station that has originated a call and desires to maintain communication with the called station while answering an incoming call. To perform the call hold function, you should use the following procedure:

1. Inform the called station that you have an incoming call, and tell the called station to stay on the line while you answer the call.

2. Answer the call according to normal procedures by setting the PLACE CALL/ANSWER switch to the ANSWER position.

3. When you have finished with the incoming call, set the PLACE CALL/ANSWER switch to the PLACE CALL position and continue with your original call.

Executive Override

When a station has received a call and is talking to the calling station at the time a second call is received, the second call is considered an override function. The call hold function cannot be used in this case.

5.10.3 Communication Interference

Communication interference while making point-to-point, conference calls, or both may occur due to cross talk and looping.

Cross talk

Cross talk is the effect created when an AC signal from one lead in a cable induces a small voltage into the adjacent lead. Crosstalk, while usually always present, is at a relatively low audio level and will be heard as a faint background conversation during a call.

Looping

Looping is an undesirable and unintentional formation of a complex series-parallel circuit among stations that are simultaneously busy. This is a result of a direct connection between terminal stations when an excessive number of simultaneous point-to-point calls are being made.

To create a loop, four or more point-to-point, conference calls, or both must be in progress at the same time and a particular and predictable relationship must exist among the station numbers of the called stations. The numbers of the calling stations are immaterial since the cable pairs carrying the calls are those assigned to the called terminal station. The called station is permanently connected to those pairs that carry the call, while the calling station connects itself in parallel to those pairs by the use of the station selector switch.

When a loop is formed, the operators of the affected stations will simultaneously hear all conversations among the stations involved in the loop. The conversations will be at relatively high audio levels, making normal communications among these stations impossible.

The only way to break a loop after it has formed is to end one of the calls. The press-to-talk switches on both handsets of the stations involved must be released to end the call. NEVER tape down the press-to-talk switch of a handset. A taped down switch will act as a continuous call even when a call is ended.

There is a caution label plate on the front cover of each terminal station to caution operating personnel against excessive traffic.

5.10.4 System Maintenance

Preventive and corrective maintenance for the system should be accomplished according to the applicable MRCs and associated technical manual(s) for the system.

5.11.0 VOICE TUBES

Voice tubes are installed aboard ship in addition to the sound-powered telephone system to provide another way for transmitting information between designated stations. The voice tube is used to transmit voice orders and information over short distances by nonelectrical means. Voice tubes are made of 3-inch brass, thin-walled tubing fitted with mouthpieces at each end. Voice tubes are installed between the following stations aboard ship as applicable:

- From the pilothouse (helmsman’s station) to the navigation bridge wings (port and starboard)

- From the pilothouse (helmsman’s station) to the exposed conning station (top of pilothouse)

- From the pilothouse chart table to the navigation bridge wing peloruses (port and starboard)

- From the chart room chart table to the navigation bridge wing peloruses (port and starboard)

- From the flag plot chart table to the flag bridge wing peloruses (port and starboard)

- From the pilothouse to the captain’s sea cabin

- Push buttons are installed at the pilothouse chart table and chart room chart table and are connected to energize a bell installed at each navigation bridge pelorus (port and starboard).

- Push buttons are installed at the flag plot and are connected to energize a bell installed at each flag bridge pelorus (port and starboard).

- A push button and buzzer are installed in the pilothouse and captain's sea cabin, with each push button connected to energize its respective buzzer.

5.12.0 SUMMARY

In this chapter, we have discussed how the sound-powered telephone system is used to provide a reliable means of verbal communication aboard ship. We have identified the various sound-powered telephone circuits used with the system.

We have explained how to operate and maintain the equipment used with the sound-powered telephone system. We have identified the call and signal circuits used with the sound-powered telephone system. We also have explained how to operate and maintain the associated equipment used with the call and signal circuits.

We have discussed the operation of the AN/WTC-2(V) sound-powered telephone system and the use of voice tubes aboard ship.

6 AUTOMATIC DIAL TELEPHONE SYSTEM

Upon completion of this chapter, you will be able to do the following:

- Describe the purpose of the automatic dial telephone system installed on Navy ships including IVN, IVCS, and MARCOM IVCS.
- Identify the two versions of the type G telephone sets used with the system.
- Describe how the two versions of the type G telephone sets operate and how the sets are maintained.
- Identify some of the more common troubles associated with the telephone sets.
- Describe some of the different types of telephone switchboards and how they are maintained.
- Describe the functions of the automatic dial telephone switchboards.
- Identify the automatic switching equipment used with the switchboard.
- Describe the function of the attendant's cabinet used with the switchboard.
- Describe the procedures for isolating and clearing the various alarms associated with the switchboard.
- Briefly describe some of the preventive maintenance procedures associated with the switchboard and the attendant's cabinet.
- Describe how shore lines are connected to the ship's automatic dial telephone system and other telephone sets on the ship.

6.0.0 INTRODUCTION

The automatic dial telephone system (designated circuit J) is used on board ship primarily as an administrative circuit. It also supplements other communication facilities for ship control, fire control, and damage control on board ship. The automatic dial telephone system provides two-way telephone communications on a fully selective basis under the direct control of the calling stations. This includes two-way communications between telephone line stations throughout the ship and between ship and shore systems.

In an automatic telephone system, the connections between the telephones are completed by remotely controlled switching mechanisms. The switching mechanisms are controlled at the calling phone by a dial on the telephone instrument. When the dial is operated, it causes a series of interruptions, or impulses, in a current flowing in the line circuit. The number of impulses sent out by the dial corresponds to the digit dialed. These impulses cause the automatic switches to operate and to select the called telephone.
The automatic dial telephone system consists of (1) telephone line station equipment and (2) an automatic dial telephone switchboard that includes the switching mechanisms necessary to interconnect the line stations and accessory equipment used to interconnect the ship's system with shore systems when the ship is in port.

6.1.0 TELEPHONE LINE STATION EQUIPMENT

The telephone line station equipment consists of a telephone set connected to a set of line terminals of an automatic dial telephone switchboard and, in some cases, auxiliary equipment.

The auxiliary equipment consists of extension signal relays and extension signal devices (visual or audible) for use in high-noise areas. An extension signal relay is a relay in an enclosure mounted externally to a telephone set. The operating coil of the relay is connected in parallel with the ringer of the telephone set. The relay contacts are designed to open and close a ship's 120-volt power circuit to energize an extension signal. An extension signal is a visual or audible signal mounted externally to a telephone set.
The signal is controlled by an extension signal relay.

The telephone set is a compact unit that transmits and receives speech, and signals the desired station. The telephone set is made up of a transmitter, receiver, dial, and ringer. The transmitter changes sounds into current variations that are sent over an electrical circuit. The receiver changes the current variations back into sound. The dial, when operated, causes a series of interruptions (impulses) in the current flowing in the line circuit. The ringer provides an audible signal when the station is called. The most common telephone sets installed aboard ship today are the type G sets.

There are two versions of the type G telephone set available for use in the automatic dial telephone system. Both versions are designed to provide shipboard, point-to-point communications over automatic dial telephone lines. Both versions can be used for either one- or two-party service. However, the physical makeup and circuitry of the two versions are different.

6.1.1 TYPE G TELEPHONE SET (VERSION 1)

There are four models of the type G (version 1) telephone set: the basic nonrestricted set, the restricted set, the portable set, and the modular set.

Basic Nonrestricted Set

The basic nonrestricted telephone set (fig. 6-1) is designed for nonrestricted communications. This set can be used in three different configurations to accommodate all ships' mounting requirements. Each configuration consists of the appropriate enclosure and basic telephone set as shown in figure 6-2.

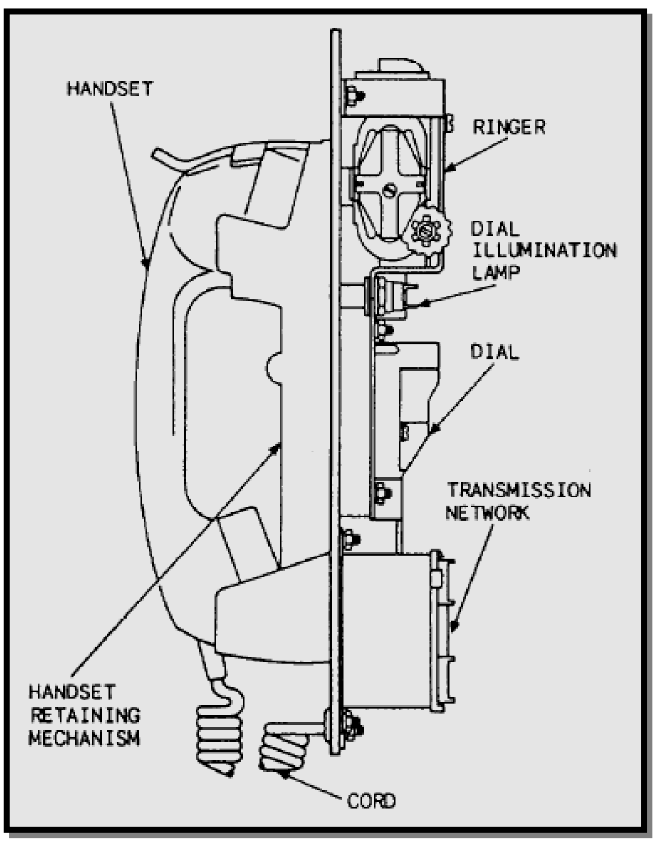


Figure 6-1.—Type G (version 1) basic nonrestricted telephone set.

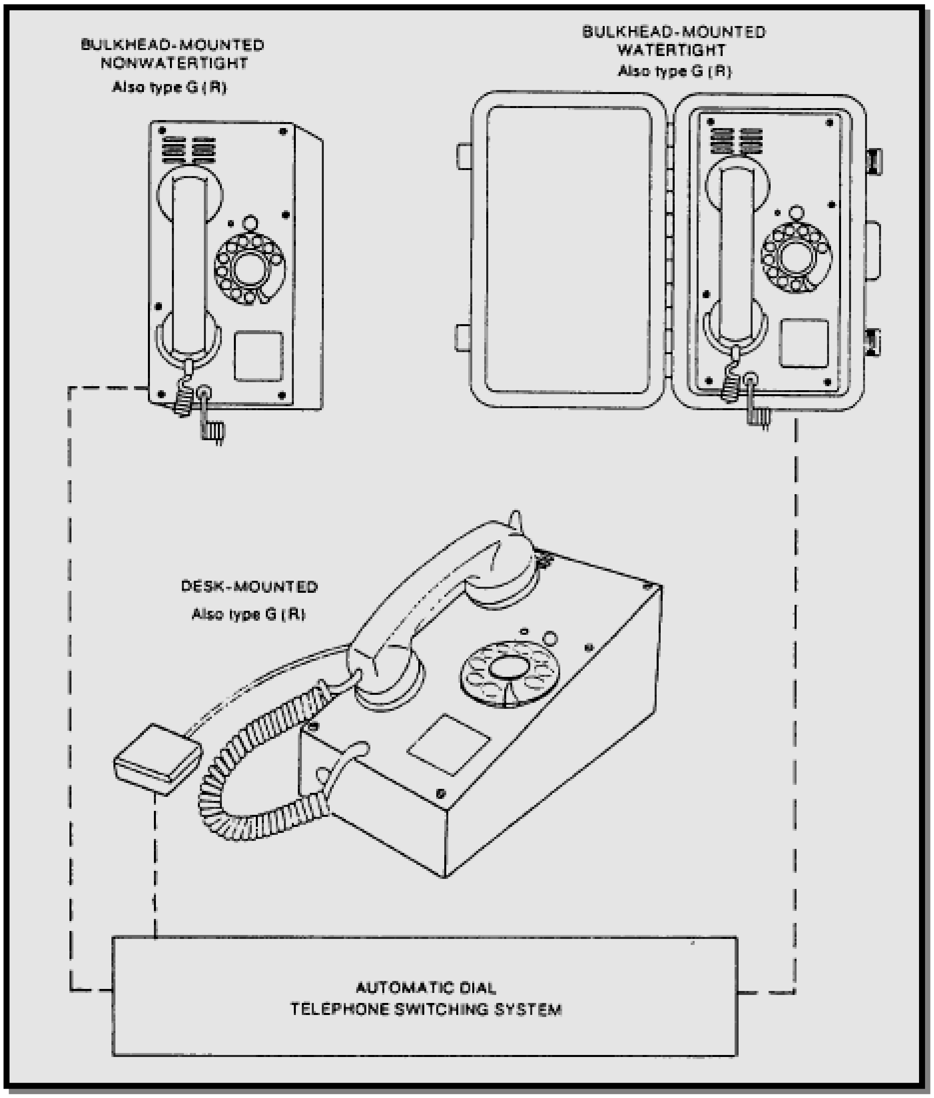


Figure 6-2.—Type G (version 1) telephone set configurations.

Bulkhead-mounted telephone sets, both watertight and nonwatertight, are connected to the automatic dial telephone switchboard electrically by connecting the telephone line (ship's cable) to a screw-type terminal board mounted within the enclosure. Desk-mounted telephone sets are connected to the switchboard by an external connector block furnished with the sets.

The handset holder and handset retaining mechanism are mounted on the front of the stainless steel cover. The remainder of the components are mounted either directly on the back side of the cover or on a steel baseplate (chassis), which is secured to the back side of the cover. There is a cutout in the cover to allow the dial to protrude through for dialing access. The cover can be mounted on any of the three enclosures. In addition, the set can e flush-mounted in a console panel or bulkhead cutout.

HANDSET.— The handset (fig. 6-3) houses the transmitter, the transmitter mounting cup, and the receiver. The handset can be equipped with a standard transmitter or a noise-cancelling dynamic transmitter for use in high-noise areas. By connecting the handset cord terminals to a screw-type terminal board mounted within the telephone set, you can electrically connect the handset to the telephone set.

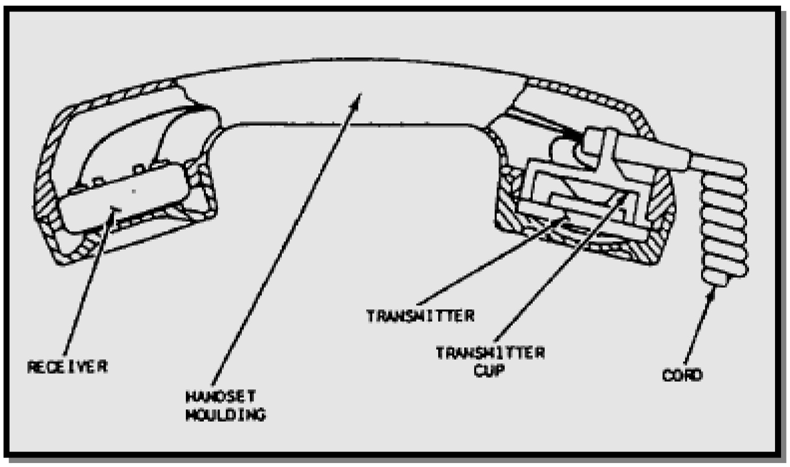


Figure 6-3.—Type G (version 1) telephone handset.

HANDSET RETAINER SLIDE.— The handset retainer slide is a mechanical control that secures the handset in the handset holder. When the handset is replaced in the handset holder, this control is activated automatically to lock the handset in place.

SLIDE ASSEMBLY RELEASE CONTROL.— The slide assembly release control is a mechanical control that consists of a button that must be depressed to unlock the handset retainer slide. When the handset retainer slide is unlocked, the handset can be removed from the handset holder.

TRANSMISSION NETWORK.— The transmission network is the control circuit for the telephone set. The transmitter output and all inputs to the receiver are extended to and from the associated automatic dial telephone switchboard under the control of this circuit. This circuit also produces and controls receiver sidetone (transmitter sounds reproduced in the receiver of the same handset).

Figure 6-4 is a simplified schematic diagram of the transmission network circuit. The handset transmitter and receiver, the hookswitch contacts, and the dial contacts are also shown to simplify the description of the circuit.

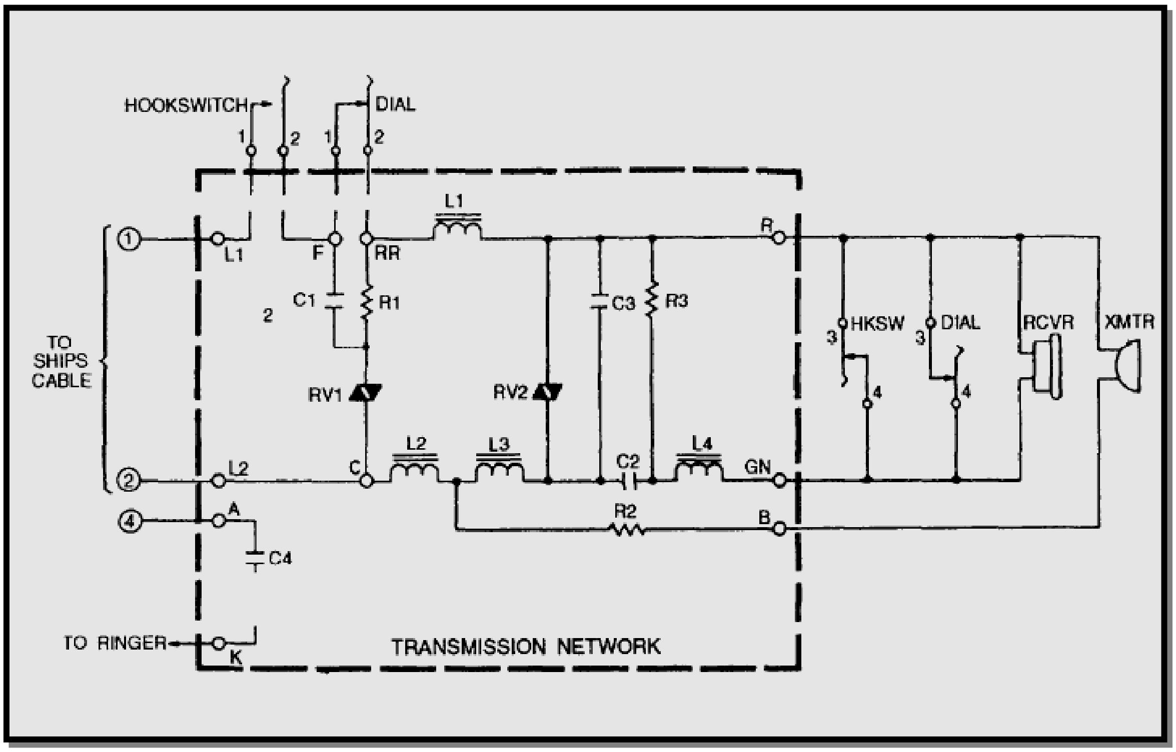


Figure 6-4.—Simplified schematic diagram of the transmission network.

When the handset is removed from the handset holder, hookswitch contacts 1 and 2 close the dc loop between terminal 1 (L1) and terminal 2 (L2) by normally closed dial (impulse spring) contacts 1 and 2 and dc paths 1, 2, and 3.

Dc path 1 is through resistor R1 and varistor RV1. Resistor R1 limits the current through varistor RV1 to protect it from high line-voltage surges. Varistor RV1, with varistor RV2, acts as an automatic gain control to maintain a constant input and output level over the range of loop resistance encountered when used with any specific automatic dial telephone switchboard.

Dc path 2 is through inductor L1, the transmitter, resistor R2, and inductor L2. This path prepares the transmitter for audio excitation. Inductors L1 and L2 balance the line for varying levels of outgoing and incoming audio signals. Resistor R2 limits the current through the transmitter to protect it from high line-voltage surges.

Dc path 3 is through inductor L1, varistor RV2, and inductors L3 and L2. This is a balancing and gain control path, with varistor RV2 acting with varistor RV1 as described in path 1. Inductors L1 and L2 function as described in path 2. Inductor L3 aids in balancing the circuit and, by mutual inductance, couples audio signals from the transmitter circuit to inductor L4 in the receiver circuit. The coupling between inductors L3 and L4 results in the receiver producing a comfortable level of sidetone.

When contacts 1 and 2 close the dc loop, the automatic dial telephone switchboard produces dial tone for outgoing calls and cuts off ringing voltage on incoming calls.

At the same time that the dc loop is closed, the incoming and outgoing audio loops are also closed. The incoming audio loop is closed by hookswitch contacts 1 and 2, dial contacts 1 and 2, inductor L1, the receiver, inductor L4, capacitor C2, and inductors L2 and L3. Audio signals appearing at terminals 1 (L1) and 2 (L2) cause the receiver to reproduce the audio signals generated at the calling station (speech, busy tone, howler tone, and so on).

The outgoing audio loop is the same as that described in dc path 2. When speech or other audio patterns excite the transmitter, the direct current flowing through the transmitter varies around its nominal value at the audio source frequency. This variation extends to terminals 1 (L1) and 2 (L2) and, subsequently, to the distant end (receiving telephone) by the loop. The loop consists of hookswitch contacts 1 and 2, dial contacts 1 and 2, inductor L1, the transmitter, resistor R2, and inductor L2.

Capacitors C2 and C3 and resistor R3 function with varistors RV1 and RV2 as an impedance balancing network for line impedance. Capacitors C2 and C3 also compensate for the line capacitance. In addition, capacitor C2 prevents dc voltages from being extended to the receiver. Capacitor C4 is in the ringer circuit.

HOOKSWITCH.— The hookswitch automatically operates when the handset is removed from or replaced in the handset holder. When you remove the handset from the handset holder, the switch shifts to the off-hook position. When you replace the handset in the handset holder, the switch shifts to the on-hook position.

In the on-hook position, as shown in figure 6-4, hookswitch contacts 1 and 2 open to prevent any line currents from entering the transmission network circuit or the receiver and transmitter when the telephone set is not in use. Contacts 3 and 4 close, placing a short circuit across the receiver to bypass any internal flow of current around the receiver. This guards against demagnetizing the receiver.

In the off-hook position, hookswitch contacts 1 and 2 close to connect the telephone set to the line. Contacts 3 and 4 open to remove the short circuit from across the receiver, thereby preparing the receiver for response to audio inputs or sidetone.

When you remove the handset from its holder to place a call, the dial and transmission network assemblies send an off-hook supervisory signal to the automatic dial telephone switchboard. This signal informs the switchboard to extend dial tone (100 millivolts [mV] peak-to-peak, 600 Hz modulated with 120 Hz) to the telephone set when it is ready to accept dialing.

If you do not start dialing within 30 seconds, the supervisory signal informs the switchboard to extend the howler tone (600 Hz at 8 impulses per second) to the telephone set. To regain the dial tone, you must hang up.

DIAL.— The dial on the basic nonrestricted telephone set operates in the same manner as a rotary dial on commercial telephones.

When the dial is at rest (no digits being dialed), dial contacts 1 and 2 close and contacts 3 and 4 open. When the dial is rotated, dial contacts 3 and 4 close to short the receiver. Shorting the receiver prevents dial pulses from entering the receiver. If dial pulses enter the receiver, the receiver could become demagnetized. Contacts 3 and 4 remain closed as long as the dial is rotating.

When the dial is released, contacts 1 and 2 open and close according to the digit dialed. For example, if the digit dialed is a 4, contacts 1 and 2 will open the dc loop four times as the dial returns to the rest position. These four dc impulses inform the associated automatic dial telephone switchboard that digit 4 has been dialed. This process will be repeated for each digit dialed. Capacitor C1 and resistor R1 in the transmission network are bridged across dial contacts 1 and 2 to suppress contact arcing.

If the called number is busy or the automatic dial telephone switchboard is operating at full capacity, the switchboard will extend a busy tone (100 mV peak-to-peak, 600 Hz interrupted at 60 impulses per minute) to the telephone set.

DIAL ILLUMINATION LAMP AND LAMP DIMMER CONTROL.— When the handset is removed from the handset holder, a lamp mounted above the dial illuminates the dial. You can vary the brightness of the dial lamp with the lamp dimmer control, which is an adjusting screw. By using a screwdriver, you can access the dimmer control through a cutout provided in the cover. The lamp and lamp dimmer control circuit (fig. 6-5) is a basic dc circuit where dc voltage is applied to the telephone set terminal board on terminals 5 and 6. Terminals 4 and 6 will be connected to lead JJ9 of the ship's cable. The voltage is extended to the lamp and lamp dimmer control circuit through a pair of hookswitch contacts that close when the handset is removed from the handset holder.

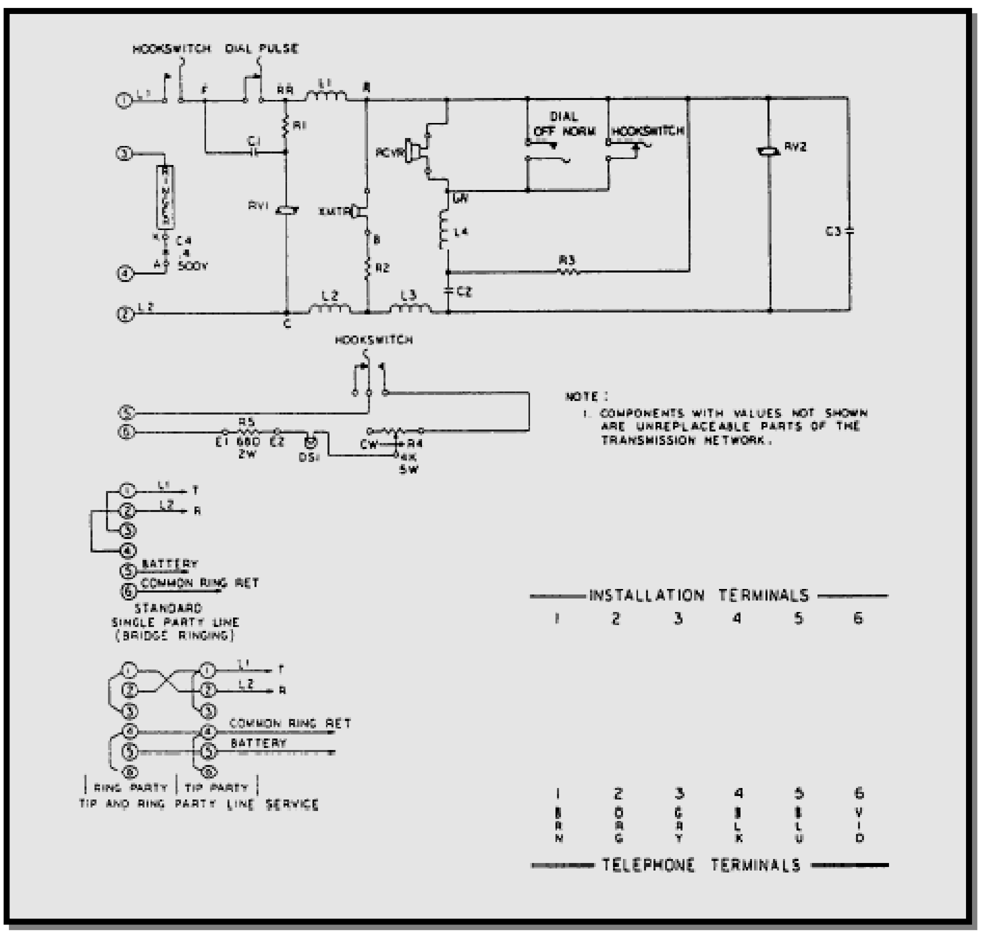


Figure 6-5.—Schematic diagram of the type G (version 1) telephone set

RINGER.— A gong and clapper-type ringer is used in the telephone set to alert personnel of an incoming call. The ringer circuit (fig. 6-5) is a basic ac circuit where 75 to 110 volts ac, 20 Hz is applied to terminals 3 and 4 of the telephone set terminal board. Capacitor C4, located in the transmission network, tunes the ringer and blocks dc voltage.

The ringer can be connected to the telephone line for one-party (private-line) service or two-party (party-line) service (fig. 6-5). For one-party service, ringing voltage is applied to the telephone set terminal on the tip (1) and ring (2) terminals. It is then bridged to terminals 3 and 4.

For two-party service, a third wire (common ring return) is used and connected to terminal 4 of both telephone sets. Ringing voltage is then applied to one telephone set across tip terminal (1) and terminal 4 and to the other telephone set across ring terminal (2) and terminal 4.

Restricted Telephone Set

The type G (R) restricted telephone set is used in security areas where the chance of inductive coupling of signals to the telephone set might compromise the security established for that area. This telephone set is equipped with a noise-cancelling transmitter, shielded handset and deskset cords, and a push-to-talk (PTT) switch. This set has a distinctive identification plate to distinguish it from the nonrestricted set. The identification plate has “Restricted” as the first line and “(R)” after the type designation. The restricted telephone set is also adaptable for high-noise areas because of the PTT and noise-cancelling transmitter features.

Figure 6-6 illustrates a basic type G (R) telephone set. This set will fit the same enclosures as the basic type G nonrestricted set. Figure 6-7 illustrates a handset and cord assembly for the type G (R) set.

Figure 6-8 is a schematic diagram of the type G (R) set.

The components and component operation of the type G (R) telephone set are identical to the basic type G nonrestricted set, except for the PTT switch and the shielded cords. The type G (R) set is also maintained in the same manner as the basic type G nonrestricted set.

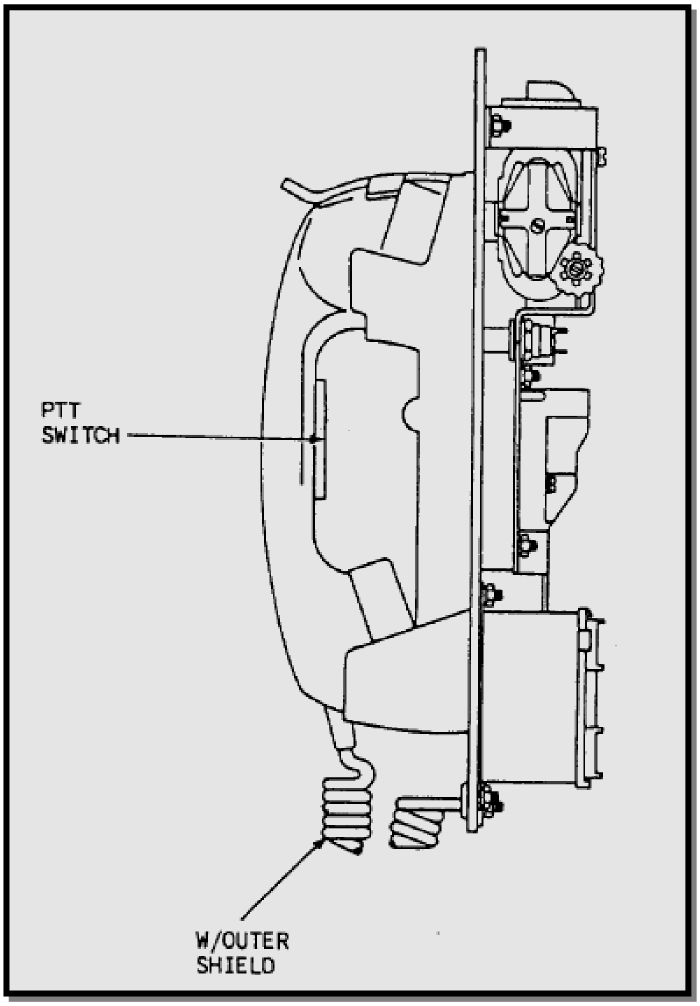


Figure 6-6.—Basic type G (R) restricted telephone set.

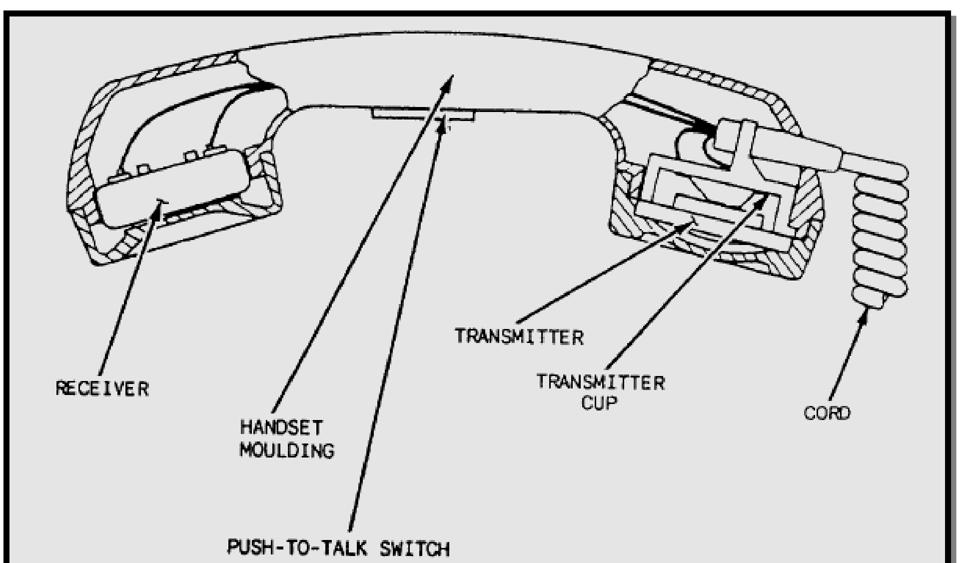


Figure 6-7.—Handset and cord assembly of the type G (R) set.

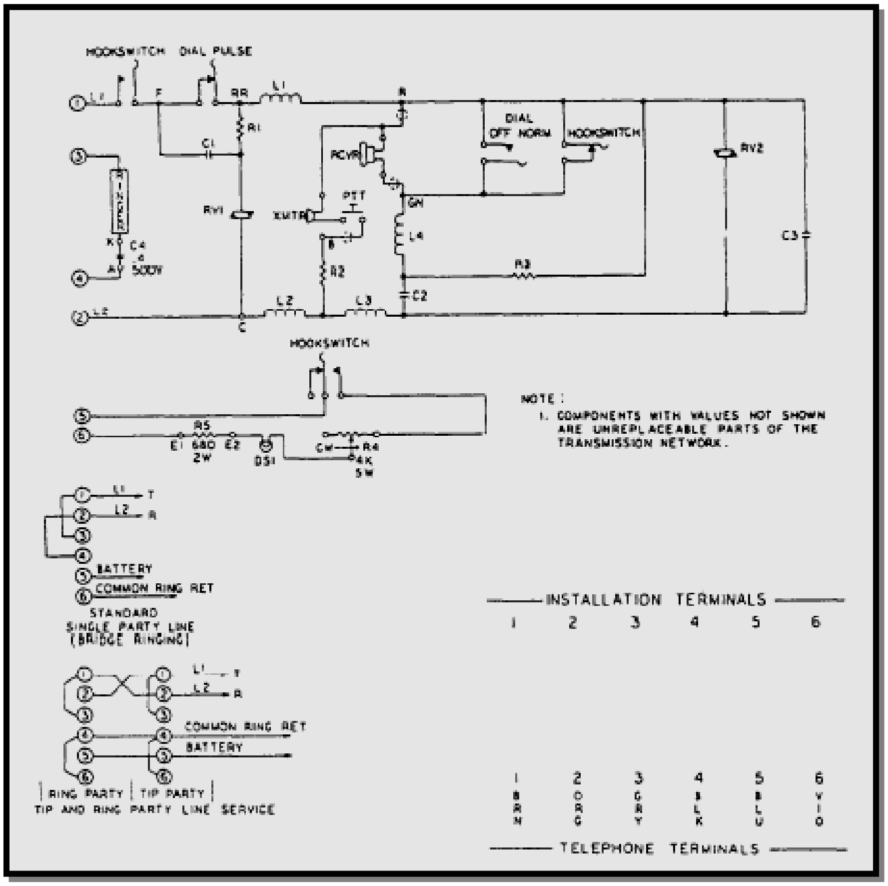


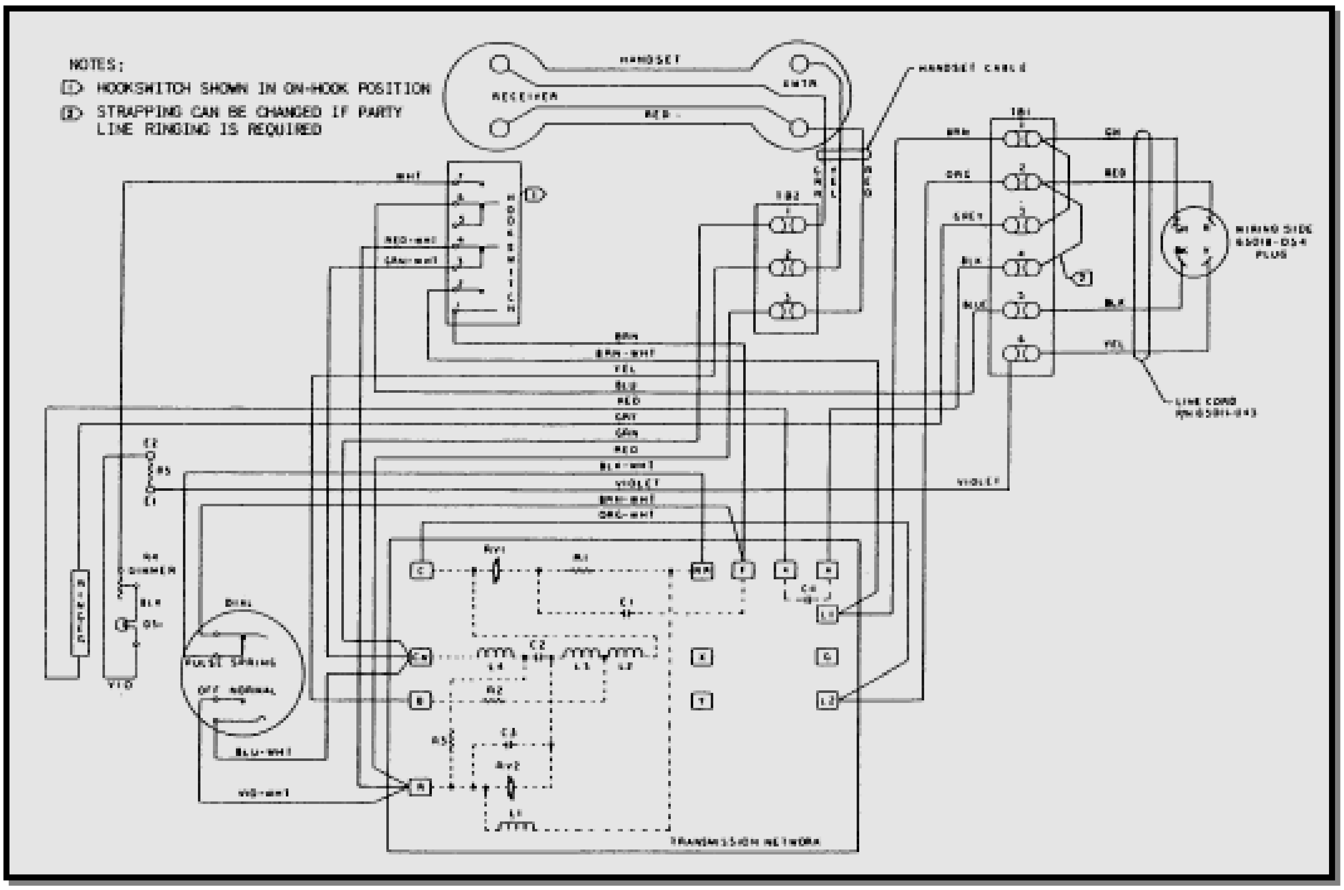
Figure 6-8.—Schematic diagram of the type G (R) set.

Portable Telephone Set

The type G portable telephone set is identical to the type G desk-mounted telephone set, except for mounting and electrical connections. The portable telephone set is provided with a cord and plug that connects to a jack in a telephone outlet box. The telephone outlet box is connected to the automatic dial telephone switchboard. The portable telephone set may be used at any location where a telephone outlet box is installed.

The telephone outlet box is a metal waterproof box designed for bulkhead mounting. A stuffing tube at the top of the box provides for electrical connections to the telephone switchboard. The box contains the telephone jack that accommodates the telephone set plug. The box also has a hinged cover to protect the jack when it is not being used.

Figure 6-9 is a wiring diagram of the type G portable telephone set. The set operates and is maintained in the same manner as the basic type G desk-mounted set.

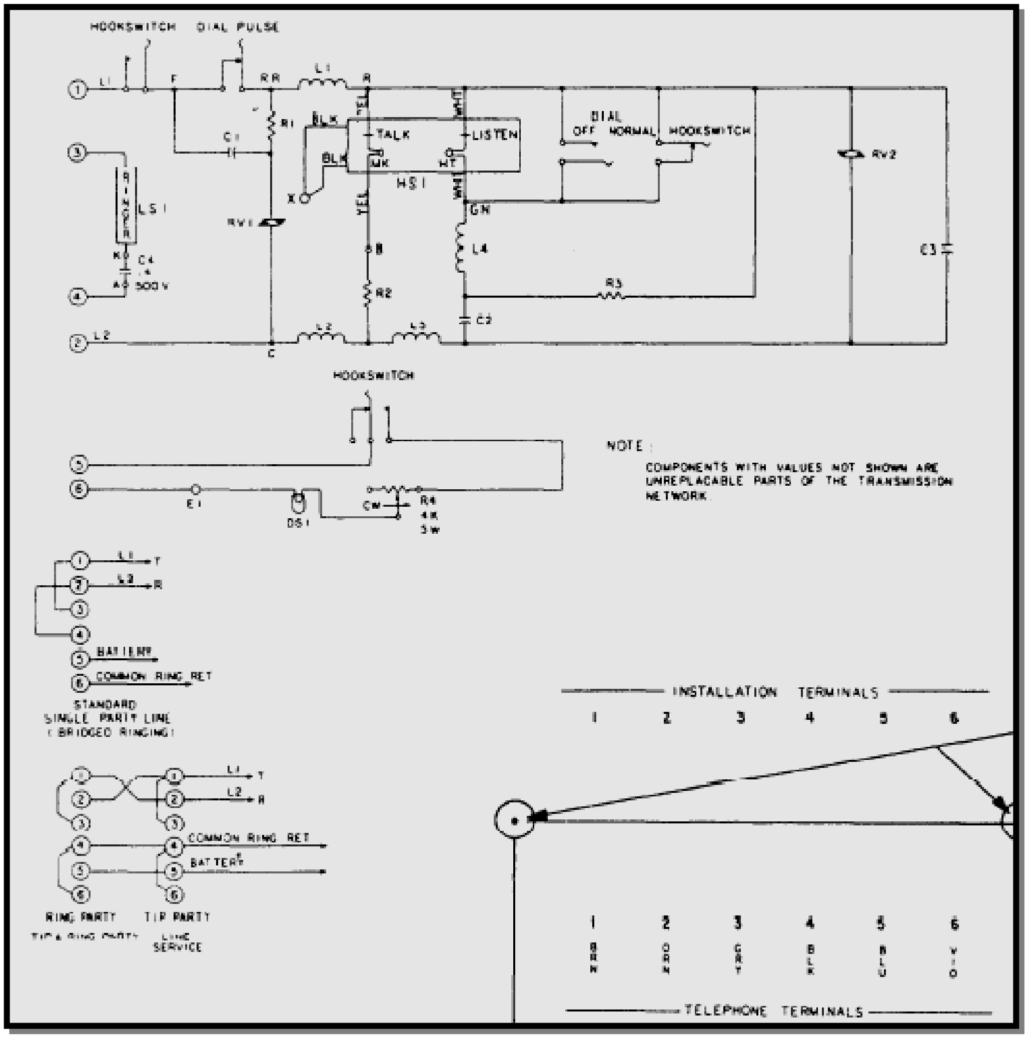


Representative Graphic. Consult appropriate Technical Manual for trouble shooting.

Figure 6-9.—Wiring diagram of the type G portable telephone set.

Modular Telephone Set

There are six models of the type G modular telephone set: a desk-mounted nonrestricted, a desk-mounted restricted, a bulkhead-mounted nonwatertight nonrestricted, two bulkhead-mounted nonwatertight restricted, and a bulkhead-mounted watertight nonrestricted. Each model is comprised of two units: the telephone set and its respective enclosure. The components and operation of the type G modular sets are identical to the basic nonrestricted and restricted type G sets, except for the modular connectors. Each enclosure has a schematic diagram (fig. 6-10) pasted inside it for convenience in troubleshooting.



Representative Graphic. Consult appropriate Technical Manual for trouble shooting.

Figure 6-10.—Schematic diagram of the type G modular telephone set.

6.1.1.1 Preventive Maintenance

The type G (version 1) telephone set, due to its simple design, requires very little preventive maintenance. Most routine tests are performed during normal operation of initiating and answering calls.

However, this type of set should be inspected and routine tests should be performed as described in the following paragraphs.

TELEPHONE SET INSPECTION.— The following operations should be performed during a routine inspection of the type G (version 1) telephone set:

1. Inspect the handset for broken or loose transmitter or receiver caps.
2. Check the handset cord for wear. Replace worn, frayed, or noisy cords. To check for a noisy cord, roll the cord back and forth between your hands while listening for a clicking or cracking noise in the receiver.
3. Inspect the handset holder for wear or chipping.
4. Check the handset retaining mechanism for positive action on release and lock functions.
5. Inspect the hookswitch lever for signs of wear. Depress the lever and check for positive outward movement of the lever on the release.

PERFORMANCE TEST.— The following operations should be performed when conducting performance tests of the type G (version 1) telephone set:

1. Remove the handset and check for the dial tone.
2. Check to see that the dial illumination lamp is lit, and rotate the dial dimmer control to see that lamp intensity varies.
3. Replace the handset in its holder to see if the illumination lamp goes out.
4. Remove the handset and wait 30 seconds for the howler tone.
5. Depress the hookswitch and release it to regain the dial tone.
6. Dial 0 and check to see if the dial returns to its normal position in approximately 1 second.
7. Listen for unwanted clicking (dial pulses) in the receiver unit.
8. Dial a number and listen for the ringback tone in the receiver unit.

9. Talk to a person at another station and determine if transmission and reception quality is satisfactory. Check that sidetone is reduced so as not to interfere with normal conversation.

10. Ask a person at another station to call you back so you can check the ringing level of the set and to see that ringing stops when the handset is removed from the handset holder.

When a preventive maintenance check reveals a malfunction in the telephone set, some form of corrective action is required.

6.1.1.2 Corrective Maintenance

Corrective maintenance of the type G (version 1) telephone set includes adjustments and replacement of failed components.

ADJUSTMENTS.— There are three adjustments on the type G (version 1) telephone set: the dial illumination lamp intensity adjustment, the ringer adjustment, and the dial speed adjustment.

Dial Illumination Lamp Intensity.— The brightness of this lamp is controlled by the dial illumination dimmer control. This control is accessed through a hole in the front panel and is adjusted with a screwdriver. You should rotate the control in a clockwise direction to brighten the lamp and in a counterclockwise direction to dim the lamp.

Ringer.— This adjustment can be made while the telephone set is on line or off line. For on-line adjustment, remove the set from its enclosure and have someone call the set number from another station. While the ringer is sounding, rotate the ringer adjustment control in the appropriate direction to obtain the desired ringing level.

For off-line adjustment, you will need two clip leads and a ringing voltage supply (75 volts at 20 Hz). Remove the telephone set from its enclosure and disconnect the terminal wires. Using the clip leads, connect the ringing voltage supply leads to the terminals of the grey and black leads. The ringer should sound. Rotate the ringer adjustment control in the appropriate direction to obtain the desired ringing level. Disconnect the ringing voltage supply from the terminals of the grey and black leads.

Dial Speed.— The bottom hook on the dial tension spring is attached to one of three tabs on the dial frame as shown in figure 6-11. To increase dial speed, use a pair of needle-nosed pliers to detach the tension spring hook from the tab being used. Then, attach the tension spring hook to the next tab in the clockwise direction. To decrease dial speed, attach the hook to the next tab in the counterclockwise direction.

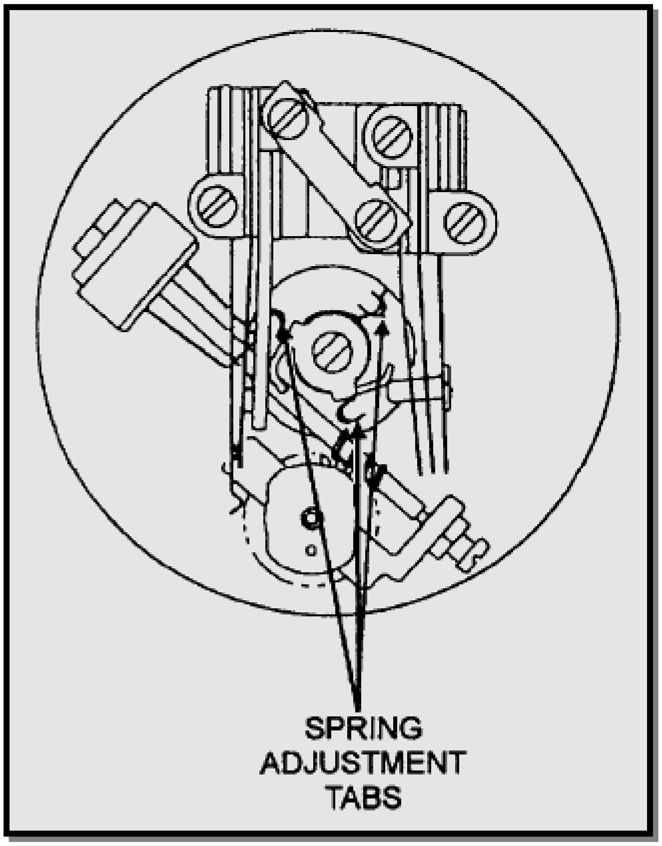


Figure 6-11.—Dial speed adjustment diagram.

REPLACEMENT OF COMPONENTS.— Most malfunctions of the type G (version 1) telephone set will be reported by those using the set. After verifying the malfunction, you should check all associated wiring for correct and secure connections before you attempt to troubleshoot the set for faulty components.

When working on the inside of the telephone set, you must follow high-voltage safety procedures. System line voltages can be as high as 54 volts dc and ringing voltages as high as 110 volts and can be dangerous. Always turn off and tag out the telephone station line switch at the automatic telephone switchboard before you begin working on the internal components of the telephone set.

When replacing the type G modular telephone sets, be sure you use the correct model set for the enclosure concerned.

The following paragraphs will discuss the procedures for replacing the components of the type G (version 1) telephone set.

Handset Transmitter and Receiver Units.— The transmitter and receiver units are not repairable and must be replaced if defective.

To replace a transmitter unit, unscrew the transmitter cap and lift the transmitter unit out of the transmitter mounting cup. Insert the new transmitter unit in the mounting cup and screw the transmitter cap onto the handset.

To replace a receiver unit, unscrew the receiver cap and lift the receiver unit out of the handset. Disconnect the handset cord red lead and green lead from the screw terminals of the receiver unit. Connect the red lead and green lead to the screw terminals of the new receiver unit. Insert the new receiver unit into the handset and screw the receiver cap onto the handset.

Handset Cords.— Handset cords are standard stock items and can be readily replaced when the cord becomes worn, frayed, or defective. To replace a handset cord, remove the telephone set from its enclosure and disconnect the three handset cord terminal wires from the terminal board on the set. Remove the cord from the telephone set and the handset from its holder. Remove the receiver unit from the handset, and disconnect the cord terminal wires from the receiver unit. Remove the transmitter unit and the transmitter mounting cup. Disconnect the handset cord terminal wires from the mounting cup. Carefully pull the handset cord from the cord hole in the handset housing.

Insert new cord terminal wires into the housing cord hole. There is one long green wire and one red jumper wire for connection to the receiver. There is also one short red wire and one short yellow wire for connection to the transmitter mounting cup. The other end of the red jumper wire connects to the same terminal on the mounting cup as the short red wire. The cord is pressure-fitted in the handset housing and locked in place by two tabs on the transmitter mounting cup.

Connect the handset cord terminal wires to the mounting cup, and put the transmitter back in the handset. Connect the cord terminal wires to the receiver, and put the receiver back in the handset. Gently insert the handset cord through the cord hole in the chassis of the telephone set. Install the strain relief bushing in the cord hole, and connect the terminal wires to the terminal board.

Dial.— To replace a dial, remove the telephone set from its enclosure and disconnect the terminal wires from the terminal board. Remove the telephone set chassis from the telephone set cover. Remove the screws that hold the dial to the chassis, lift the dial out of the chassis, and remove the dial dust cover. Disconnect the four leads from the screw terminals of the dial.

Connect the four leads to the new dial, and secure the dust cover on the dial. Insert the new dial in the chassis, and secure the dial to the chassis. Secure the chassis on the telephone set cover, and reassemble the telephone set for normal operation.

Ringer.— To replace a ringer, remove the telephone set from its enclosure and disconnect the terminal wires from the terminal board. Remove the telephone set chassis from the telephone set cover. Unsolder the red lead and the green lead from the ringer terminals. Remove the screws that hold the ringer to the chassis and lift the ringer off the chassis.

Mount the new ringer on the chassis and secure the ringer to the chassis. Solder the red lead and the green lead to the ringer. Secure the chassis on the telephone set cover and reassemble the telephone set for normal operation.

Dial Illumination Lamp.— To replace the dial illumination lamp, remove the telephone set from its enclosure. Remove the screw that secures the lamp holder to the chassis. Lift the lamp holder up until the lamp is clear of the grommet, and then turn the lamp holder over. Remove the lamp from the lamp holder by pressing the lamp down gently and rotating it counterclockwise approximately one-quarter turn.

Install the new lamp in the lamp holder by pressing the lamp down gently and rotating it clockwise approximately one-quarter turn. Turn the lamp holder over and insert the new lamp in the grommet. Press down until the lamp holder is against the grommet. Secure the lamp holder to the chassis. Remove the handset from its holder and check to see that the lamp lights.

Transmission Network. — To replace the transmission network, remove the telephone set from its enclosure and disconnect the terminal wires from the terminal board. Remove the 17 lead terminals from the transmission network. Remove the two nuts and lockwashers that secure the transmission network to the cover. Lift the transmission network off the threaded studs. Position the new transmission network on the studs and secure it to the cover. Connect the 17lead terminals to the network. Reconnect the terminal wires to the terminal board and secure the telephone set in its enclosure.

6.1.1.3 Common Telephone Troubles

Some of the more common telephone set troubles include (1) no dial tone, (2) dial impulses heard in the receiver while dialing, (3) poor transmission quality, (4) low reception, (5) can transmit but cannot receive, (6) can receive but cannot transmit, (7) ringer does not sound, (8) telephone set consistently dials the wrong number, (9) noisy connection, and (10) sidetone too loud. Procedures for analyzing these troubles and the corrective actions you should take if they occur are discussed briefly in the following paragraphs.

NO DIAL TONE.— If no dial tone is present, you must determine whether the telephone set, telephone line, or automatic dial telephone switchboard is the cause of the problem. To isolate the problem, connect a hand test telephone across the line. If a dial tone is present using the hand test telephone, then the problem is in the telephone set. If the problem is in the set, it could be in the hookswitch, the receiver, the handset or desk set cord, or the transmission network. Once you isolate the problem, replace the defective component.

If a dial tone is not present when checking the line with the hand test telephone, then the problem is either an open in the telephone line coming from the automatic dial telephone switchboard or in the switchboard itself. If the problem is found in the switchboard, you will need to refer to the switchboard technical manual.

DIAL PULSES HEARD WHILE DIALING.— Dial pulses heard in the receiver while you are dialing are usually the result of the hookswitch shunt spring contacts being out of adjustment. The contacts should make when dialing. If the hookswitch contacts are working properly, check the transmission network. If there is a problem with the transmission network, replace it. If the contacts are out of adjustment, adjust the contacts by bending them.

POOR TRANSMISSION QUALITY.— If a telephone transmits poorly, the fault is probably in the transmitter unit. One cause could be the carbon granules inside the transmitter clinging together. You can try and loosen the carbon granules in the transmitter by holding the handset in a horizontal position and shaking it, using a circular motion. If this does not work, then strike the transmitter end of the handset sharply with the palm of your hand. If the granules cannot be loosened, replace the transmitter.

Another cause could be loose connections or dirty contact springs in the transmitter cup. If replacing the transmitter or cleaning the transmitter cup contact springs does not correct the problem, check the transmission network. If there is a problem with the transmission network, replace it.

WEAK RECEPTION.— If a telephone has poor or weak reception, the trouble may be caused by a weak transmitter, a worn receiver cord, loose connections inside the handset, or a problem in the transmission network. If the problem is loose connections, tighten the connections. If the problem is a defective component, replace the component.

CAN TRANSMIT BUT CANNOT RECEIVE.— When a telephone can transmit but cannot receive, the problem is usually in the hookswitch or in the receiver unit. The fault could also be caused by a shorted transmitter unit or a shorted contact of the dial shunt springs. After you isolate the problem, replace the defective component.

CAN RECEIVE BUT CANNOT TRANSMIT.— When a telephone can receive but cannot transmit, check the transmitter unit as you would for poor transmission. If the transmitter is found to be defective, replace it. If the transmitter is not defective, replace the transmission network.

RINGER DOES NOT SOUND.— If the ringer at a called station does not ring, the fault could be caused by an open ringer coil or capacitor, or reversed or loose connections at the ringer terminals. Also, the ringer will not ring properly if the ringer is not properly adjusted, if the gongs have become loose, or if the position of the gongs has shifted with respect to the clapper. If the ringer does not sound at all, you should first check the connections and correct them if they are reversed or tighten them if they are loose. If the cause of the problem is a defective component, replace the component. If the ringer is ringing improperly, adjust the ringer as described earlier.

WRONG NUMBERS.— The most frequent cause of wrong numbers is the dial speed being too fast or too slow. If the dial speed is incorrect, adjust it as described earlier. If adjusting the speed does not correct the problem, replace the dial.

Another frequent cause of wrong numbers is jiggling the hookswitch before dialing. This can result in a series of pulses similar to those sent out by the dial. Also, keeping the dialing finger on the dial while it is returning to its normal position may result in wrong numbers.

NOISY CONNECTIONS.— Noisy connections are caused by worn handset or deskset cords, loose connections in the telephone set, partial shorts or grounds on the line, or noisy transmitter units. Check the telephone set cord as described earlier, and replace the cord as necessary. Tighten loose connections and clear any shorts or grounds on the line. If the problem is found to be in the transmitter unit, replace it.

SIDETONE TOO LOUD.— When you have a loud sidetone in the receiver of the handset, the problem is in the transmission network, which you should replace.

6.1.2 TYPE G TELEPHONE SET (VERSION 2)

The type G (version 2) telephone set is very similar in appearance and operation to the type G (version 1) set; however, slight differences do exist between them. The principle differences are component nomenclature, the handset holder and retaining mechanism, and the internal circuitry of the telephone set. The following paragraphs will only discuss the features of the version 2 set that are different from the version 1 set.

Component Nomenclature

The components of the type G (version 2) set are identified in figure 6-12, views A and B. Several components of the version 2 set serve the same function as components of the version 1 set, but are identified by different names. For example, the network assembly in the version 2 set serves the same purpose as the transmission network in the version 1 set.

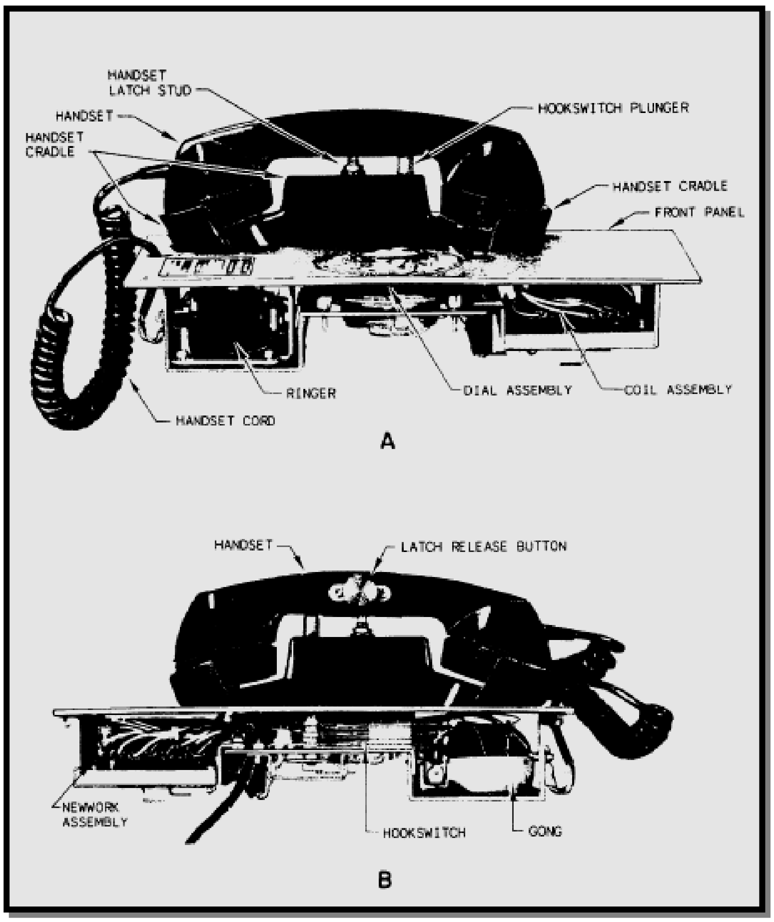


Figure 6-12.—Type G (version 2) telephone set.

Handset Holder and Retaining Mechanism

The handset for the version 2 set is equipped with an internal latching mechanism and a latch release button. The latching mechanism is used with the handset latch stud to retain the handset in its cradle. The latch release button is located on the side of the handset. If you press this button, the handset will be released from its cradle.

Internal Circuitry

Figure 6-13 is a schematic diagram of the type G (version 2) telephone set. The circuit is designed and operates in a slightly different manner as that of the version 1 set. Circuit operation will be discussed in the following paragraphs.

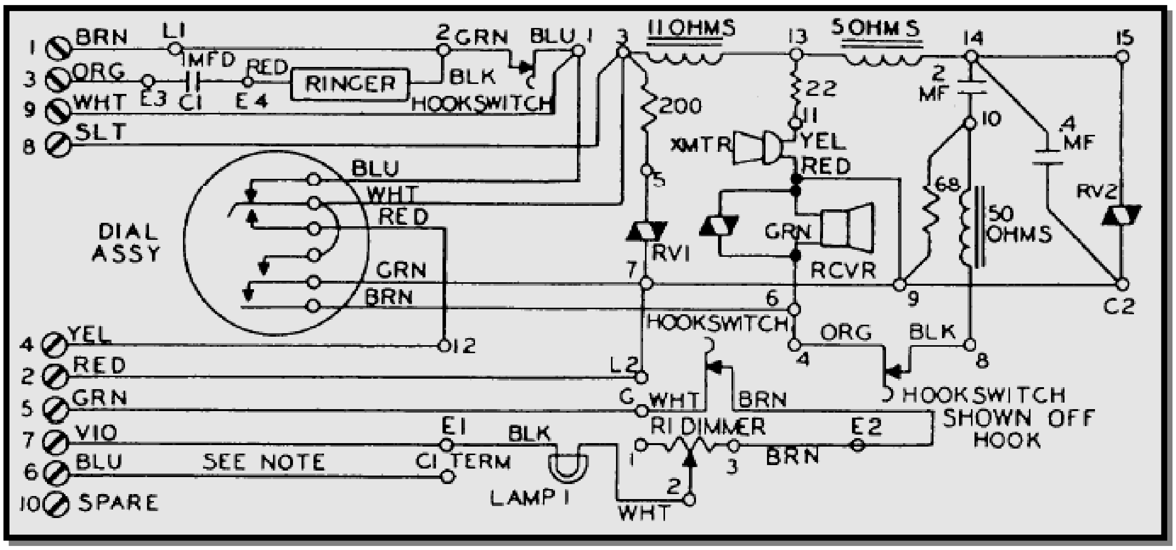


Figure 6-13.—Schematic diagram of the type G (version 2) telephone set.

NETWORK ASSEMBLY.— Figure 6-14 is a simplified schematic diagram of the network assembly circuit. This circuit serves the same function as the transmission network circuit in the version 1 set.

When you remove the handset from its cradle, three paths for dc are provided from terminal L1 to terminal L2. Dc path 1 is through resistor RI and varistor RV1. Dc path 2 is through inductor L1, resistor R2, and the transmitter. Dc path 3 is through inductors L1 and L2 and varistor RV2.

The mutual inductance of inductors L1, L2, and L3 and the value of resistor RB (resistor, balance 68 ohms) is such that a comfortable level of sidetone is heard in the receiver when the transmitter is excited.

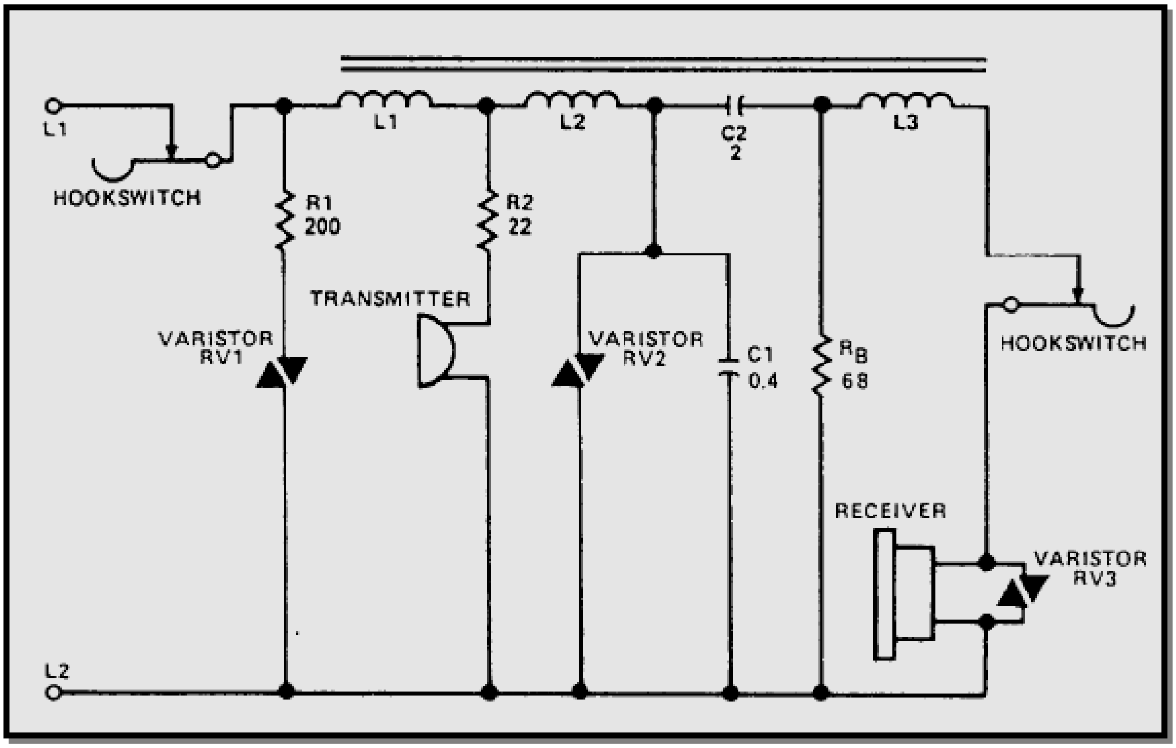


Figure 6-14.—Simplified schematic diagram of the network assembly circuit.

Capacitor C1, varistor RV1, and resistor RB constitute an impedance balancing network for the line impedance. Capacitor C1 also compensates for the line capacitance. Capacitor C2 prevents dc voltages from being extended to the receiver.

Varistors RV1 and RV2 comprise a gain control to maintain a constant input and output level regardless of whether the telephone is connected to a long or a short loop. Resistor R1 is a current-limiting device to protect varistor RV1 from high line-voltage surges.

Varistor RV3 acts as a click suppressor and is almost a short circuit across the receiver when the voltage across RV3 reaches approximately 1 volt. This action also prevents demagnetization of the receiver.

SIDETONE CIRCUIT.— Figure 6-15 is a simplified schematic diagram of the receiver sidetone circuit. Because current will not flow through a balanced circuit, the turns ratio of inductors L1 and L2 is unbalanced by a predetermined amount and the value of resistor RB is changed so as not to match the line impedance. This way, a controlled amount of signal can be induced into L3 to be used as receiver sidetone.

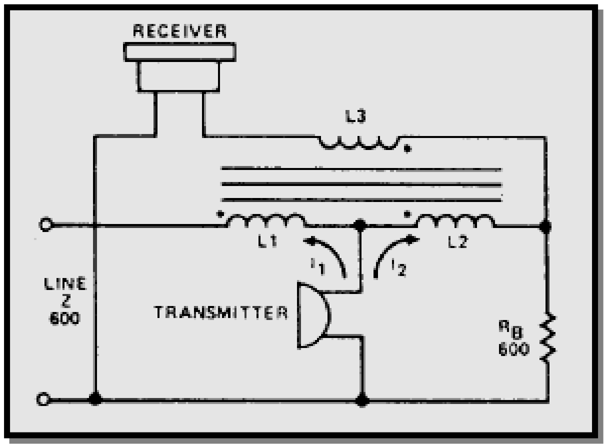


Figure 6-15.—Schematic diagram of the sidetone

RINGER CIRCUIT.— The ringer can be connected to the telephone line for one- or two-party service. Figure 6-16, views A and B, illustrates how the telephone set is connected for the service desired. For two-party service, ringing is extended to the prime telephone set over the R (L2) lead and to the extension set over the T (L1) lead.

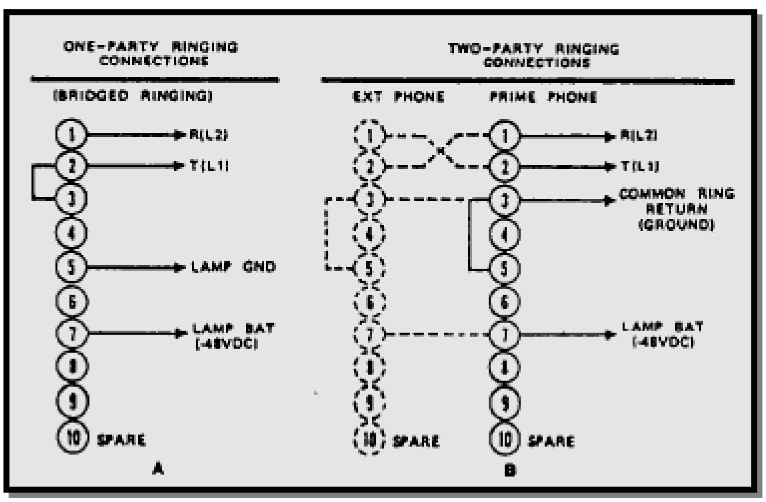


Figure 6-16.—Type G (version 2) ringer connectors.

When a caller dials your number, the ringing generator located in the automatic dial telephone switchboard applies 75 to 100 volts ac at 20 Hz to the ringer of your telephone set through capacitor C1 (fig. 6-13), causing the bell to ring. When you pickup your receiver, you complete a dc circuit through the switchboard, which operates relays to disconnect the ringing generator and connect you to your calling party.

6.1.2.1 Preventive Maintenance
Preventive maintenance for the version 2 set is the same as for the version 1 set.

6.1.2.2 Corrective Maintenance
Corrective maintenance of the version 2 set includes adjustments and replacement of failed components.

ADJUSTMENTS.— There are four adjustments on the type G (version 2) telephone set: the hookswitch contact springs adjustment, the ringer adjustment, the gong adjustment, and the dial illumination lamp intensity adjustment. Dial illumination lamp intensity on the version 2 set is adjusted in the same manner as the version 1 set. Dial speed on the version 2 set is not adjustable; therefore, if the dial speed is too slow or too fast, the dial must be replaced.

Hookswitch Contact Springs.— Figure 6-17 is an illustration of the hookswitch assembly. To adjust the hookswitch contact springs, bend the contact-spring stiffeners with a spring adjuster and measure the contact separations with a standard feeler gauge. With the hookswitch plunger fully operated on the hook, adjust the X and Z combinations for a contact separation of 0.025 to 0.035 inch and the Y contact combination for a contact separation of 0.045 to 0.055 inch.

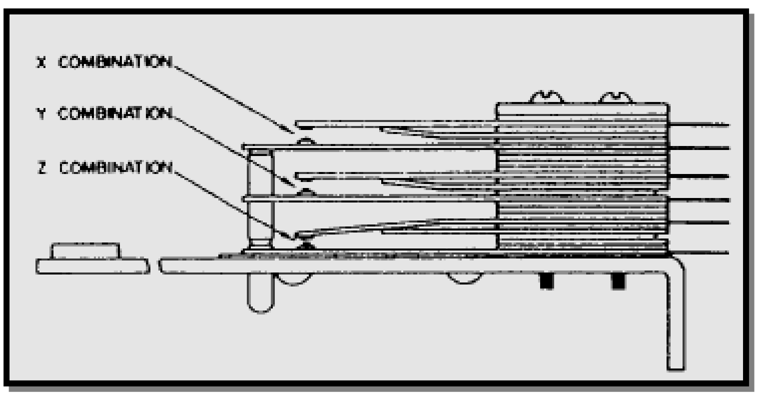


Figure 6-17.—Hookswitch assembly.

After adjustment, check the follow (overtravel) of each contact combination. In going from on hook to off hook, the minimum follow must be 0.010 inch and the contact springs must not touch adjacent stiffeners.

Ringer.— To adjust the ringer, slightly loosen the three screws located on the bottom of the ringer. Be careful not to loosen the screws too much as the magnetic field could be broken and the ringer will need remagnetization. Next, insert a nonmagnetic feeler gauge of 0.025 inch thickness between the armature face and the pole face. Slide the coil and lamination assembly toward or away from the armature until a setting of 0.020 to 0.025 is obtained. Tighten the screws and remove the gauge.

Gong.— To adjust the gong, loosen the gong nut and have someone dial the number of the telephone set. While the telephone is ringing, rotate the gong until you get the desired ring level. Lift the handset to stop the ringing. Hold the gong so it does not move, and tighten the gong nut.

REPLACEMENT OF COMPONENTS.— As with the version 1 set, most malfunctions of this telephone set will be reported by those using the set. When replacing components in the version 2 set, use the same basic troubleshooting procedures and safety precautions as described earlier for the version 1 set.

The following paragraphs will discuss the procedures for replacing the components of the version 2 set. Only those components that are removed and replaced in a different manner than those described earlier for the version 1 set will be discussed.

Ringer.— To replace a ringer, remove the telephone set from its enclosure. If you are replacing the ringer on a bulkhead-mounted telephone set, you will need to disconnect the 9-lead line cord and take the set to a workbench.

Unsolder the red ringer wire connected to terminal E4. Disconnect the black ringer wire from terminal 2 of the network assembly. Remove the four nuts that hold the ringer to the panel and remove the ringer from the panel.

Secure a new ringer to the panel. Solder the red ringer wire to terminal E4. Connect the black ringer wire to terminal 2 of the network assembly. Reconnect the line cord, if required, and secure the telephone set to its enclosure.

To replace the ringer capacitor, remove the telephone set from its enclosure. Remove the capacitor retainer nut and unsolder the capacitor wires from the terminals. Remove the capacitor from the set. Solder the new capacitor to the terminals and secure the capacitor to the panel with the retainer nut. Secure the telephone set to its enclosure.

Network Assembly.— To replace the network assembly, remove the telephone set from its enclosure. Remove the three nuts holding the network assembly to the frame. Disconnect the wires from the assembly and remove the assembly from the frame. Connect the wires to the new network assembly and secure the assembly to the frame. Secure the telephone set to its enclosure.

Dial Illumination Lamp.— To replace the dial illumination lamp, remove the telephone set from its enclosure. Remove the locking nut holding the lamp socket. Lift out the lamp socket and remove the lamp. Insert a new lamp in the socket and secure the lamp socket to the frame. Secure the telephone set in its enclosure.

6.1.2.3 Common Telephone Troubles

Common troubles for the version 2 telephone set are basically the same as those for the version 1 set.

6.2.0 AUTOMATIC DIAL TELEPHONE SWITCHBOARD

The automatic dial telephone switchboard is the switching center of the dial telephone system. The switchboard is designed to perform the automatic switching functions necessary for shipboard point-to-point communications between telephone sets operating over automatic dial telephone lines.

6.2.1 Maintenance

As an IC Electrician, you will be required to perform routine preventive maintenance on the switchboard. Since corrective maintenance should be performed by a qualified technician specifically trained on this system, only preventive maintenance will be discussed.

Routine preventive maintenance of the switchboard consists of a systematic series of inspection, cleaning, and routine operational check procedures. The routine checks are designed to be performed without disturbing the equipment any more than necessary. Do not make any adjustments while performing preventive maintenance, and avoid moving equipment wiring when inspecting or cleaning the equipment. Preventive maintenance should be performed according to the maintenance requirement cards (MRCs) associated with the system. The following paragraphs will discuss some of the more common preventive maintenance checks.

Hinges and Locking Mechanisms

The hinges and locking mechanisms of cabinet doors and the equipment gates should be cleaned and lubricated once a week.

Inspection

Switchboard Cabinets - Inspect the switchboard cabinets using the following procedure:

1. Open the cabinet doors.

2. Check to see that the equipment gates are properly fastened.

3. Check to see that the circuit card assembly retaining bars are properly fastened.

4. Check for accumulations of dust, dirt, or grease in the cabinets. If the cabinets require cleaning, clean them according to the applicable MRC.

6.3.0 SHIP'S SERVICE TELEPHONE SYSTEM (J-DIAL) AND INTEGRATED VOICE NETWORK (IVN) SYSTEM

The circuit J Ship's Service Telephone System (SSTS) consists of 17 equipment units, as well as standard G-Type analog telephone sets and a seamless interface to the Integrated Voice Network (IVN). These units are labeled and defined on Figure 6-18. Unless noted, all J-Dial equipment is located in Aft IC on IVN equipped ships.

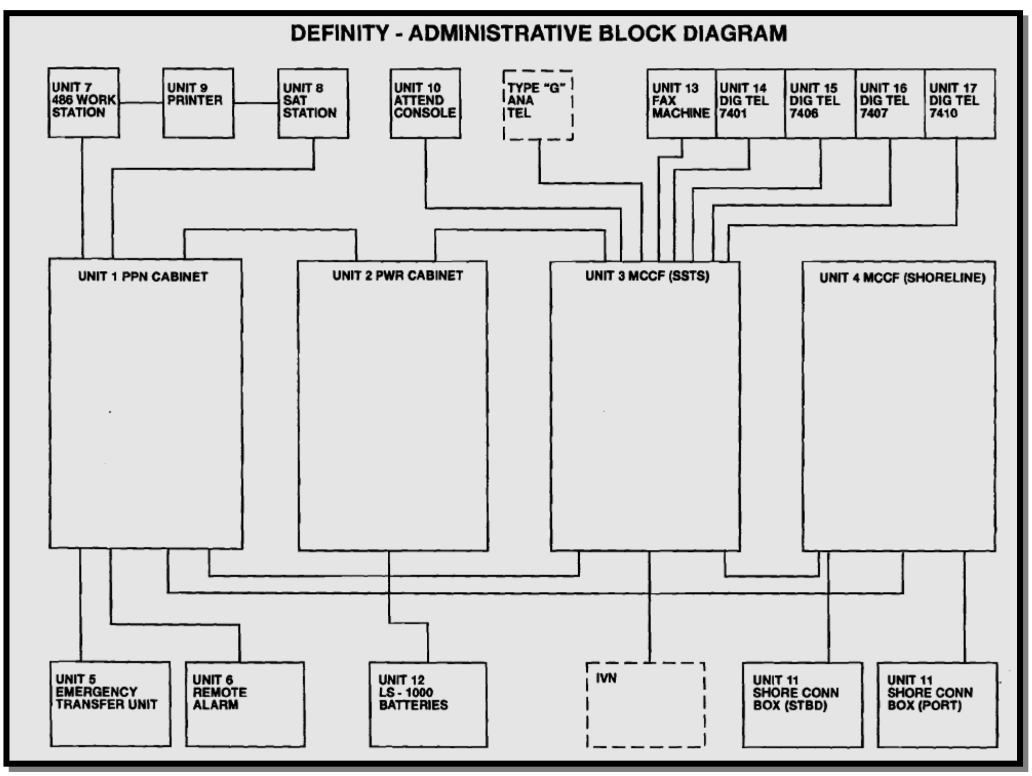


Figure 6-18.—SSTS Circuit J.

6.3.1 J-Dial Equipment

Unit 1 of the J-Dial system is the G3i system PPN (Processor Port Network). A PPN is a port network (PN) controlled by a switch processing element (SPE). An SPE provides the necessary traffic control for routing internal switch, communications and voice and data signals. The J-Dial PPN cabinet has a redundant SPE (SPE "A" and SPE "B" to prevent signals from being lost in the event of system fault. A PN provides system timing and monitoring functions. The PPN cabinet also contains circuit packs for interfacing telephones, IVN, and shorelines with the J-Dial system.

Unit 2 of the J-Dial system is the Power Cabinet. This cabinet accepts 115VAC from the ship's 60Hz power system and rectifies this voltage to -48 VDC for J-Dial system equipment. This voltage value is standardly utilized by telephone equipment to initiate an "off-hook" signal. The power bay is supported by a backup battery system (Unit 12) to provide the -48 VDC in the event of power casualty.

Unit 3 of the J-Dial system is the SSTS Main Cross Connect Field (MCCF), referred to in shipboard documentation as MCCF1. The MCCF1 contains all the electrical signal hardwire connections from the PPN and shipboard interfaces. The MCCF1 can be used by the maintenance technician to verify telephone operation prior to signal transfer into the PPN.

Unit 4 of the J-Dial system is the Shoreline MCCF, referred to in shipboard documentation as MCCF2. The MCCF2 contains all the electrical signal hardwire connections from the MCCF1 to the shore connection boxes (Unit 11). Shore based PBX (Public Exchange) switches are temporarily interfaced with these connection boxes via stowed cables when the ship is in port to provide off ship calling capability. Sixty-four shore lines are available for PBX connection on IVN equipped ships. The MCCF2 can be used by the maintenance technician to verify shoreline calling prior to interface with the shipboard telephones through the PPN cabinet.

Unit 5 of the J-Dial system is the Emergency Transfer Unit, used to transfer emergency 211 calls to one of the two Quarterdeck OOD stations when in port, or the Pilot House underway. Dialing of the emergency 211 number results in a steady tone at the receiving end to indicate an urgent call. This tone is provided by a ringing generator, physically installed in the MCCF1 cabinet. Selection of the respective ODD station is provided by a slide switch in the Emergency Transfer Unit (Panel). The J-Dial Emergency Transfer Unit is shared with the IVN system for 211 dialing from any shipboard telephone.

The 211 Emergency Transfer Unit provides a means of routing shipboard emergency telephone calls immediately to the manned Bridge OOD Station while underway, or one of the Quarterdeck OOD telephones when in port.

This unit provides a means of connecting the Definity 4 wire e&m trunk to one of three analog telephone units. A digital telephone may not be utilized for the emergency 211 circuit due to the required ringing pattern (steady tone). This ringing pattern is provided by the ring generator, located in the lower right hand corner of the J-Dial MCCF 1 cabinet in After IC. 90-110 Volts is provided to the ring generator to provide the continuous ringing pattern.

A means of manually selecting the telephone unit (Bridge, Starboard Quarterdeck or Port Quarterdeck OOD Station) that emergency calls will be routed to is provided by a selector switch located inside the 211 emergency transfer unit in After IC for the J-Dial system.

If the terminating telephone is busy, the call will be pre-empted to connect a 211 emergency call. This preemptive condition is produced by relays located inside the Emergency Transfer Unit.

The Emergency telephone transfer circuit requires termination to a 4-wire e&m TN760 Tie Trunk Circuit pack. The TN760 Tie Trunk circuit pack installed in slot 1A02 of the J-Dial Definity PPN cabinet is used solely for 211 circuit operation. The Definity switch must be administered to route all emergency calls (when the digits 211 are dialed from any shipboard telephone unit) to this trunk. The TN760D has four ports used for four-wire e&m lead signaling tie trunks, set up for automatic signal transfer. The TN760D uses administrable Mu-law compounding. Each port on a TN760D has the following signal leads: T, A, T1, A1, E, and M. On IVN equipped ships and 7, only Port 1 is used for signal transfer to any of the three switch selected telephone units. The Tie Trunk circuit pack port is connected from the associated 11 0 block in the J-Dial MCCF 1 cabinet (Block 1, row 2) to the associated 110 block for connection to the Emergency Transfer Switch (Block 7, Row 6) via an Amphenol connector located on the unit. Also connected from Block 7, row 6 for the Emergency Transfer unit are 2-wire lines to the individual telephone unit ports, which are activated when the Emergency 211 number is dialed from any telephone. The associated vendor wiring diagrams for this circuit connection within the J-Dial MCCF 1 cabinet are shown in Figures 6-19 and 6-20.

The Emergency telephone transfer circuit requires two sources of power as follows:

a. -48 VDC, 0.2 Amps for equipment operation and control

b. 90-110 VAC, 20 Hz AC Ringing Power superimposed on the -48 VDC to provide 211 steady ringing pattern.

DEFINITY PORT ASSIGNMENT RECORD - TIE TRUNK (4 PORT)

CIRCUIT				TIE TRUNK (TM 760D)				110 CROSS CONNECT						SHIPS CABLE RUNNING LIST						
								FROM			TO									
CABINET	CARRIER	SLOT	PORT	DIAL ACCESS CODE	LEAD DESIGNATION	25 PAIR CONN PIN NUMBER	CONN CABLE COLOR CODE	BLOCK	ROW	PAIRS	BLOCK	ROW	PAIRS	CABLE NO.	FROM	TO	SHIPS TERMINAL MARKING	STATION COMPARTMENT	VOICE TERMINAL	USER NAME OR COMPARTMENT NAME
1	A	02	1	211	T1	26	W-BL	1	2	1	7	6	7							
					R1	1	BL-W													
					T1	27	W-O	1	2	2	7	6	8							
					R11	2	O-W													
					E1	28	W-G	1	2	3	7	6	9							
					M1	3	G-W													
1	A	02	2		T2	29	W-BR	1	2	4										
					R2	4	BR-W													
					T12	30	W-S	1	2	5										
					R12	5	S-W													
					E2	31	R-BL	1	2	6										
					M2	6	BL-R													
1	A	02	3		T3	32	R-O	1	2	7										
					R3	7	O-R													
					T13	33	R-G	1	2	8										
					R13	8	G-R													
					E3	34	R-BR	1	2	9										
					M3	9	BR-R													
1	A	02	4		T4	35	R-S	1	2	10										
					R4	10	S-R													
					T14	36	BK-BL	1	2	11										
					R14	11	BL-BK													
					E4	37	BK-O	1	2	12										
					M4	12	O-BK													

Figure 6-19.—TN760 Wiring.

DEFINITY PORT ASSIGNMENT RECORD - EMERGENCY TRANSFER UNIT

CIRCUIT				AUXILIARY LEADS				110 CROSS CONNECT						SHIPS CABLE RUNNING LIST						
								FROM			TO									
CABINET	CARRIER	SLOT	PORT	EXTENSION NUMBER	LEAD DESIGNATION	25 PAIR CONN PIN NUMBER	CONN CABLE COLOR CODE	BLOCK	ROW	TERMINALS	BLOCK	ROW	TERMINALS	CABLE NO.	FROM	TO	SHIPS TERMINAL MARKING	STATION COMPARTMENT	VOICE TERMINAL	USER NAME OR COMPARTMENT NAME
					T	26	W-BL	7	6	26	P	3	5							BRIDGE TELEPHONE CIRCUIT
					R	1	BL-W	7	6	1	P	3	6							
					T	27	W-O	7	6	27	6	12	28						1E1803	BRIDGE LINE CIRCUIT (TO PBX)
					R	2	O-W	7	6	2	6	12	3						X7013	
					T	28	W-G	7	6	28	E	3	9							QUARTER DECK STARBOARD TELEPHONE CIRCUIT
					R	3	G-W	7	6	3	E	3	10							
					T	29	W-BR	7	6	29	4	8	49						1D1016	QUARTER DECK STARBOARD LINE CIRCUIT
					R	4	BR-W	7	6	4	4	8	24						X7529	
					T	30	W-S	7	6	30	E	5	5							QUARTER DECK PORT TELEPHONE CIRCUIT
					R	5	S-W	7	6	5	E	5	6							
					T	31	R-BL	7	6	31	4	9	26						1D1101	QUARTER DECK PORT LINE CIRCUIT
					R	6	BL-R	7	6	6	4	9	1						X7529	
					T	32	R-O	7	6	32	1	2	26							DEFINITY SSTS 4W E & M TRUNK CIRCUIT
					R	7	O-R	7	6	7	1	2	1							
					T1	33	R-G	7	6	33	1	2	27							
					R1	8	G-R	7	6	8	1	2	2							
					E	34	R-BR	7	6	34	1	2	28							
					M	9	BR-R	7	6	9	1	2	3							

Figure 6-20.—Emergency Transfer Unit Wiring.

Any voice terminal with the appropriate permissions granted by system administration, may dial extension 7013 (Bridge) or 7529 (Port/Starboard Quarterdeck), even though these units are connected through the Emergency Transfer unit. The telephone unit may be used like any other to make and receive calls, unless emergency 211 is dialed. Once dialed, a relay in the Emergency Transfer Unit (DP-11676) is energized, causing the relay contacts to break with the normal telephone line and connect to the TN760 Tie Trunk circuit pack wiring line. This will switch the -48 VDC control power to the ringing generator. The 211 call will be sent to the specified OOD telephone, based on the selector arm position of the manual switch inside the Emergency transfer unit.

If this line was preempted, the voice connection will be immediately made. If the line was idle at the time of the 211 call, a steady tone will be generated. All telephones will be assigned accessibility to Emergency 211 by administration of the Class of Restriction forms. The -48 VDC and Ground enter the ringing generator (WP-91567) on pins 5 and 3 respectively of connector P7. A separate -48 Volts is sent to Pin 3 of connector P6 (ringing generator output connector) and is combined on Pin 6 with a 20 Hz rider signal from the ringing generator, providing for a total of 96-110 VAC for the 211 ringing pattern. The -48 VA and B signals are provided by the Alarm Auxiliary Power terminals within the MCCF cabinet. A schematic of power wiring is provided in Figure 6-21.

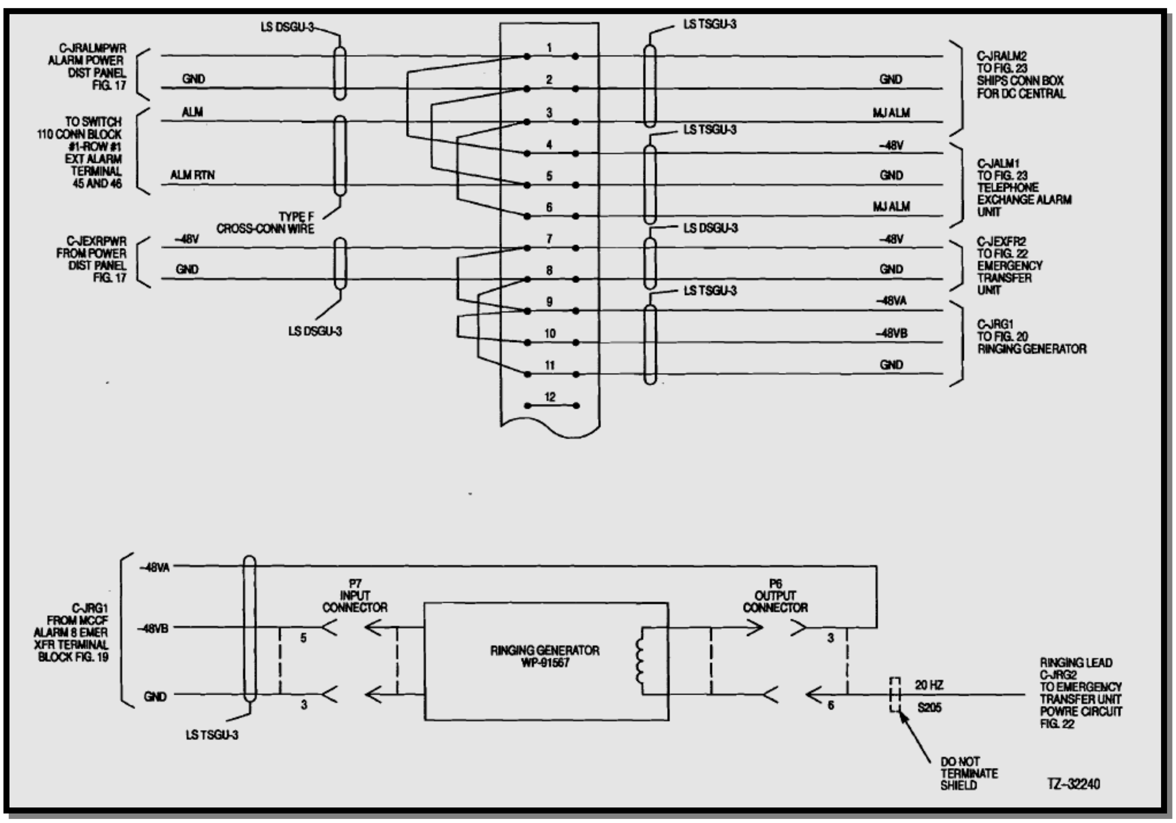


Figure 6-21.—Ringing Generator Power.

Unit 6 of the J-Dial system is the Remote Alarm. The Remote Alarm Panel provides visual and audible indication of a major alarm status. A minor fault is one in which only 1 port is affected. Conversely, a major alarm indicates more than 1 port affected. The Minor Alarm indicator is not connected on IVN equipped ships.

Alarm Function and Arrangement

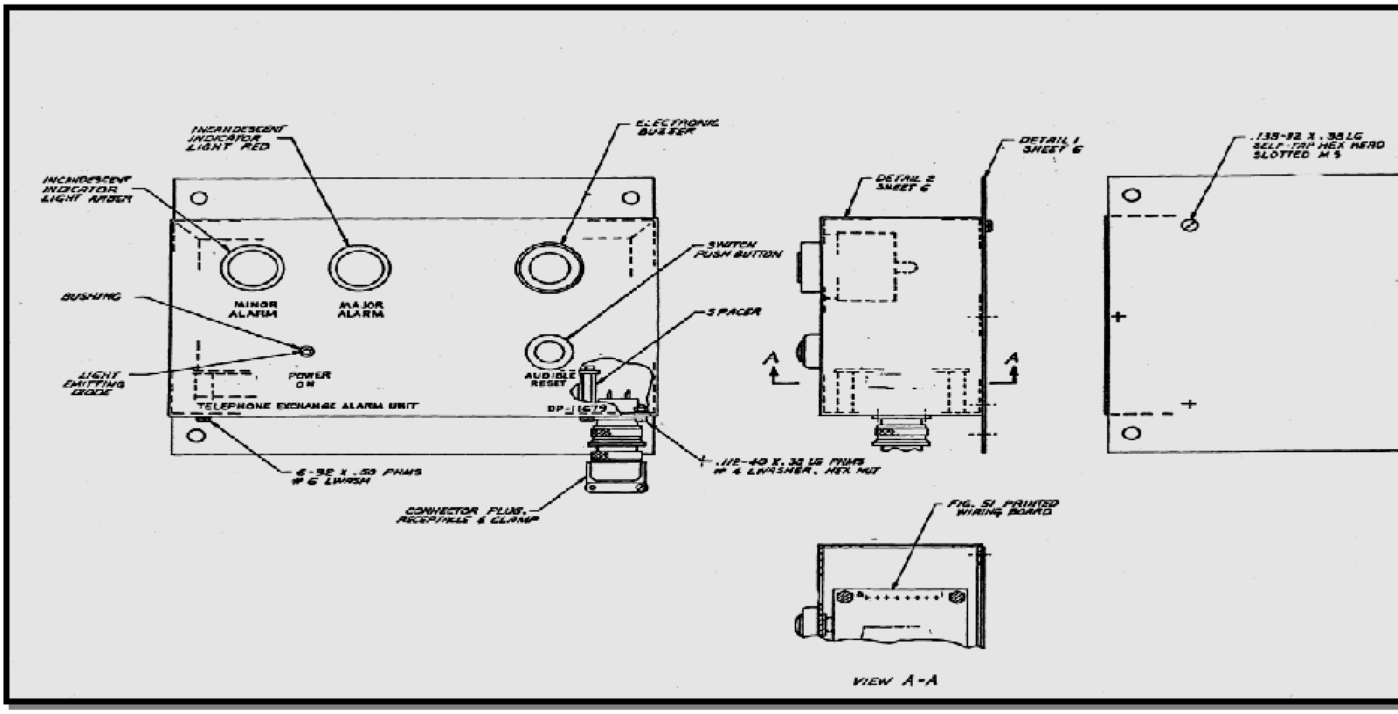


Figure 6-22.—Telephone Exchange Alarm Unit.

The remote alarm unit for the IVN system is powered by -48 VDC from the Lorain Power bay circuit breaker #6 in its respective IC space. The remote alarm unit for the J-Dial system is connected to the Power Bus for the Lorain cabinet, and is always "hot" (no circuit breaker). Each cabinet, including the Power Bay, Definity, DCSS A and B provides a lead that is grounded when it is in an alarm state. The ground activates the remote alarm unit's visual and audible signals. The audible signal can be silenced by depressing the audible reset button. Minor or major alarms in the 10callVN center will activate the remote alarm MAJOR (RED) visual indicator in the local alarm unit and the MINOR (AMBER) visual indicator in the remote alarm unit. For the J-Dial system in Aft IC, the MINOR alarm visual signal is not utilized and all alarms will activate the MAJOR (RED) visual indicator.

Unit 7 of the J-Dial system is the 486 work station. This terminal provides trunk monitoring for the Call Accounting System (CAS). The CAS is utilized to printout a record of all off-ship telephone calls.

Unit 8 of the J-Dial system is the SAT station, or System Administration Terminal. This terminal provides two input ports to communicate with the PPN cabinet and the AUDIX (Audio Information Exchange) module which is physically located inside the PPN cabinet. AUDIX provides four lines for voice mail access to designated shipboard telephone stations. The PPN-to-Manager Terminal allows system access for programming individual telephones and maintenance functions.

Unit 9 of the J-Dial system is the system Printer, used to provide Call Accounting System output data and other specified printouts. The Call Accounting System (CAS) provides a listing of all trunk line calls (off ship) by station. This listing is much like the long distance telephone bill you would expect to receive from your local telephone company. Specified ranges, such as time limit of reported calls may be programmed into the CAS computer terminal by the IC technician.

Unit 10 of the J-Dial system is the Attendants Console, used to provide an operator interface with the ship's telephone system. This console may also be used to monitor trunk lines used for off ship dialing, for fault localization. The Attendants Console technical manual, AT&T COTS (Commercial-off-the-shelf) manual, Comcode 555-200-700, is provided to assist in console operations and maintenance. This console will not be covered in this course.

Unit 11 of the J-Dial system is the Shore Connection Boxes, located near the Port and Starboard mooring stations. As explained previously for Unit 4 (MCCF2), the Shore Connection Boxes are the interfacing point for wiring from the shore based PBX switch to the shipboard telephone system. These boxes contain fuse protection and lightning arrestors for circuit electrical surge protection. Although 100 shorelines may be connected into a box, only 80 are wired on IVN equipped ships. Both Shore Connection Boxes are hardwired to the MCCF2 panel for all 100 lines, although only one will be connected to the pier side telephone exchange panel, dependent upon ship's pier positioning. Only 64 shore lines may be connected to the Definity Switch in the IVN equipped ships J-Dial configuration.

Unit 12 of the J-Dial system is the LS-1 000 Battery Set (Liberty Series), the backup battery set for the system power bay cabinet. The four battery set consists of three 12VDC and one 10VDC battery valve regulated (Sealed for maintenance-free) lead-acid batteries connected in a series-aiding arrangement. Actual voltage output is from -46 to -52 VDC.

Float charging for the batteries is provided by the rectifier units in the system power bay, which also contains a separately installed battery disconnect switch to remove battery power from the cabinet for maintenance functions. Battery voltage may be charged directly using the power bay "equalize" function. This should be done whenever loss of power causes the battery set to provide a sustained charge. System COTS manual, Liberty Series 1000 Installation and Operating Instructions provides maintenance and installation technical data.

Unit 13 of the J-Dial system is a shipboard Fax modem machine for sending data. This unit is not the maintenance responsibility of the IC technician and will not be covered in this course.

Units 14-17 are the 7401, 7406, 7407, and 7410 Digital Voice Terminal telephone units which are installed throughout the ship for voice and data communications.

6.3.2 IVN Equipment

The Integrated Voice Network (IVN) consists of two sets of 16 equipment units, as well as the Programmable Integrated Communications Terminals, J-Dial, and Sound-Power System Interface equipment. These units are labeled and defined on Figure 6-23. With the exception of the actual voice terminals for Nets, Sound-power, and telephones, the major IVN equipment units are located in both Forward and Aft IC on IVN equipped ships. The units in Aft IC are assigned as system 1, while the units in Forward IC are assigned as system 2 (i.e. Unit X-1 designates this piece of equipment is part of the After IVN system, while Unit X-2 designates the equipment component as being part of the Forward IVN system). Figure 6-24 shows the overall system block diagram for the Definity SSTS.

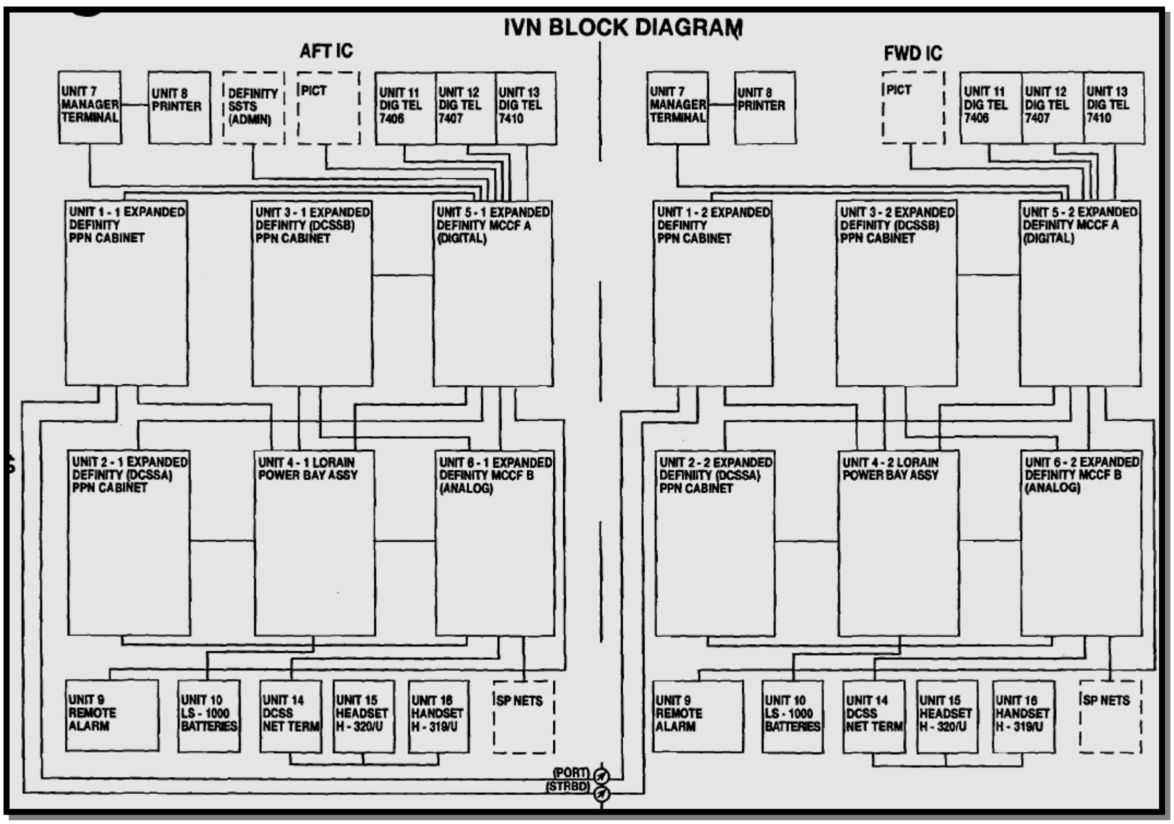


Figure 6-23.—IVN.

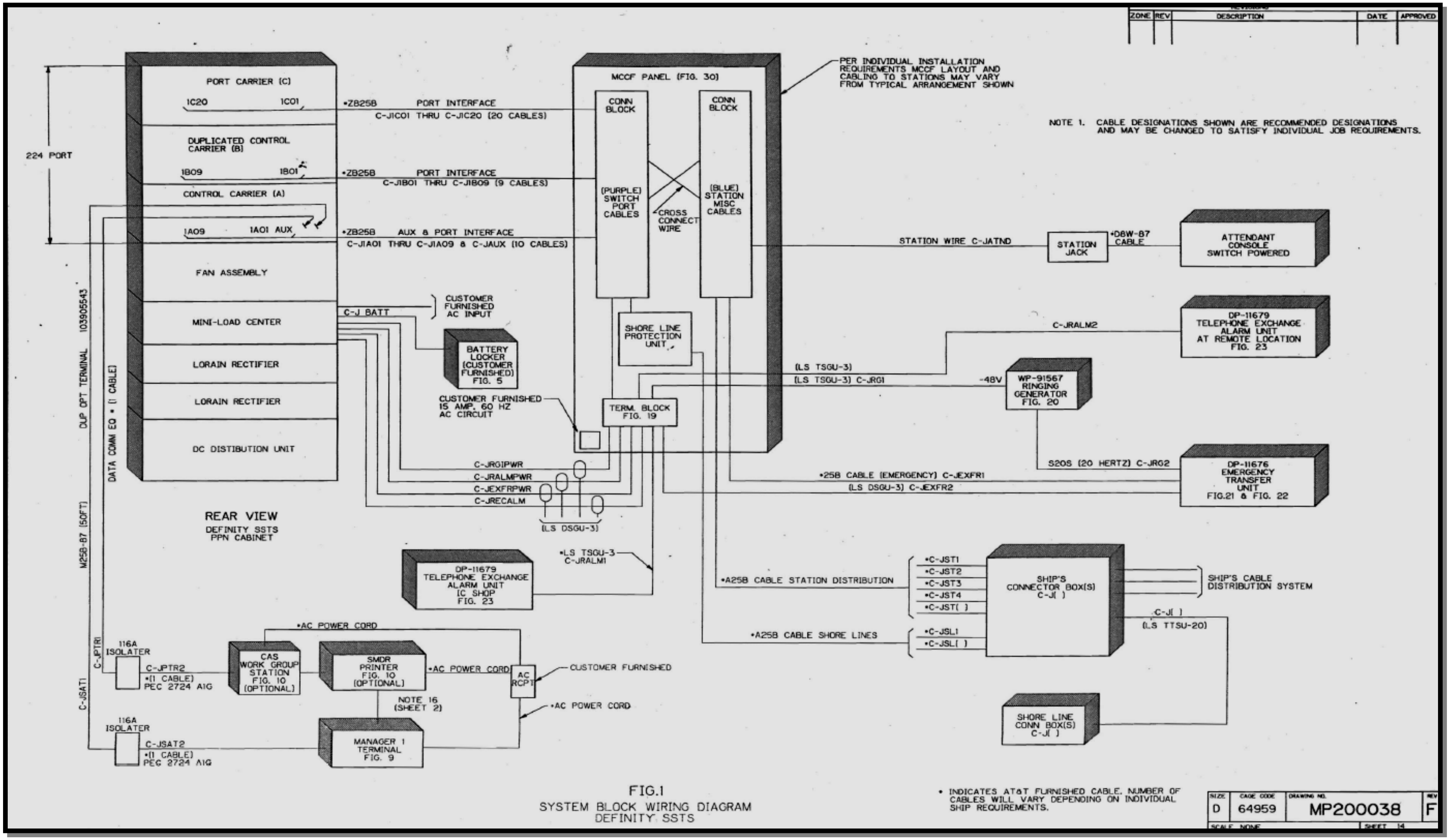


Figure 6-24.—System Block Wiring Diagram for Definity SSTS.

Units 1-1 and 1-2 of the IVN system are G3i Expanded Definity 75 PPN cabinets. The IVN system uses an expanded cabinet set (DCSS) which interfaces with the PPN cabinet to provide access to analog sound-power and net circuits. The IVN PPN cabinets also contain dual switch processing elements for system redundancy as well as port circuit packs for interfacing with digital telephone units, the system manager terminal, and other IVN system cabinets. The IVN PPN cabinet houses the Digital Data Multiplexer (DDM) unit, which provides a dual fiber optic link between Forward and Aft IC to transfer control and voice signals between the two independent systems. Critical communications stations have built-in redundancy via hardwire and programming coverage to both systems.

Unit 2-1 and 2-2 of the IVN system are Expanded Definity DCSSA (Digital Conferencing Switch Set) PPN Cabinets. These units provide the expanded interface to the analog net and sound-powered circuits required by IVN. This interface performs Analog-to-Digital (A-D) and Digital-to-Analog (D-A) conversion between the DCSSA and PPN cabinets, via the DDM. The DCSSA cabinet also contains a dual redundant control section to provide signal routing and timing, as well as port circuit packs for interfacing with net jackboxes and sound-powered telephone circuits.

A maximum of 4 net jackboxes may be tied in series on any net port within the DCSS cabinet, and a maximum of 9 sound-powered telephones may tie into a sound-power port.

The DCSS acts as the tenth sound-powered telephone on the string, and is provided with cutout capability at sound-powered selector switch units, labeled IVN cutout *(c/o).*

Exceeding the maximum number of drops on either the net or sound-powered strings will result in excessive power loss causing voice signal cancellation, The DCSS cabinet also provides isolation from the sound-power system via transformer boards located in the rear of the cabinet.

This board prevents DCSS cabinet faults from feeding back into the sound-power system, and also helps to provide an "on-hook" signal for the cabinet. The DCSS 240e Cabinet provides a total of 240 available ports used for audio conferencing.

Units 3-1 and 3-2 of the IVN system are Expanded Definity DCSSB (Digital Conferencing Switch Set) PPN Cabinets. For system redundancy, the sound-powered circuits, which generally interface to the Forward switch center, are split between the "A" and "8" DCSS cabinets. Net jackboxes are run to various ports, in both the Forward and Aft DCSSA and 8 cabinets. The DCSS8 cabinet provides an additional 240 available ports for the IVN system as well as redundancy for system survivability.

Units 4-1 and 4-2 of the IVN system are the system power bays. These cabinets accept 240VAC from the ship's 60 Hz power system and convert it to -48VDC for system control. The IVN power bays provide a greater amperage output than the J-Dial system would require due to the number of equipment loads. The IVN power bays are also supported by a backup battery system (Unit 10) to provide the -48VDC in the event of power system casualty, as well as supported by a casualty power jack on the system power panel. The power bays distribute -48VDC to the Definity PPN cabinet, the DCSSA and B cabinets, the remote alarm units, and the DCSS net jackboxes to provide an "off-hook" signal.

Units 5-1 and 5-2 of the IVN system are the Expanded Definity Digital MCCF panels. The Digital Main Cross Connect Fields provide the hardwire interface to the PPN cabinets for PICT units and Digital Voice Terminals, as well as ADU (Asynchronous Data Unit) for manager terminal interface, remote alarm, and horn extension relay interface.

Units 6-1 and 6-2 of the IVN system are the Expanded Definity Analog MCCF panels. The Analog MCCF cabinets provide the hardwire interface to the DCSS cabinets for Net circuit jackboxes (DCSS Terminals) and sound-powered telephone circuits. These cabinets also provides fuse protection for the system from the -48VDC used for the DCSS terminals.

Unit 7 represents the IVN network manager terminals which interface, via ADU connections, to provide maintenance and administrative tasks to be performed on the system cabinets by the responsible IC technician. Through the manager terminal in either switch center, access to the Forward or Aft IVN DCSSA and B or DDM cabinets may be accessed through the Definity PPN cabinet. IVN equipped ships has been outfitted with a RCS-9000 COTS unit, produced by Greco Systems Inc. This unit is fully ruggedized per MIL-STD-810E and is essentially a 486DX, 66MHz computer with a 270 MB internal hard drive, 4 MB of RAM, with standard keyboard and trackball and monochrome monitor. The IVN manager terminal utilizes the Windows based Procomm Plus program format, which provides user friendly function key maneuvering and help feature. The individual formats for the accessed cabinets will vary according to unit software design.

Unit 8 represents the printer units for use with the IVN manager terminal. The normal procedure for printing a desired page on the system monitor when accessing the Forward or Aft Definity is typing "p" following a command line (example display station 7561p - Damage Control Central). If this does not work with the installed system, the following procedure may be used after power up and system log-in:

a. Type the command to be printed (example -display station 4681-Air Officer in Primary Flight Control). When the first line starts to appear on the monitor screen, press keys ALT-N simultaneously. This will print the first screen only.

b. To print subsequent screens, ALT-N must be depressed again at the beginning of each screen.

NOTE:
ALT-N is a short cut key for "Print Capture". Clicking on print capture or pressing ALT-N sends all characters to your printer as they are displayed in the monitor window. To save printed characters to a disk file for printing at a later time, "print capture" is also used. Press ALT-F1, or access Print Capture by selecting File and then File Capture, to save the data to a floppy disk file.

For the DCSS or DDM, following power up and system log-in, the following procedure is used:

a. Prior to typing a command to be displayed or printed, press keys ALT-N. At the bottom left of the monitor screen, *starting print logging* should be displayed.

b. Type the command for the DCSS or DDM or select a menu item to be displayed and the information will be sent directly to the printer.

Unit 9 of the IVN System is the Remote Alarms. The Remote Alarm Units are similar to the one used in the J-Dial system, except that each alarm indicator light represents major or minor alarms present in either the Local or Remote IC room. The Red indicator light (labeled Major) signals a local IVN alarm for the respective IC space; while an Amber indicator light (labeled Minor) signals a remote IVN alarm for the other IC space. If an alarm signal is detected, the Remote Alarm Panel will also produce an audible tone in both IC Rooms. The Remote Alarm is powered by -48 VDC from the power bay cabinet.

Unit 10 of the IVN system is the LS-1000 UPS (Uninterruptable Power Source) Battery backup for the IVN systems Forward and Aft. The UPS system for IVN consists of 8 batteries: Two Sets of 4 batteries, identical to the J-Dial batteries, each of the 4 batteries wired in series. The 2 sets are then wired together in parallel configuration to provide the added amperage required by the load. The battery disconnect switch for the IVN system is located inside the Lorain Power Bay cabinet.

Units 14-16 of the IVN system represent the DCSS Net Terminals installed throughout the ship in command and control tactical environments, as well as the ancillary H-320/Uand H-319/U Handset and Headsets that are utilized with the Net jackbox. The DCSS Net Terminal is basically a TA-1002 terminal, modified to work with the IVN system.

As seen in Figure 6-25, the installed modification specifically includes the PICT LS-613 loudspeaker net interface operating power, provided by the -48VDC "off hook" operating voltage to the net box via S1(front panel of net box ON/OFF switch) closed contacts.

This operating voltage is supplied by the Lorain Power Bay for the associated IVN system in Forward or Aft IC on TB-1-1 and TB-1-2.

Switch S1 is shown in the normally open (NO) position on the diagram. The LS-613 may be connected to J1 on the front of the net box, instead of the usual handset or headset.

The -48VDC will then be converted by the DC-DC A2 module circuitry to +10.6VDC for the loudspeaker at pin J1-J (Accessory Power). The LS-613 may be operated in talkback mode with this modification.

The DCSS net boxes use 4-wire E&M (ear and mouth) signaling. The first two wires provide audio and audio return for voice communications between the net box and DCSS cabinet when S1 is closed.

This voice signal is routed from the Analog MCCF to the DCSS cabinet via 110 block-to-Amphenol connector wiring. The second set of wires connects the -48VDC from the IVN power bay via the Analog MCCF to TB-1-1 and TB-1-2.

The Terminal Board 1 (TB-1) in the DCSS net box provides external connection points for hardwire applications. Connector J1 allows adaptation of a headset handset, or talkback speaker to the net box. Module A1 provides all associated transceiver circuitry for audio signal routing.

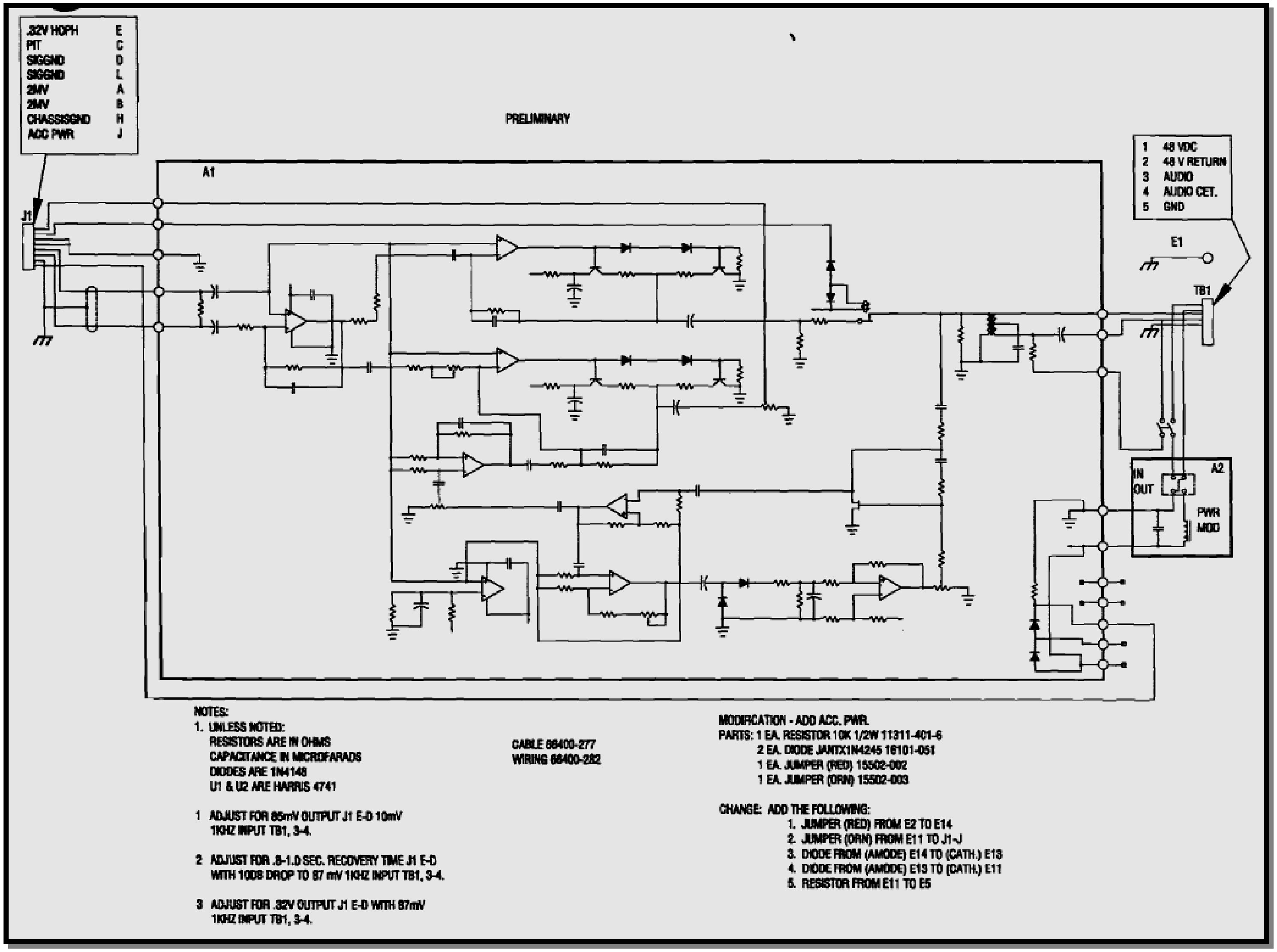


Figure 6-25.—DCSS Modification Schematic.

The Ship System Manual for IVN provides specific interface cabling and routing data for the various net circuits. Refer to Table 6-1 for an example of Table 9-1 of the Ship System Manual for IVN. This Table lists the net box cabling in DCSS circuit number order (i.e. C-CS3183). This number will appear on the cable circuit tag and on the associated wire list for this cable in alpha-numerical cable order. The breakdown of this number is as follows:

a. C -IC System Cable
b. CS -IVN System
c. 3 -Module 3 (Frame 65-97)
d. 183 -Cable number for this DCSS circuit.

NOTE:
Module 1 - FWD to Frame 49. Module 2 - Frame 49-65. Module 3 - Frame 65-97. Module 4 Frame 97 AFT. Module 5 - 03 Level and above. All system drawings for J-Dial and IVN will be divided by Ship's integrated modules.

DCSS CIRCUITS			
DCSS Circuit Number	**Compartment Number**	**Compartment Name**	**Cable Routing Sheet Number**
C-CS3139	2-85-1-C	Conflag Sta No.6 & Well Dk Debark (1st Lt)	14
C-CS3140	2-85-1-C	Conflag Sta No.6 & Well Dk Debark (Asst Cmbt Cargo)	14
C-CS3142	2-85-1-C	Conflag Sta NO.6 & Well Dk Debark (Asst Cmbt Cargo)	14
C-CS3147	02-73-2-C	TACLOG & HLSC (Status/Plot Bd 1)	17
C-CS3148	04-73-STBD	FAS Opr Platf	24
C-CS3149	06-77-STBD	FAS King Post & Outrigger	25
C-CS3151	1-69-2-Q	Prpln Rpr Smn	14
C-CS3153	1-69-2-Q	Prpln Rpr Smn	14
C-CS3155	1-69-2-Q	Prpln Rpr Smn	14
C-CS3161	1-73-1-Q	AMID Rpr No.4	14
C-CS3163	1-73-1-Q	AMID Rpr No.4	14
C-CS3166	1-73-1-Q	AMID Rpr No.4	14
C-CS3168	1-73-1-Q	AMID Rpr No.4	14
C-CS3172	1-84-2-Q	Prpln Rpr 5-A No. 1	14
C-CS3174	1-84-2-Q	Prpln Rpr 5-A No.1	14
C-CS3177	1-86-2-Q	Prpln Rpr 5-A No.2	14
C-CS3179	1-86-2-Q	Prpln Rpr 5-A No.2	14
C-CS3181	01-77-2-L	Med Or No.6 Ent Trtmt Rm (Mn Battle Dr Sta)	14
C-CS3183	01-83-2-C	Conflag Sta No.5	14
C-CS3186	01-65-01-L	Passage (Unit Patrol Lkr)	14
C-CS3189	1-67-1-L	Passage Fr 81 S (Decon Sta 4)	14

Table 6-1.—DCSS Circuits.

Looking at the data for this cable (C-CS3183), information provided on this table consists of the Compartment number (01-83-2-C) and Name (CONFLAG STA No.5) where the net box for this cable is installed, and the Figure 9-1 of the system manual sheet number (14) where cable routing information can be found within the manual. Figure 6-26, Sheets 1 and 2, shows this information as displayed from the manual. As shown on sheet 2 of Figure 6-26, this cable connects into Terminal Box C-CS309 in the Passageway (1-67-2-L) at Frame 74 for Net 80 (Damage & Stability Control Net). Figure 6-27 is the wiring connection list for this cable. Shown on this diagram are the following information blocks:

a. Drawing No. LH5432028 -IVN System Module 3 Wire Connection List

b. Ref. DWG No. LH5432027 -IVN System Module 3 Cable Block & Rtg. Diag.

c. Circuit No. C-CS 3183 -DCSS Circuit No.

d. CableTypeCI2XSOW·3-ThreeTwisted Shielded Pairs with Overall Shield and Water Blocking

e. #Active Wires 4 -2 Spare Wires (Pair 3)

f. Unit-A Data Terminal Box Symbol No. (524.1) from DWG., EID No. (432027033001) -Equipment ID #, Nomenclature -Terminal Box C-CS309, Compartment -1-67-2-L Passage (FR74)

g. Unit-B Data Part No. -66400-270, EID No. (432027026076), Nomenclature DCSS Net Terminal (Net Jack Box), Compartment -01-83-2-C CONFLAG STA. No.5

h. CNDCT/GRP OOOS (Overall Shield), 0001-2-3S (Pair Shields), 0011-0031 (Black wire of each pair), 0012-0032 (White wire of each pair)

i. UNT -Unit A (left connection) to B (right connection)

j. TERMINAL NC -No Connection, TB5-2, 4, 6, 8 -Terminal Board Connection point for Unit A only (Left), TB1-5, 3, 4, 5, 1, 2 -Terminal Board Connection point for Unit B only (Right)

k. MARKER (CS3172-1,-2,-3,-4) wire marker data*

i. WIRE-COLOR Color of wire insulation.

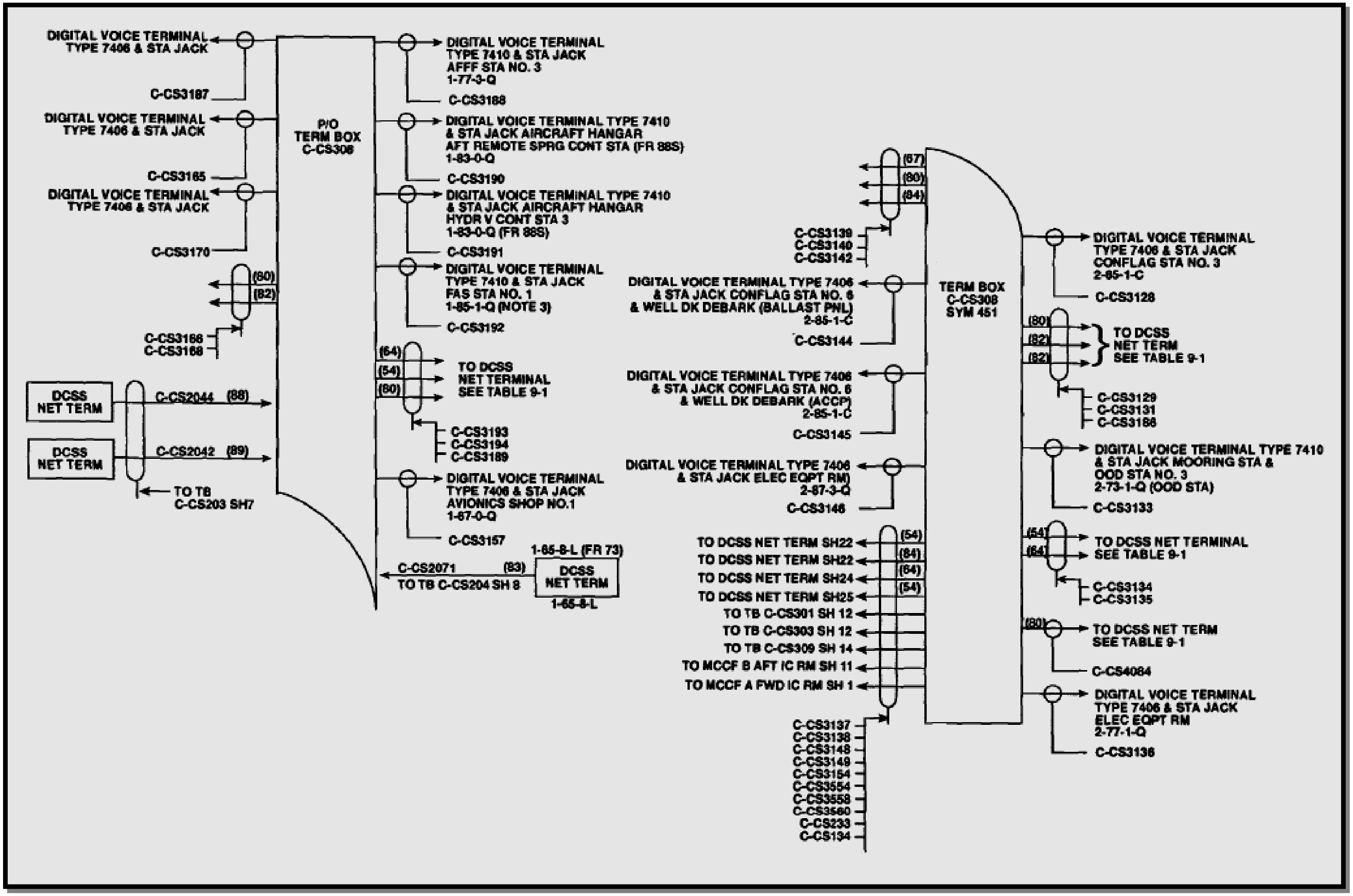


Figure 6-26.—Cable Routing (Sheet 1 of 2).

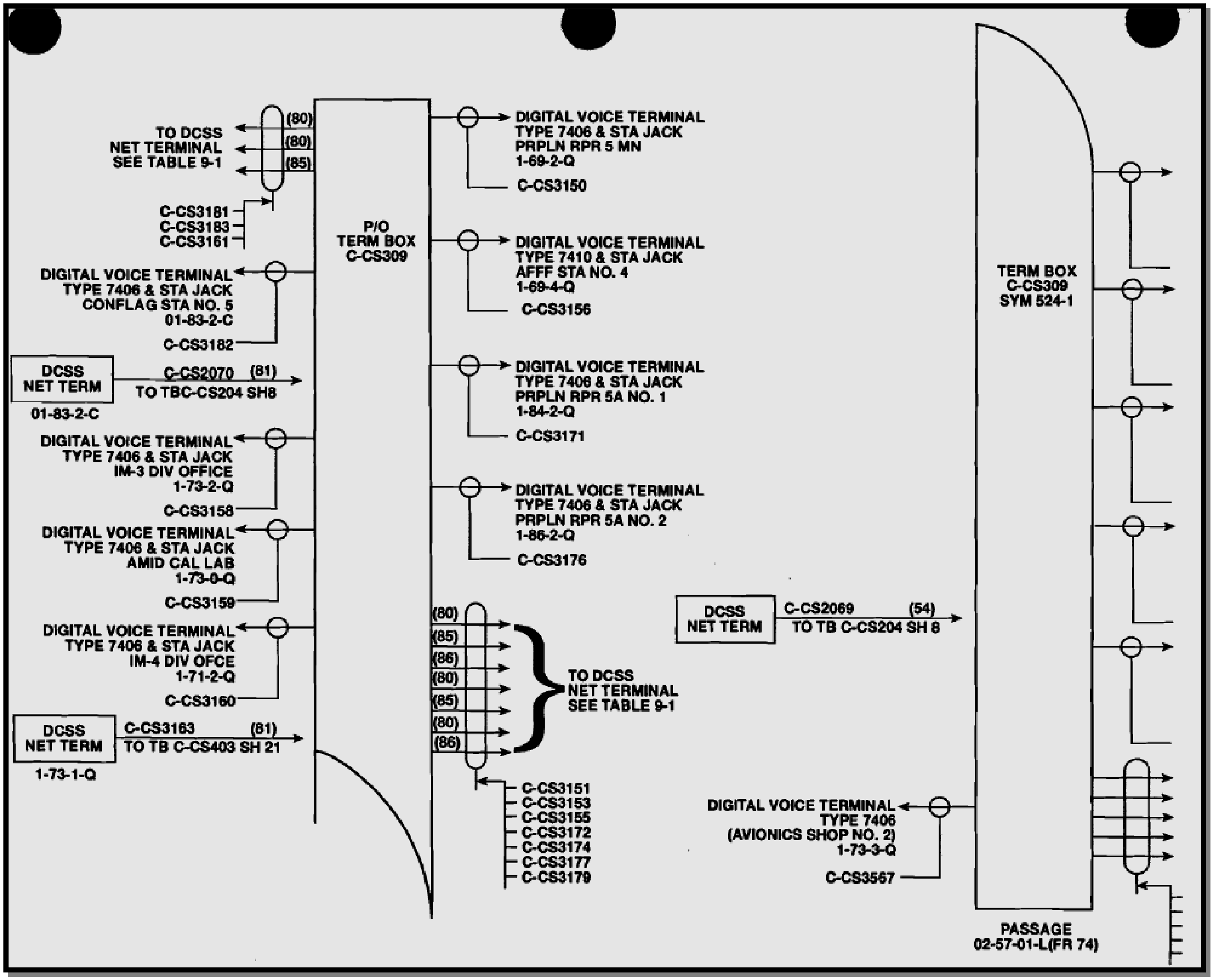


Figure 6-26.—Cable Routing (Sheet 2 of 2).

WIRING LIST

DATE: 06/08/95
CONTRACT: 76 LHD 5
DRAWING: LH5432028 REFERENCE DRAWING: LH5432027
REPORT NO.: X88310-R1
256

CIRCUIT NUMBER: C-CS3183 A
ACTIVE WIRES: 4 CABLE TYPE: CI2XSOW-3

UNIT-A: SYM 524.1
EID: 432027033001
NOMEN: TERMINAL BOX
COMPT: 1-67-2-L

C-CS309

UNIT-B: 66400-270
EID: 432027026076
NOMEN: DCSS NET TERMINAL
COMPT: 01-83-2-C

CNDCT/ GRP	UNT	TERMINAL	MARKER		WIRE-COLOR	UNT	TERMINAL	MARKER	FUNCTION
000S	A	NC		OTR SHLD		B	NC		
001S		NC		SHLD			TB1-5	CS03172-1	
0011	.	TB5-2	CS3172-1		BLK		TB1-3	CS3172-1	
0012		TB5-4	CSS3172-2		WHT		TB1-4	CSS3172-2	
002S		NC		SHLD			TB1-5	CS03172-3	
0021		TB5-6	CS3172-3		BLK		TB1-1	CS3172-3	
0022		TB5-8	CSS3172-4		WHT		TB1-2	CSS3172-4	
003S		NC		SHLD			NC		
0031		NC	SPARE		BLK		NC	SPARE	
0032		NC	SPARE		WHT		NC	SPARE	

Figure 6-27.—C-CS3183 Wiring List.

The wire marker data should reflect the number of the specified cable (CS3183); however, for DCSS net boxes, this number will reflect the lowest numbered cable in the net box string (maximum of 4 before there is an unacceptable dB loss of the signal). Table 6-2 shows Table 9-2 from the IVN System Manual, which lists the net conferences (a conference is a string of net boxes for a specific net) as they are programmed into the DCSS network processor. As with any computer, the system must identify the specific string in order to provide access for administration and maintenance. As no two strings can be identical, a "file" number is placed at the end of each string (.*) to distinguish between the various strings within a specified Net circuit. Table 6-2 shows Cable C-CS3183 as being Conference number 80.4 in the System. As the smallest numbered cable in this string is C-CS3172, this number will be used for the wire markers for all three cables connecting to net boxes on this string. The locations of the other terminal boxes associated with Conference number 80.4 are also shown. The Wiring Lists for these cables is shown on Figures 6-28 and 6-29. The signal from Terminal Box CS-309, as shown in the IVN System Manual, will be routed to Terminal Box C-CS308 in the Passageway at 2-81-3-L as a singular signal line (Figure 6-30) on cable C-CS3560. Further tracing to Terminal Box C-CS308 (see Figure 6-26 Sheet 1) shows the signal being routed to the "B" (Analog) MCCF in the Aft IC Room on cable C-CS233. For specific IVN system connection and MCCF hookup, vendor drawings are provided (Table 6-3). These drawings break the net circuit down into specific conferences and IVN systems (Forward or Aft) for both the Digital and Analog Main Cross Connect Fields.

WIRING LIST

DATE: 06/08/95
CONTRACT: 76 LHD 5
DRAWING: LH5432028 REFERENCE DRAWING: LH5432027
REPORT NO.: X88310-R1
252

CIRCUIT NUMBER: C-CS3177 A
ACTIVE WIRES: 4 CABLE TYPE: CI2XSOW-3

UNIT-A: SYM 524.1
EID: 432027033001
NOMEN: TERMINAL BOX
COMPT: 1-67-2-L

C-CS309

UNIT-B: 66400-270
EID: 432027026072
NOMEN: DCSS NET TERMINAL
COMPT: 1-86-2-Q

CNDCT/ GRP	UNT	TERMINAL	MARKER		WIRE-COLOR	UNT	TERMINAL	MARKER	FUNCTION
000S	A	NC		OTR SHLD		B	NC		
001S		NC		SHLD			TB1-5	CS03172-1	
0011		TB5-10	CS3172-1		BLK		TB1-3	CS3172-1	
0012		TB5-12	CSS3172-2		WHT		TB1-4	CSS3172-2	
002S		NC		SHLD			TB1-5	CS03172-3	
0021		TB5-14	CS3172-3		BLK		TB1-1	CS3172-3	
0022		TB5-16	CSS3172-4		WHT		TB1-2	CSS3172-4	
003S		NC		SHLD			NC		
0031		NC	SPARE		BLK		NC	SPARE	
0032		NC	SPARE		WHT		NC	SPARE	

Figure 6-28.—C-CS3177 Wiring List.

WIRING LIST

DATE: 06/08/95
CONTRACT: 76 LHD 5
DRAWING: LH5432028 REFERENCE DRAWING: LH5432027
REPORT NO.: X88310-R1
249

CIRCUIT NUMBER: C-CS3172 A
ACTIVE WIRES: 4 CABLE TYPE: CI2XSOW-3

UNIT-A: SYM 524.1
EID: 432027033001
NOMEN: TERMINAL BOX
COMPT: 1-67-2-L

C-CS309

UNIT-B: 66400-270
EID: 432027026070
NOMEN: DCSS NET TERMINAL
COMPT: 1-84-2-Q

CNDCT/ GRP	UNT	TERMINAL	MARKER		WIRE-COLOR	UNT	TERMINAL	MARKER	FUNCTION
000S	A	NC		OTR SHLD		B	NC		
001S		NC		SHLD			TB1-5	CS03172-1	
0011		TB5-10	CS3172-1		BLK		TB1-3	CS3172-1	
0012		TB5-12	CSS3172-2		WHT		TB1-4	CSS3172-2	
002S		NC		SHLD			TB1-5	CS03172-3	
0021		TB5-14	CS3172-3		BLK		TB1-1	CS3172-3	
0022		TB5-16	CSS3172-4		WHT		TB1-2	CSS3172-4	
003S		NC		SHLD			NC		
0031		NC	SPARE		BLK		NC	SPARE	
0032		NC	SPARE		WHT		NC	SPARE	

Figure 6-29.—C-CS3172 Wiring List.

DCCS Net Terminals Connected in Parallel			
***Conf#**	**DCSS Circuit Number**	**Compartment Number**	**Compartment Name**
67.6	C-CS1053 C-CS1054	02-E-1-Q 02-1-1-Q	Co & FSM Ofce "D" Co Co & FSM Ofce "E" Co
73.1	C-CS4083 C-CS5023	01-131-S 04-54-S	Weather Ok (Ram No.2) Weather Ok (Ram No.1)
75.1	C-CS5018 C-CS5087	04-65-3-M 08-Wea	CIWS Mag No. 1 CIWS Mt21
75.2	C-CS4063	01-132-Port	Weather Ok (CIWS Mt 22)
77.1	C-CS1056 C-CS1060	02-7-6-M 02-15-P	.50 Cal Mag No. 1 Weather Ok (.50 Cal Gun Platt)
77.2	C-CS3389 C-CS3396 C-CS3407	02-73-Port 02-83-S 02-86-2-M	Folding Platf (25mm Gun) Folding Platf (25mm Gun) 25mm Mag No.1
77.3	C-CS4100 C-CS4103	01-133-CL 02-125-P	Weather Ok (Mg Platt) .50 Cal Mg Platf
77.4	C-CS1057 C-CS1061	02-7-5-Q 02-15-S	.50 Cal/25mm Mag Armory .50 Cal Gun Platf
77.5	C-CS4117 C-CS4142	01-110-7-M 02-126-S	.50 Cal/25mm Mag No.2 .50 Cal Mg Platf No.3
78.1	C-CS2079 C-CS3390 C-CS3398	02-56-P 02-73-P 06-65-1-C	Folding Platf (Mk 137 Lchr 28-4) Folding Platf (Mk 137 Lchr 6) Pilot House (Lchr Cont Stbd)
78.2	C-CS2066 C-CS2089	02-62-S 06-65-1-C	Folding Platf (Mk 137 Lchr 1, 3, 5) Pilot House (Lchr Cont Port)
80.1	C-CS1045 C-CS1050 C-CS1058	02-T-2-Q 02-T-0-Q 02-13-6-L	Fwd Rpr2F Secondary Conning Sta Vestibule (Decon Sta 1)
80.2	C-CS4121 C-CS4130	01-110-4-Q 02-113-4-Q	Ord Rpr 6A &Gallery Ok Repr 7A Electric Shop
80.3	C-CS3151 C-CS3181	1-69-2-Q 01-77-2-L	Prpln Apr 5Mn Med or No.6
80.4	C-CS3172 C-CS3177 C-CS3183	1-84-2-Q 1-86-2-Q 01-83-2-C	Prpln Apr 5A No. 1 Prpln Rpr 5A No.2 Conflag Sta No.5
80.5	C-CS2037 C-CS2067 C-CS4084	1-54-2-Q 02-51-9-Q 01-98-1-C	Fwd Rpr 2A Ord Rpr 6F & Gallery Dk Rpr 7F Conflag Sta 7 & Hgr Dk Cont Rm
***Note**: Conference number is equal to net number plus suffix.			

Table 6-2.—DCSS Net Terminals Connected in Parallel.

WIRING LIST

DATE: 06/08/95
CONTRACT: 76 LHD 5
DRAWING: LH5432028 REFERENCE DRAWING: LH5432027

REPORT NO.: X88310-R1
776

CIRCUIT NUMBER: C-CS3560 A
ACTIVE WIRES: 16 CABLE TYPE: LSTTSU-10

UNIT-A: SYM 524.1 EID: 432027032003 NOMEN: TERMINAL BOX C-CS309 COMPT: 1-67-2-L	UNIT-B: SYM 451 EID: 432027033003 NOMEN: DCSS NET TERMINAL C-CS308 COMPT: 2-81-3-L

CNDCT/ GRP	UNT	TERMINAL	MARKER	WIRE-COLOR	UNT	TERMINAL	MARKER	FUNCTION
0011	A	TB4-1	CS3151-1	BLK	B	TB7-1	CS3151-1	
0012		TB4-3	CSS3151-2	WHT		TB7-3	CSS3151-2	
0021		TB4-5	CS3151-3	BLK		TB7-5	CS3151-3	
0022		TB4-9	CSS3151-4	WHT		TB7-7	CSS3151-4	
0031		TB4-2	CS3153-1	BLK		TB7-9	CS3153-1	
0032		TB4-4	CSS3153-2	WHT		TB7-11	CSS3153-2	
0041		TB4-6	CS3153-3	BLK		TB7-13	CS3153-3	
0042		TB4-8	CSS3153-4	WHT		TB7-15	CSS3153-4	
0051		TB5-1	CS3155-1	BLK		TB7-17	CS3155-1	
0052		TB5-3	CSS3155-2	WHT		TB7-19	CSS3155-2	
0061		TB5-5	CS3155-3	BLK		TB7-21	CS3155-3	
0062		TB5-7	CSS3155-4	WHT		TB7-23	CSS3155-4	
0071		TB5-2	CS3172-1	BLK		TB7-18	CS3172-1	
0072		TB5-4	CSS3172-2	WHT		TB7-20	CSS3172-2	
0081		TB5-6	CS3172-3	BLK		TB7-22	CS3172-3	
0082		TB5-8	CSS3172-4	WHT		TB7-24	CSS3172-4	
0091		NC	SPARE	BLK		NC	SPARE	
0092		NC	SPARE	WHT		NC	SPARE	
0101		NC	SPARE	BLK		NC	SPARE	
0102		NC	SPARE	WHT		NC	SPARE	

Figure 6-30.—Terminal Box Route Wiring List.

Aft "B" MCCF

Net Term Circuit Pack TN1625	Port	Net No.	Cable No	Cable Type	Lead Desig	Conn Cable Color Code	Cross Connect From: Block 2 Row 3	Cross Connect To: Terminal Board	Cable No	Cable Type	Pair No.	Ships Terminal Marking	Station Compartment	Equipment Type	User Name or Compartment Name
Conn 2J11 Slot 25	00	80.11	B02J11	ZB25B	T0 Ro	W-BL BL-W W-O O-W W-G G-W	1 2 3 4 5 6	7-17 7-18					03-73-1-L	DCSS Net Terminal	Decon Sta 3; Cont Sta (61)
	01	80.12			T1 R1	W-BR BR-W W-S S-W R-BL BL-R	7 8 9 10 11 12	7-19 7-20					1-122-1-Q		Repair 3; Aft Repair 3 (104)
	02	80.13			T2 R2	R-O O-R R-G G-R R-BR BR-R	13 14 15 16 17 18	7-21 7-22					1-81-5-L		Decon Sta 4; Cont Sta 4 (61)
	03	80.14			T3 R3	R-S S-R BK-BL BL-BK BK-O O-BK	19 20 21 22 23 24	7-23 7-24					02-97-0-L		Con Sta Fr 110, Decon Sta 5 (61)
Conn 2J11 Slot 26	00	80.2			T0 R0	BK-G G-BK BK-BR BK-BK BK-S S-BK	25 26 27 28 29 30	7-25 7-26					02-110-4-Q		Ord Repair 6A Gallery (95)
	01	80.3			T1 R1	Y-BL BL-Y Y-O O-Y Y-G G-Y	31 32 33 34 35 36	7-27 7-28					1-69-2-Q		Prpln Repair 5 Main (102)
	02	80.4			T2 R2	Y-BR BR-Y Y-S S-Y V-BL BL-V	37 38 39 40 41 42	7-29 7-30					01-83-2-C		Conflag Sta 5 (50)
	03	80.6			T3 R3	V-O O-V V-G G-V V-BR BR-V	43 44 45 46 47 48	7-31 7-32					1-102-2-Q		Hangar Deck Repair 1-H (75)
						V-S	49								
						S-V	50								

Table 6-3.—Vendor Drawing Sheet.

The Sound-Powered Nets displayed on Figure 6-23, identify the DCSS cabinet interface, via the Analog MCCF, with the ship's Sound-Powered System. All sound power is fed via 2-wire connection.

Unit 11-13 represent the IVN Digital Voice Terminals (DVTs), installed throughout the ship in command and control spaces for tactical communications. The IVN system utilizes the following DVT types: 7410, 7406, 7407, 8410, and *8510* (future install). These telephone terminals are identical to the units used with the J-Dial system. Only the system Administration is different. DVT units are wired to the station jack, which contains an RJ-45 telephone plug connector. Shipboard Wiring is connected to the rear of the station jack front plate. For IVN equipped ships, the following hook-up is used for ALL DVT units:

Station Jack	To RJ-11 Plug
1 –TXT	Blue -Pin 1
2 –TXR	Orange -Pin 2
3 –PXT	Black -Pin 3
6 –PXR	Yellow -Pin 6

Refer to Figure 6-31 for a view of station jack connection points. The four signal lines used for a DVT unit are for Telephone and Port Tip and Ring. "Tip" and "Ring" are standard telephone signals, representing audio and *audio* return respectively. Telephone power, for "off-hook" system status, is -48VDC. All telephone Wiring is connected through the Digital MCCF in Forward or Aft IC.

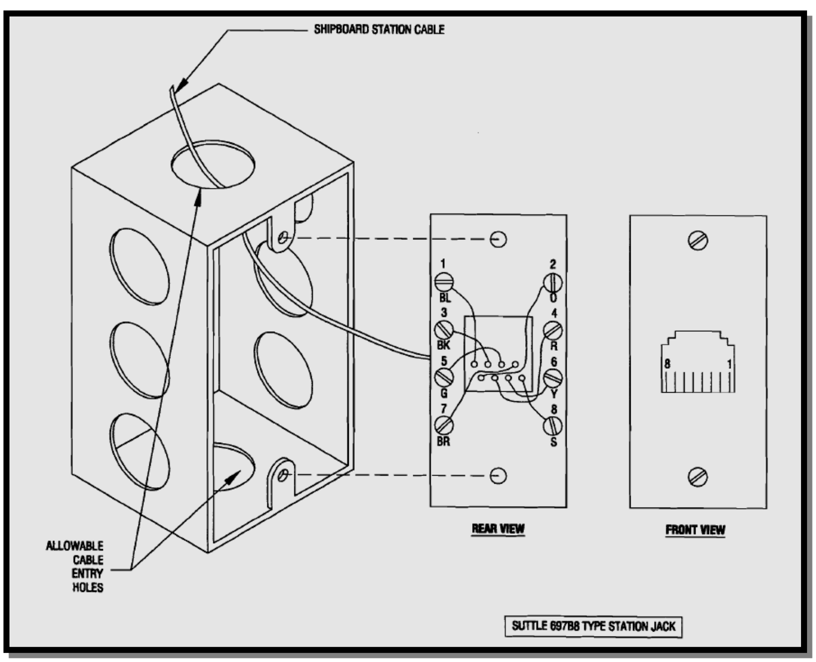


Figure 6-31.—DVT Station Jack.

IVN telephone number extensions begin with the number 4, which distinguishes them from J-Dial telephone extensions which begin with the number 7. See Figure 6-32 (from the Shipboard Integrated Voice Communications Directory, IVN equipped ships) to note the extensions numbers for the IVN and J-Dial telephones located in the Landing Force Commanding Officer's Cabin, 02-63.5-1-L. The telephone number for this compartment's station jack, as administered in the IVN system, is 4584. Note that all extension numbers beginning with 45 or46areconnectedtothe Digital MCCF in Forward IC, while all extension numbers beginning with 40 or 41 are connected to the Digital MCCF in Aft IC. The drawings shown in Figure 9-1 of the Ship System Manual for IVN equipped ships are in module order, as defined earlier in this Topic.

J - L ALPHABETICAL LISTING

JOINT MESSAGE CENTER; NAVMACS SYS SUPV, 02-89-2-C	4581
JOINT MESSAGE CENTER; TROOP SUPV, 02-89-2-C	4103
JOINT MESSAGE CENTER; TROOP SUPV, 02-89-2-C	7249
JOINT MESSAGE CENTER; WATCH SUPV, 02-89-2-C	4582
JOINT MESSAGE CENTER; WATCH SUPV, 02-89-2-C	7250
JP-5 PUMP ROOM NO. 1, 6-41-0-E	7562
JP-5 PUMP ROOM NO. 2, 5.5-101-0-E	7575
L	
LANDING FORCE COMMANDING OFFICER'S CABIN, 02-63.5-1-L	4584
LANDING FORCE COMMANDING OFFICER'S CABIN, 02-63.5-1-L	7188
LANDING FORCE COMMANDING OFFICER'S STATEROOM, 02-63.5-3-L	4583
LANDING FORCE COMMANDING OFFICER'S STATEROOM, 02-63.5-3-L	7688
LANDING FORCE COMMUNICATIONS OFFICE, 02-71-2-Q	4585
LANDING FORCE COMMUNICATIONS OFFICE, 02-71-2-Q	7216
LANDING FORCE COMMUNICATIONS OFFICE, 02-71-2-Q	7217
LANDING FORCE EXECUTIVE OFFICER'S CABIN, 02-62-1-L	4674
LANDING FORCE EXECUTIVE OFFICER'S CABIN, 02-62-1-L	7183
LANDING FORCE EXECUTIVE OFFICER'S STATEROOM, 02-62-3-L	7683
LANDING FORCE OFFICERS STATEROOM, 02-58.5-1-L	7685
LANDING FORCE LANDING OFFICER'S STATEROOM, 02-58.5-1-L	7198

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ALPHABETICAL LISTING L

LANDING FORCE OPERATIONS CENTER	. SEE LFOC
LANDING FORCE OPERATIONS OFCR STATEROOM, 02-60-1-L	7199
LANDING FORCE REGISTERED PUBN OFFICE, 02-97-2-Q	7333
LANDING FORCE STAFF ADMIN OFFICE, 02-110-2-Q	7307
LANDING FORCE STAFF ADMIN OFFICE, 02-110-2-Q	7308
LANDING FORCE STAFF ADMIN OFFICE, 02-110-2-Q	7309
LANDING FORCE STAFF ADMIN OFFICE, 02-110-2-Q	7310
LANDING FORCE STAFF ADMIN OFFICE, LF PERS O, 02-110-2-Q	7311
LAUNCHER CONTROL ROOM NO. 1, 05-65-1-C	4104
LAUNCHER CONTROL ROOM NO. 1, 05-65-1-C	7491
LAUNCHER CONTROL ROOM NO. 2, 01-130-3-C	4105
LAUNCHER CONTROL ROOM NO. 2, 01-130-3-C	7493
LAUNDRY, 4-73-0-Q	7541
LCAC 400 HZ CONV RM, 3-98-3-Q	4106
LCAC PUMP ROOM, 6-93-0-E	7571
LEGAL OFFICE, 02-117-0-Q	7286
LFOC; 02-73-0-C	7220
LFOC; CLF, 02-73-0-C	3060/3560/-/-
LFOC; CLF, 02-73-0-C	7221
LFOC; LF ASST WO, 02-73-0-C	4107
LFOC; LF CIO, 02-73-0-C	4111
LFOC; LF COS, 02-73-0-C	4108
LFOC; LF COS, 02-73-0-C	7608
LFOC; LF OPS CHIEF, 02-73-0-C	4109
LFOC; LF OPS CHIEF, 02-73-0-C	7609
LFOC; LF OPS O, 02-73-0-C	-/-/3363/3863
LFOC; LF OPS O, 02-73-0-C	4675

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Figure 6-32.—DVT Station Jack.

Modules can be readily identified in either the J-Dial or IVN system by the cable identification number shown on the cable tag. For example, cable number C·CS3156 indicates the far end connection point for this cable (telephone location) can be found in the Module 3 documentation; whereas cable number C-CS1022 indicates the telephone unit can be traced in the Module 1 documentation. As the compartment number for the Landing Force CO Cabin is 02-63.5-1-L, the Module 2 (Frame 49-65) documentation should be reviewed. Figure 6-33 (System Manual Module 2 data from Figure 9-1) shows the cable number for this IVN telephone (extension 4584) to be C-CS2063.

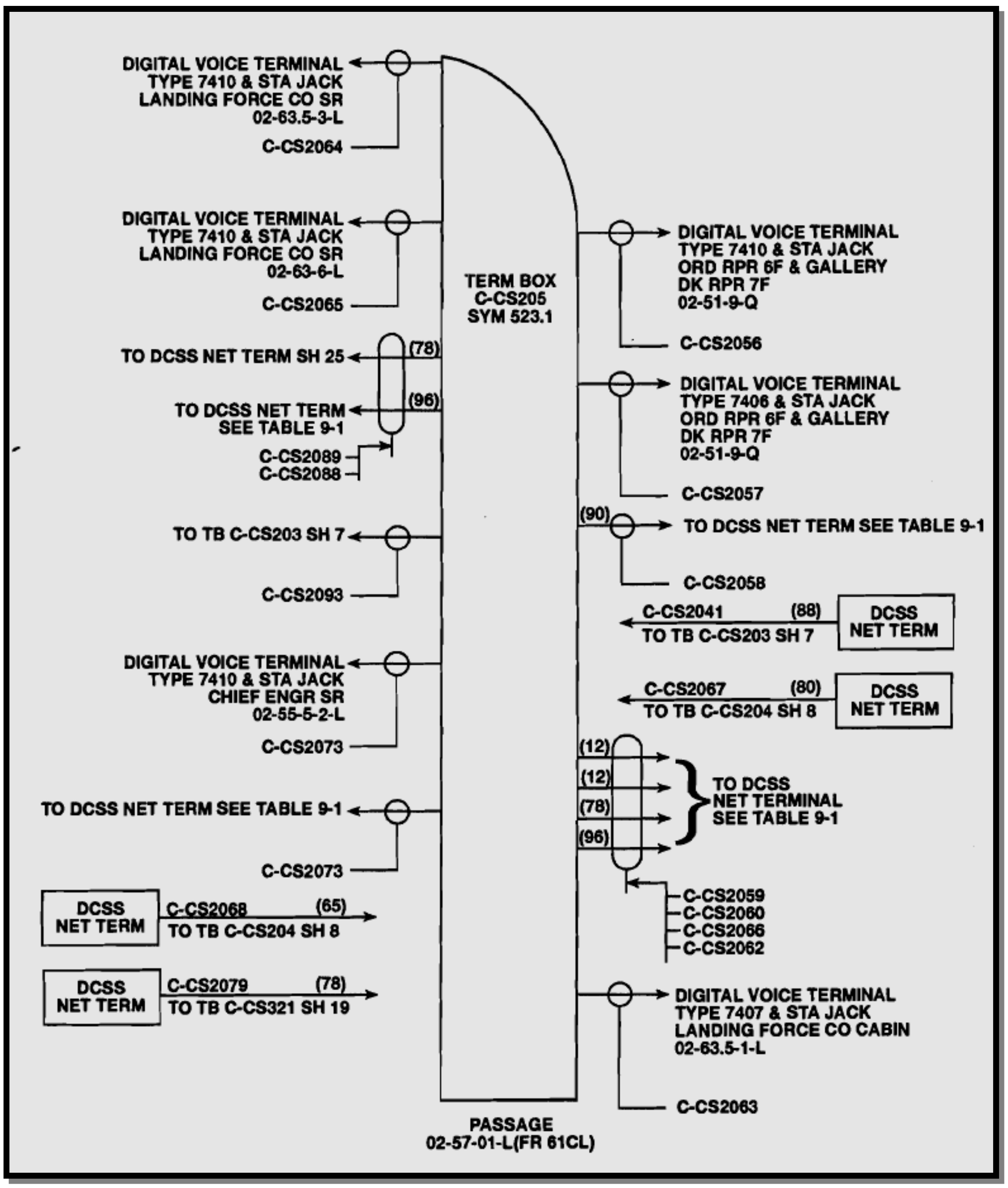


Figure 6-33.—System Manual, Module 2.

Other information provided includes the DVT type (7407) and compartment name and number. Actual wiring list information from Drawing 432-6857906 (IVN Module 2 Wiring Connection List) is shown in Figure 6-34. Unit B reflects the station jack hook-up for this terminal (1, 2, 3, and 6). Note that 2XSOW-3 (three shielded paired, overall shield) cable is used between the terminal box and the station jack. All IVN equipped ships DVT units use 4-wire signals; therefore, pair 3 is always spared. Shield grounds are always connected to standard ship's ground (hull) unless otherwise specified on the wiring list. Table 6-4 shows the vendor drawing for the IVN Digital MCCF located in Forward IC. Port 05 on this page reflects the 7407 DVT located in the Landing Force CO Cabin at extension 4584.

WIRING LIST

DATE: 07/21/95
CONTRACT: 76 LHD 5
DRAWING: LH5432026 REFERENCE DRAWING: LH5432025

REPORT NO.: X88310-R1
61

CIRCUIT NUMBER: C-CS2063 A
ACTIVE WIRES: 4 CABLE TYPE: 2XSOW-3

UNIT-A: SYM 523.1
EID: 432025011002
NOMEN: TERMINAL BOX
COMPT: 02-57-01-L

C-CS205

UNIT-B: F32471
EID: 432025009014
NOMEN: HANDY BOX/STA JACK
COMPT: 02-63.5-1-L

CNDCT/ GRP	UNT	TERMINAL	MARKER		WIRE-COLOR	UNT	TERMINAL	MARKER	FUNCTION
001S	A	NC		SHLD		B	BND	CS02063-1	
0011		TB1-2	CS2063-1		BLK		1	CS2063-1	
0012		TB1-4	CSS2-63-2		WHT		2	CSS2063-2	
002S		NC		SHLD			GND	CS02063-3	
0021		TB1-6	CS2063-3		BLK		3	CS2063-3	
0022		TB1-8	CSS2063-4		WHT		6	CSS2063-4	
003S		NC		SHLD			NC		
0031		NC	SPARE		BLK		NC	SPARE	
0032		NC	SPARE		WHT		NC	SPARE	

Figure 6-34.—Wire List for IVN Cable C-CS2063.

Fwd "A" MCCF															
							Cross Connect								
							From	To							
ICT Circuit Pack TN754	Port No.	Ext No.	Cable No	Cable Type	Lead Desig	Conn Cable Color Code	Block 4 Row 12	Terminal Board	Cable No	Cable Type	Pair No.	Ships Terminal Marking	Station Compartment	Equipment Type	User Name or Compartment Name
Slot 1C14	01	4504	J1C14	ZB25B	TXT1 TXR1 PXT1 PXR1	W-BL BL-W W-O O-W W-G G-W	1 2 3 4 5 6	13-9 13-10 13-11 13-12					1-13-1-Q	7410	AFFF Sta 1 (26)
	02	4524			TXT2 TXR2 PXT2 PXR2	W-BR BR-W W-S S-W R-BL BL-R	7 8 9 10 11 12	1-5 1-6 1-7 1-8					07-66-1-C	7406	CIWS; Local Control Rm #1 (45)
	03	4544			TXT3 TXR3 PXT3 PXR3	R-O O-R R-G G-R R-BR BR-R	13 14 15 16 17 18	1-21 1-22 1-23 1-24					06-86-3-C	7410	Stat US/Debark Control Central Plot Bd 1 (60)
	04	4564			TXT4 TXR4 PXT4 PXR4	R-S S-R BK-BL BL-BK BK-O O-BK	19 20 21 22 23 24	5-13 5-14 5-15 5-16					02-78-2-C	7410	Flag Briefing & Planning Area; Work Table (70)
	05	4584			TXT5 TXR5 PXT5 PXR5	BK-G G-BK BK-BR BK-BK BK-S S-BK	25 26 27 28 29 30	5-17 5-18 5-19 5-20					02-63.5-1-L	7407	LF CO Cabin (81)
	06	4604			TXT6 TXR6 PXT6 PXR6	Y-BL BL-Y Y-O O-Y Y-G G-Y	31 32 33 34 35 36	17-29 17-30 17-31 17-32					5-61-2-L	7410	Mag Sprg Grp 11 (126)
	07	4624			TXT7 TXR7 PXT7 PXR7	Y-BR BR-Y Y-S S-Y V-BL BL-V	37 38 39 40 41 42	2-25 2-26 2-27 2-28					5-71-1-Q	7406	Radar Rpr (102)
	08	4644			TXT8 TXR8 PXT8 PXR8	V-O O-V V-G G-V V-BR BR-V	43 44 45 46 47 48	4-9 4-10 4-11 4-12					03-65-1-Q	7406	Sqdn Work Ctr; Flight Line (114)
						V-S	49								
						S-V	50								

Table 6-4.—Vendor Drawing Sheet.

The PICT units are also connected to the Definity switch in either Forward or After IC, via the Digital MCCF. The PICT unit, utilized for tactical communications efforts, runs an internal self test when power is first applied or when the RESET button on the Front Panel is depressed and held down for approximately 3 seconds. The back lights on the touch screen face will extinguish as a result of this action, and a successful BIT occurs when the Back Lights illuminate, the IVN End Points become a steady white indicating the PICT is synchronized with the Lucent switch, the IVN EP buttons are solid dark Blue, Radio End Points are a solid Cyan (providing an SA-2112 is connected) on the Main Menu or Dial Mode Screens (Figures 6-35 and 6-36) and Bit results indicate *PICT Bit Passed* on the Terminal Configuration Screen (Figure 6-37). There are two types of Fatal Errors:

a. Static: PICT will default to the Terminal Configuration Screen, display the ERROR and not respond to any touches.

b. Dynamic: PICT will Screen will be flashing and will not respond to any touches.

In both cases, the PICT is disabled and MUST be replaced. The PICT is a sealed unit and must be returned intact or the equipment warranty will be voided. The model number of the IVN equipped ships PICT unit, 7300-2211, must be included on all returns and re-orders. The last four digits of the model number indicate the circuit board arrangement within the PICT by single-digit code. The 22 code indicates that two SVS circuit boards for SA-2112 Secure Voice interface are installed. The 11 indicates that two ISDN circuit boards for IVN interface are installed. Other options include 3 for STC-2 interface and 4 for Video interface.

MAIN MENU SCREEN: Upon completion of BIT the PICT will default to the Main Menu Screen. The Main Menu Screen consists of:

a. 20 light Blue SINGLE ACCESS (SA) buttons arranged from left to right, top to bottom SA01 thru SA20.

b. Green, MONITOR, HOLD, CONFERENCE, OVERRIDE, DIAL, TERMINAL CONFIGURATION, and PROGRAM SINGLE ACCESS (SA) KEY. IC button.

c. Grey with Red border EP-2.

d. Dark Blue END POINT (EP-1 IP and EP-3IP) button.

e. Cyan END POINT (EP-5) RADIO LEFT (RL) AND END POINT (EP-7) RIGHT RADIO (RR) buttons.

f. Three Black with Gold border RESERVED END POINTS buttons.

g. One Grey CLEAR CALL and HANDS FREE buttons.

h. An information area that will display EP status, Terminal ID, and Configuration Module change information.

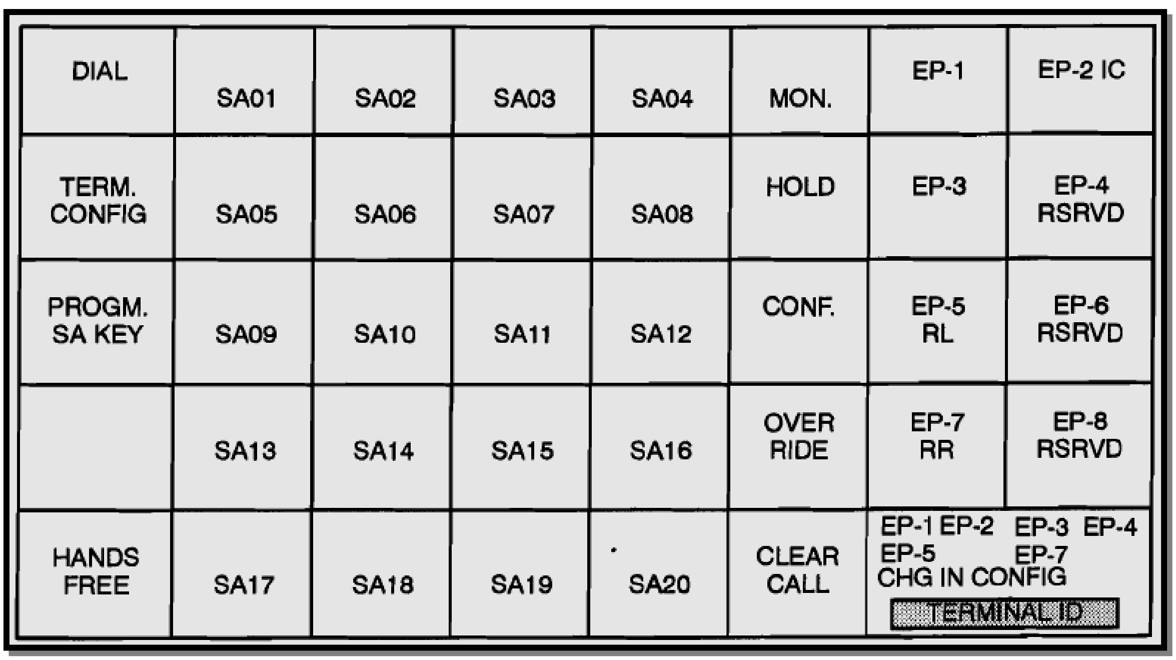


Figure 6-35.—Main Menu Screen.

DIAL MENU SCREEN: When the Dial button on the Main Menu Screen is touched, it will take you to the Dial Menu Screen. The Dial Menu Screen consists of:

a. One light Blue dial pad with numbers from 1 to 0, *, # signs.

b. Green, MONITOR, HOLD, CONFERENCE, OVERRIDE, TERMINAL CONFIGURATION, and RETURN TO MAIN buttons.

c. One Grey with Red border EP-2 IC button.

d. Dark Blue EP-1 IP and EP-3IP buttons.

e. Cyan EP-5 RL and EP-7 RR buttons

f. Three Black with Gold borders reserved buttons.

g. One Grey CLEAR CALL button.

h. User information screen.

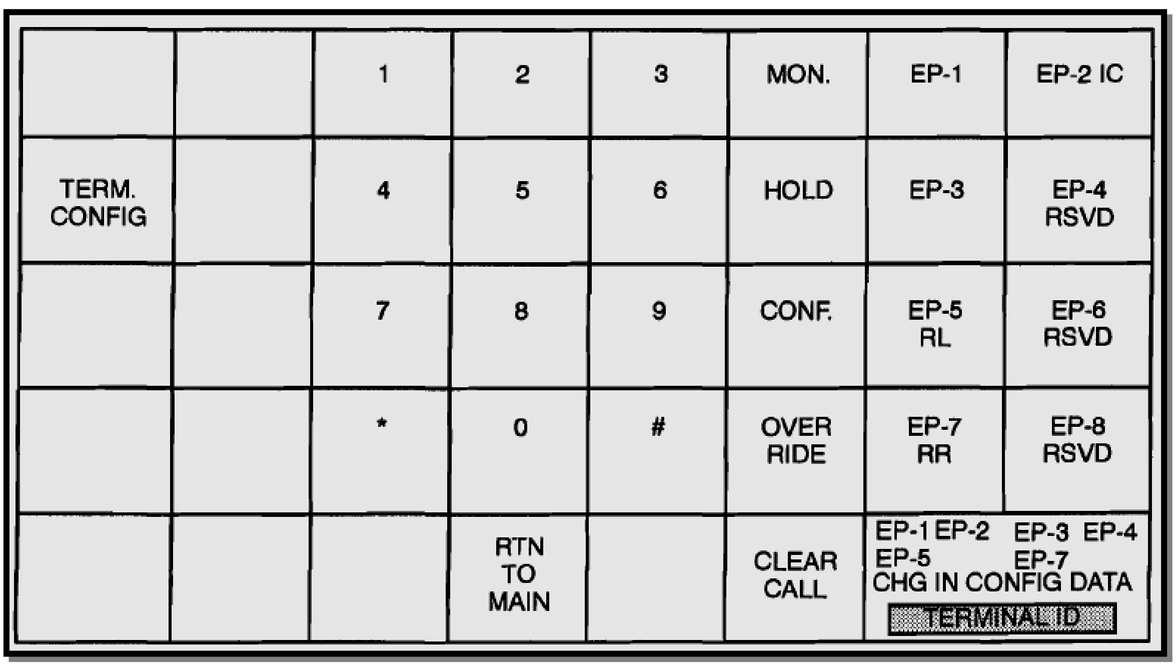


Figure 6-36.—Dial Menu Screen.

TERMINAL CONFIG SCREEN: The TERMINAL CONFIGURATION SCREEN is accessed from the Dial Menu or Main Menu Screens by touching the Terminal Configuration button. The Terminal Configuration Screen consists of:

a. Dark Blue ACTIVE, MONITOR, LOUDSPEAKER, INTERCOM, RADIO LEFT, RADIO RIGHT, and RINGER buttons.

b. Green, DAULT LEVELS, LEVEL DOWN, LEVEL UP, SET RINGER ON/OFF, TERMINAL ID, WASH SCREEN, CALIBRATION SCREEN, SPID CONFIGURATION, RETURN TO MAIN, CONFIGURATION MODULE STORE, and CONFIGURATION MODULE LOAD Buttons.

c. Grey with Red border EP-2 IC button.

d. A User data display area that contains BUILT INTEST (BIT) results, INTERFACE (IF) POWER, MASTER BRIGHTNESS & VOLUME control settings and CONFIGURATION MODULE (CM) status.

e. Four Gold INTERFACE (IF) status buttons.

f. Light Blue MONITOR SPEAKER ON/OFF button.

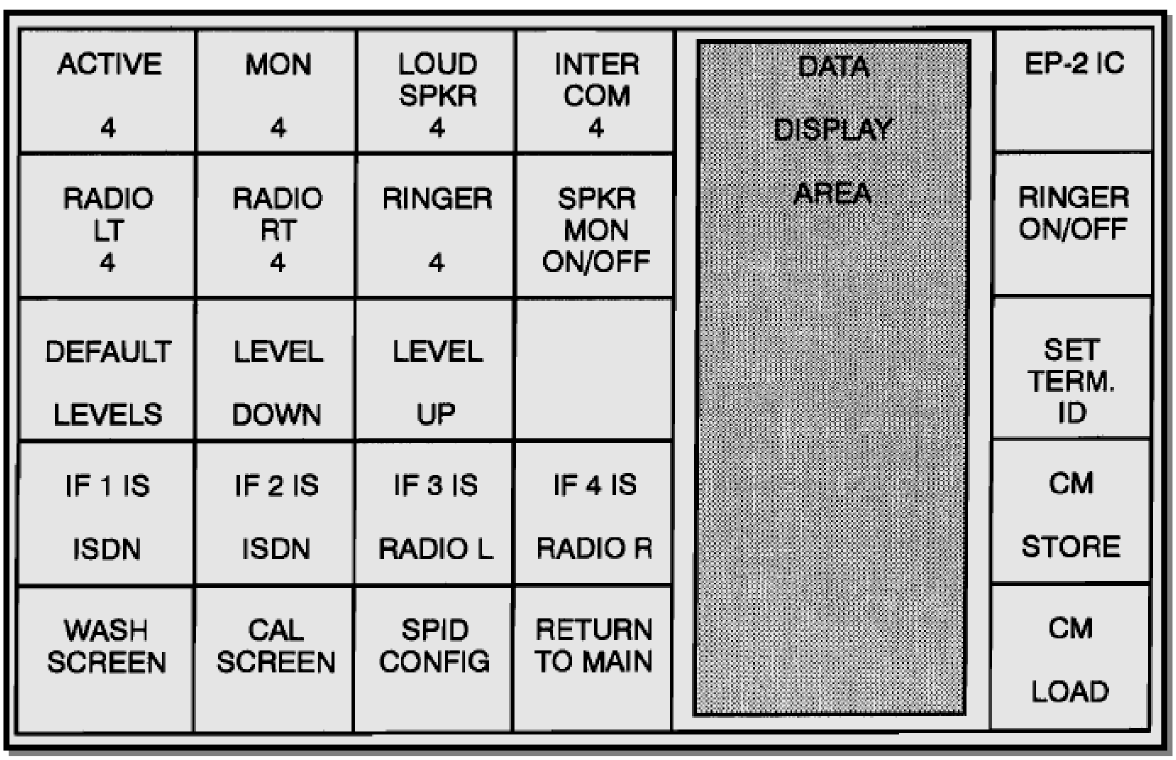


Figure 6-37.—Terminal Configuration Screen.

These options will be incorporated in future systems installations. The model number digits (2211) refer to the circuit board packs which connect to J3, J4 (SVS), J5, and J6 (ISDN) on the rear of the PICT unit respectively (Figure 6-38). J1 and J2 are located on the front panel of the PICT unit and are labeled as *USER (J1)* and *SUPVR (J2).* Using a special LIMO type connector adapter (Vendor part number EEG.1 K.308.CLN CONNECTOR) these jacks interface the operator by providing for a PICT headset or handset to be connected to the unit. The Supervisor Jack (J2) also allows for PTT override via internal signal wiring. The wired connection points for J1 and J2 are listed in Table 6-5.

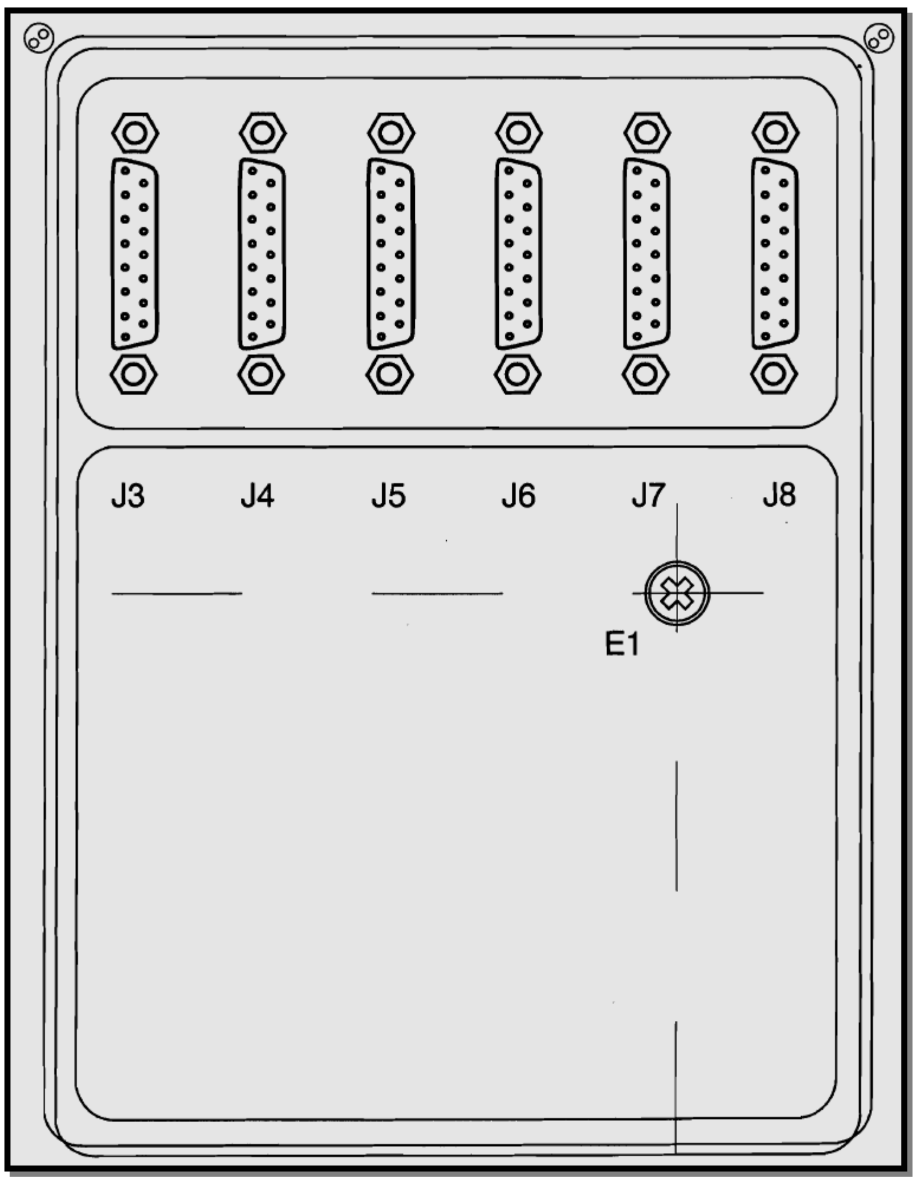


Figure 6-38.—Rear PICT Connectors.

J1 & J2 CONNECTIONS	
PIN NO.	**SIGNAL**
1	ACT-RXP
2	/PTT
3	TXN
4	TXP
5	MON-RXN
6	MON-RXP
7	ACT-RXN
8	GND

Table 6-5.—J1 & J2 Connections.

The functions and connection points for signal transfer of the rear PICT connectors (Vendor part number C8DH15P1 BR-0.5) are listed in Table 6-6.

PICT Rear Connector Wiring				
PIN NO.	**J3/J4 SA-2112 INTERFACE**	**J5//J6 ISDN/BRI INTERFACE**	**J7**	**J8**
1	+26 VDC	NOT USED	GND	PROCESSOR CIRCUIT BOARD – CAN INTERFACE WITH CONFIGURATION MODULE
2	GND	NOT USED	/PTT-FSW	
3	RX A	TE TRANSMIT +	IC-OUTN	
4	RX B	TE TRANSMIT -	IC-OUTP	
5	CIN +26 VDC	TE RECEIVE +	AUX-OUTN	
6	CIN GND	TE RECEIVE -	AUX-OUTP	
7	TX A	NOT USED	AUX-INN	
8	TX B	NOT USED	AUX-INP	
9	MODE IND	RESERVED	GND	
10	NOT USED	PWR SINK 2 + (24-70V)	PTT-OUTN	
11	PTT	PWR SINK 2 – (24 TO 70V)	PTT-OUTP	
12	HOOKSWITCH	RESERVED	+5V	
13	MODE SEL	ISDN SPS	+5V	
14	RESERVED	GND	+5V	
15	CHASSIS GND	CHASSIS GND	GND	

Table 6-6.—PICT Rear Connector Wiring.

The following is a breakdown of the signal lines shown in Tables 6-5 and 6-6:

a. J1/J2 -Signal lines include RECEIVE audio and RECEIVE audio return (RXP/RXN) for ACTIVE and MONITOR Channels, Transmit audio and audio Return (TXP/TXN) for ancillary device microphone, and Push-To-Talk (PTT).

b. J3/J4 -Signal· lines include +26 VDC power input, Cipher +26 VDC input, Receive and Transmit audio and audio return (RX/TX) , Mode Indicator signal for Secure/Plain, and PIT.

c. J5/J6 -Signal lines include Power in (approximately 50 VDC on IVN equipped ships) and Transmit and Receive audio and audio return.

d. J7 -Signal lines include Intercom talkback transmit and return (IC-OUTP/N), Auxiliary unit Receive and Transmit audio and audio return (AUX-OUT/IN/P/N), PIT, and footswitch PTT.

These connectors are internally wired to the connector jacks mounted atop the PICT environmental enclosure, with the exception of J1 and J2 operator user jacks, which are on the front panel of the PICT unit itself and J8 (Processor jack). A configuration module (CM Module) may be connected to J8 on the rear of the PICT unit for storing PICT programming for fast installation in the event of casualty. Data storage and recovery may be initialized from the Terminal Configuration Menu on the PICT touch screen. Connector interface between PICT unit rear connectors and environmental enclosure jacks is as follows:

a. J3 -SVS 1 to J7 on Environmental Enclosure
b. J4 -SVS2 to J1 0 on Environmental Enclosure
c. J6 -ISDN 1 to J8 on Environmental Enclosure
d. J5 -ISDN 2 to J6 on Environmental Enclosure
e. J7 -Talkback Speaker interface to J3 on Environmental Enclosure

Other connectors mounted on the environmental housing are J9 (Power in) and J5 (PTT Footswitch). The PTT Footswitch is used with headsets which are not provided with a built-in PIT function. Wiring of the environmental housing connectors is per shipboard IVN wiring diagrams (Figure 6-39).

WARNING:
The connectors on the back of the PICT are clearly labeled and serious damage will result if an interface (IVN or SVS) connector with power is connected to the processor or audio connectors J8 and J7 respectively.

WIRING LIST

DATE: 10/26/95
CONTRACT: 76 LHD 6
DRAWING: LH5432032 REFERENCE DRAWING: LH6432031

REPORT NO.: X88310-R1
59

CIRCUIT NUMBER: CS5056 A
ACTIVE WIRES: 4
CABLE TYPE: 2XS-2

UNIT-A: SYM 524.1
EID: 432031012002
NOMEN: TERMINAL BOX
COMPT: 05-73-1-C
C-CS504

UNIT-B: 411090-280
EID: 432031009001
NOMEN: PROGRAMMABLE INTEGRATED COMMUNICATION TERMINAL
COMPT: 05-73-1-C JACK: J8
CONN: M28840/16AA1S1 FN: 24 PLUG: P8
TOOLS: W01 BIN: 452
BKSL: M28840/6-24WA FN: 25

CNDCT/ GRP	UNT	TERMINAL	MARKER		WIRE-COLOR	UNT	TERMINAL	MARKER	FUNCTION
001S	A	NC		SHLD		B	4		
0011		TB4-9	CS5056-1		BLK		5		
0012		TB4-11	CSS5056-2		WHT		7		
002S		NC		SHLD			4		
0021		TB4-13	CS5056-3		BLK		1		
0022		TB4-15	CSS5056-14		WHT		2		

Figure 6-39.—J8 Wire List - PICT.

There is no corrective maintenance, as stated earlier in this Topic, as the PICT is a sealed unit. Preventive maintenance is performed using the IVN maintenance terminal or built-in-test function. The BIT test procedure is outlined in the Operational Manual for the Programmable Integrated Communications Terminal (PICT), vendor manual number 411140-100.

6.4.0 INTEGRATED VOICE COMMUNICATION SYSTEM (IVCS)

Integrated Voice Communication System AN/STC-2(V) (STC-2) is a processor controlled, solid-state communications system designed for shipboard use. The STC-2's primary function is to provide reliable voice-to-voice communication. Figure 6-40 displays the assemblies (with subassemblies) that comprise the STC-2 system.

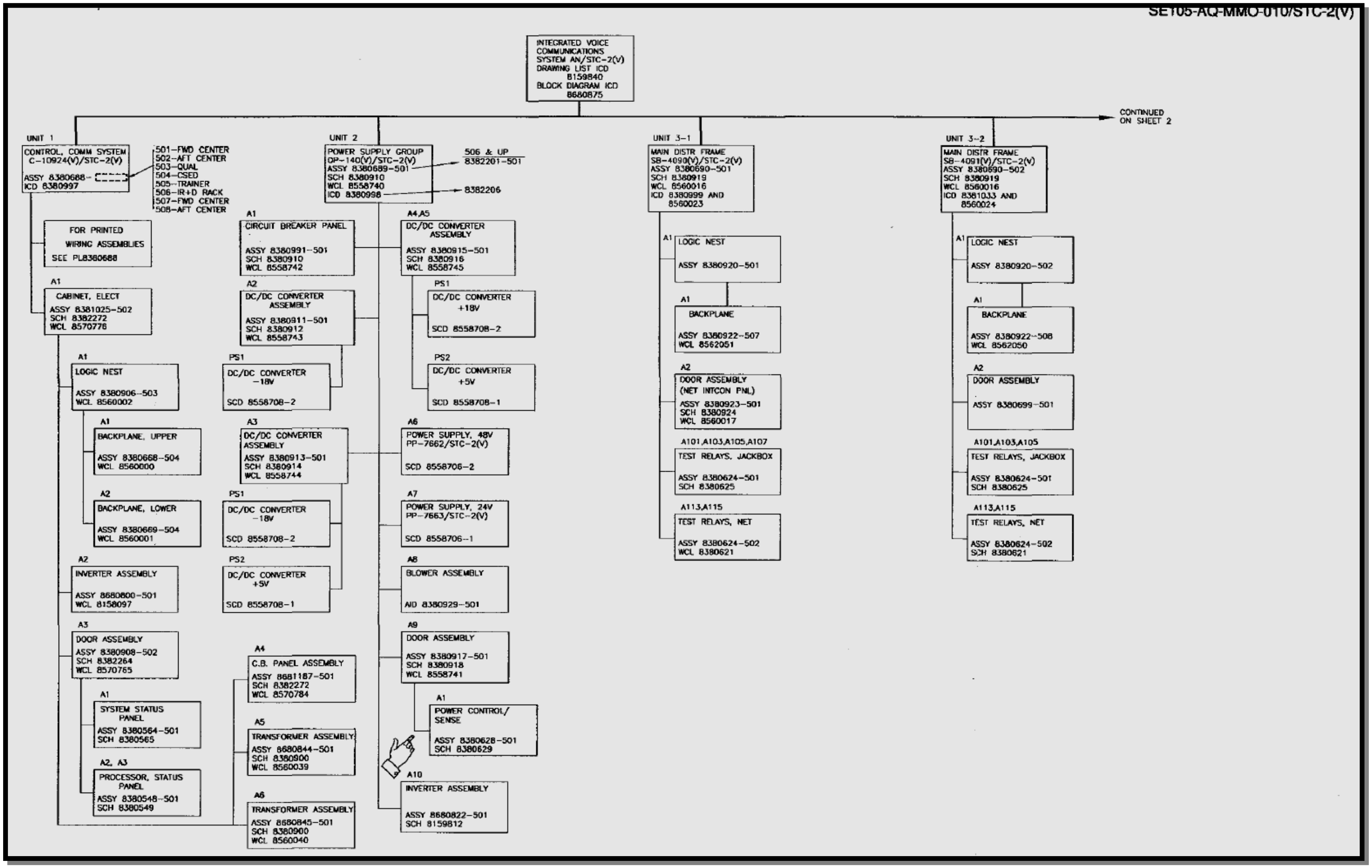


Figure 6-40.—IVCS Configuration (Sheet 1 of 2).

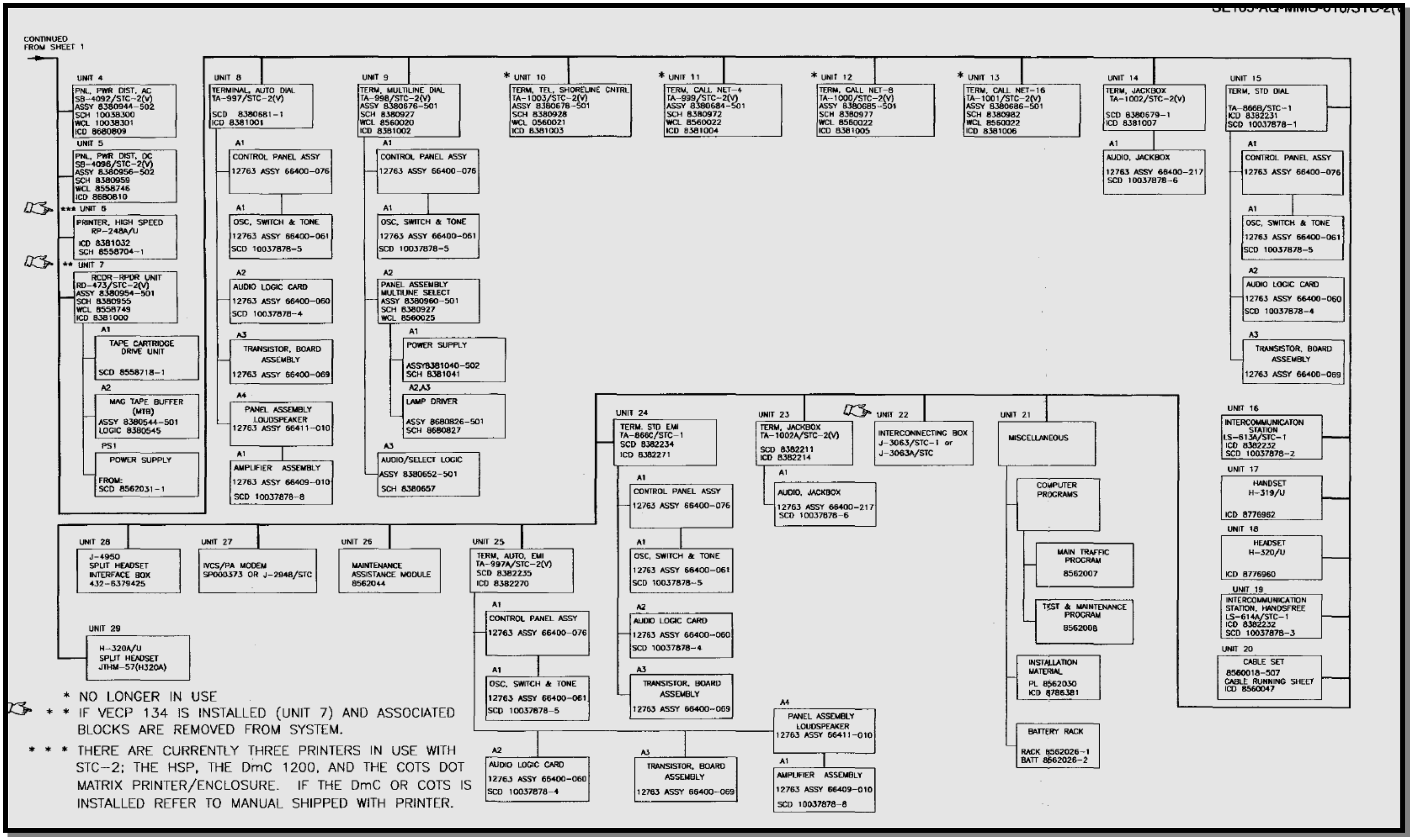


Figure 6-40.—IVCS Configuration (Sheet 2 of 2).

6.4.1 System Capabilities

The STC-2 incorporates a variety of electronic and mechanical ancillary equipment (refer to figure 6-41 and table 6-7), interconnected or attached to provide reliable, interior voice communications with high-quality voice reproduction. The physical configuration of STC-2 provides users with easy access to dial terminal units.

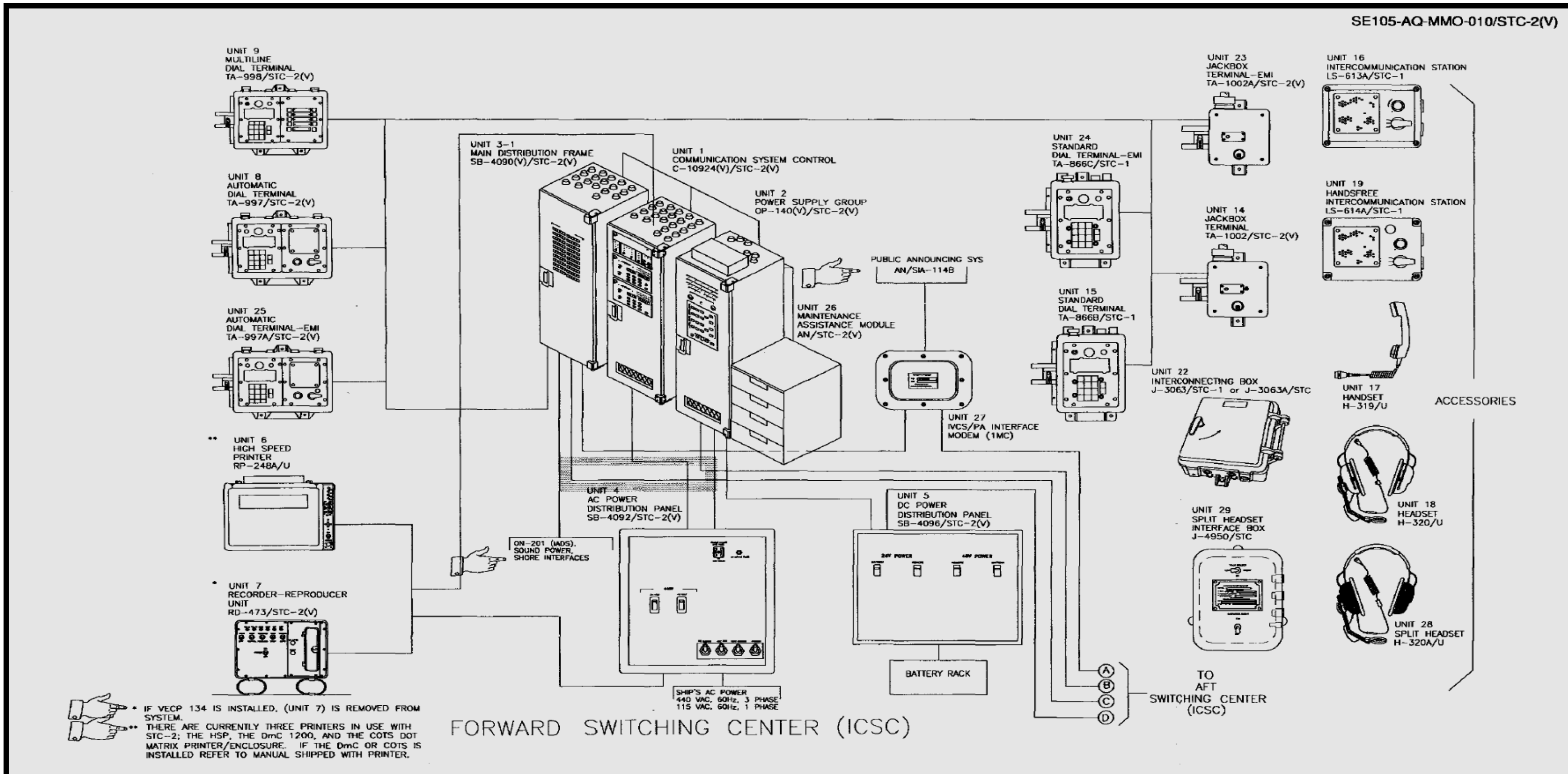


Figure 6-41.—IVCS Interrelationship of Units (Sheet 1 of 2).

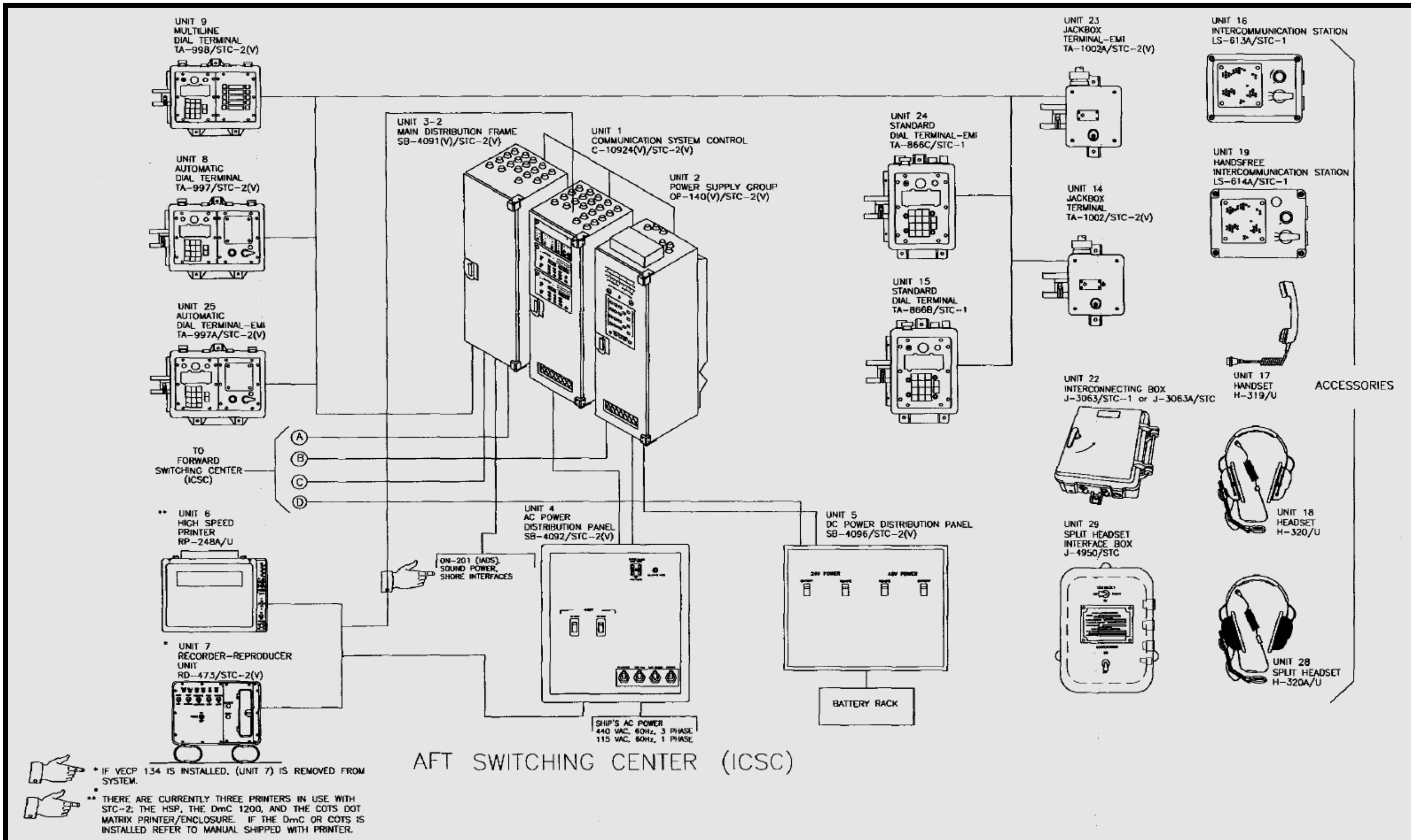


Figure 6-41.—IVCS Interrelationship of Units (Sheet 2 of 2).

Unit No. Ref. Des.	Nomenclature	Colloquial or Common Name
1	Communication System Control Cabinet C-10924M/STC-2(V)	CSC
2	Power Supply Group Cabinet OP-140(V)/STC-2(V)	PSG
3-1	Main Distribution Frame SB-4090(V)/STC-2(V) (FWD)	FWD MDF
3-2	Main Distribution Frame SB-4091(V)/STC-2(V) (AFT)	AFT MDF
4	AC Power Distribution Frame SB-4092/STC-2(V)	AC Panel
5	DC Power Distribution Frame SB-4096/STC-2(V)	DC Panel
6	High-Speed Printer RP-248A/U	HSP
7	Recorder-Reproducer Unit RD-473/STC-2(V) or Recorder-Reproducer Emulator K10048119	RRU RRE
8	Automatic Dial Terminal TA-997/STC-2(V)	AT
9	Multiline Dial Terminal TA-998/STC-2(V)	DM
14	Jackbox Terminal TA-1002/STC-2(V)	NJ
15	Standard Dial Terminal TA-866B/STC-1	DS
16	Intercommunication Station LS-613A/STC-1	LS-613
17	Handset H-319/U	Handset
18	Headset H-320/U	Headset
19	Handsfree Intercommunication Station LS-614A/STC-1	LS-614
20	Cable Set – Interrack	Cable Set
21	Miscellaneous	MISC
22	Interconnecting Box J-3063/STC-1	J-3063
23	Jackbox Terminal TA-1002A/STC-2(V) – EMI	NJA
24	Standard Dial Terminal TA-866C/STC-1 – EMI	DSC
25	Automatic Dial Terminal TA-997A/STC-2(V) - EMI	ATA
26	Maintenance Assistance Module Kit	MAM

Note:
Unit 10 - Shoreline Control Terminal TA-1 003/STC-2(V) (SLCT) - No longer in use.
Unit 11 - Call Net 4 Terminal TA-999/STC-2(V) (CNT 4) - No longer in use.
Unit 12 - Call Net 8 Terminal TA-1000/STC-2(V) (CNT 8) - No longer in use.
Unit 13 - Call Net 16 Terminal TA-1001/STC-2(V) (CNT 16) - No longer in use.

Table 6-7.—IVCS AN/STC-2(V) Equipment Compliment.

Physical Configuration

The STC-2 consists of two independent real-time circuit switching centers (one FWD, one AFT). Each switching center is identified as an Interior Communications Switching Center (ICSC) and interfaces with STC-2 dial terminals and remote equipment, such as the Intercommunication Interconnecting Group ON-201/UYQ-21 (V) (ON-201), the public announce (PA) system, the sound powered (SP) telephone system, and the shore telephone system.

Interior Communications Switching Center

The ICSCs are similar and each serves approximately half the users onboard ship. Two ICSCs are provided for reliability and vulnerability considerations and to offer the maximum degree of user service. Each ICSC contains dual redundant Computer Special Purpose (CSP-3C) microprocessor controllers, Time Division Matrices (TDMX), and power systems. Each ICSC also has its own batteries for emergency power if ship's power fails. ICSCs provide automatic switching of line-to-line, line-to-net, and line-to-external interfaces.

An ICSC is divided into four main subsystems:

a. Control

b. Switching

c. Power Distribution

d. Call Distribution

The Control subsystem in each ICSC is governed by dual redundant CSP-3C microprocessors. The Switching subsystem in each ICSC consists of dual redundant, 512-line, non-blocking Time Division Matrices (TDMX). The Power Distribution subsystem in each ICSC is comprised of two AC/DC power supplies used to convert ship's 440VAC, 60Hz, 3-phase power into +24VDC and -48VDC. +24VDC is utilized for lamp and terminal power. -48VDC is used primarily as the source for DC/DC converters which supply logic power to the Control and Switching subsystems. The AC/DC power supplies in one ICSC are capable of supplying power to the remote ICSC if required. The Call Distribution subsystem in each ICSC consists of the Main Distribution Frame (MDF). The MDF accommodates up to 1,920 screw termination points utilized to terminate STC-2 terminals, STG-2 nets, STG-2 system trunks, and external interfaces to the ICSC.

Trunks. Nets, and Control Cables

Forty audio trunk lines interconnect the two ICSCs. These trunks provide sufficient audio paths between the two ICSCs to ensure the probability of a blocked trunk call is less than 1 in 1,000 (Le., P = 0.001). Fifty six ship-wide nets are in the STC-2 design. A net intertie for each net interconnects the two ICSCs. The majority of nets are internal to STC-2 only, however certain designated nets interface with sound powered circuits. Power and control cables provided by the shipbuilder interconnect the two ICSCs to transmit and control 24-volt power and 48-volt power from ICSC to ICSC. The control lines are also used for remote status and alarm indications.

Traffic Handling

The TDMX is non-blocking by design, allowing STC-2 to handle a line-to-line call rate of 0.004 calls/terminal/second and a line-to-net call rate of 0.00 2 calls/terminal/second with zero blocking. Sufficient Receiver/Sender Generators (RSG) guarantee that no more than one call in 1,000 is delayed more than three seconds in obtaining an RSG or in misrouting due to an RSG error. Call completion delay from receipt of last dialed digit until ring at called terminal is a maximum of 0.5 second for local calls and three seconds for inter-ICSC calls. The probability of misrouting a call due to any STG-2 error is less than 1 in 10^6.

6.4.2 System External Interfaces

Each ICSC interfaces with the following: shore telephone service, sound powered system, ON-201 secure voice system, and 1MC announcing circuit. Twenty Switchboard Interface (SWI) trunks (10 in each ICSC) connect STC-2 to shore telephone service. Up to 16 Sound Powered Interface {SPI} circuits {eight in each ICSC} may connect STG-2 to various sound powered circuits. Thirty-six Integrated Audio Distribution System (IADS) trunks {18 in each ICSC} connect STC-2 to ON-201 system. Six Public Announce/Radio Interface Unit (PAR) circuits (three in each ICSC) connect STC-2 to 1MC announcing circuit. ECP 118 (table 6-8) connects Public Switched Telephone Network (PSTN) equipment to STC-2.

FC	ECP	Description
1	34C2	Change jack labels on PSP PWAs (1A1A3A2 and 1A1A3A3) from "P1 ," "P2," and "P3" to "J1 ," "J2," and "J3," respectively, in accordance with ANSI-Y32.14.
2	46R1	Change screws mounting top and bottom door hinge plates to cabinet with longer screws to accomplish sufficient retention by locking inserts in cabinet.
3	65R1	Install dowel pins in door frame to support RFI spring fingers to prevent fingers from migrating out of position.
4	72	Replace momentary pushbutton switches on door assembly with shock-hardened pushbutton switches.
5	78	Change power source for MATRIX ON LINE LEDs from System Status Panel +5VDC to the associated matrix +5VDC.
6	68	Replace 1A1A4 switch panel assembly with 1A1A4 circuit breaker panel assembly.
7	93	Install tie bar supports to inductors 1A1 L7 to 1A1 La to shock harden inductors (CG 47-CG 65, DOG 51 only).
8	94	Rewire RETAIN INSTRUCTION switch/indicator on processor status panels (A and B) to indicate state of switch when processor panel is disabled.
9	118	Install Commercial Line Interface Circuit (CLIC).
10	120R3/ 132R1	Install Advanced Maintenance Control System (AMCS).
11	134	Recorder-Reproducer Emulator (RRE), Production cut-in at DDG93.

Table 6-8.—C-10924(V)/STC-2(V), Unit 1, Field Change Record.

6.4.3 Unit Description

Interior Communications Switching Center

The STC-2 utilizes three cabinets to house the four major subsystems within an ICSC (figure 6-42). The Control and Switching subsystems are housed in the Communication System Control (CSC) Cabinet C-10924(V)/STC-2(V). The Power Distribution subsystem is housed in the Power Supply Group (PSG) OP-140(V)/STC-2(V). The Call Distribution subsystem is housed in the Main Distribution Frame (MDF), SB-4090(V)/STC-2(V) (FWD MDF) or SB-4091(V)/STC-2(V) (AFT MDF). The Recorder-Reproducer Unit (RRU) RD-473/STG-2(V), AC Power Distribution Panel (AC Panel SB-4092/STC-2(V), DC Power Distribution Panel (DC Panel) SB-4096/STC-2(V), High-Speed Printer (HSP) RP-248A/U, and a maintenance terminal are located at each ICSC. If the STC-2 system is supplied with ECP134 (table 6-8), as identified by Field Change #11 stamped on C-10924(V)/STC-2(V) CSC cabinet, then a Recorder-Reproducer Emulator card (PIN K10048119) is present in slot XA802 of the CSC to perform software loading functions, instead of the RD-473/STC-2(V) RRU. A battery supply and battery rack supplied by the shipbuilder are also located at each center. Interrack cables are used to interconnect the three ICSC cabinets. An IVCS/PA interface modem for STC-2/1MC interface is located in the FWD ICSC. Every ship is equipped with at least one MAM kit.

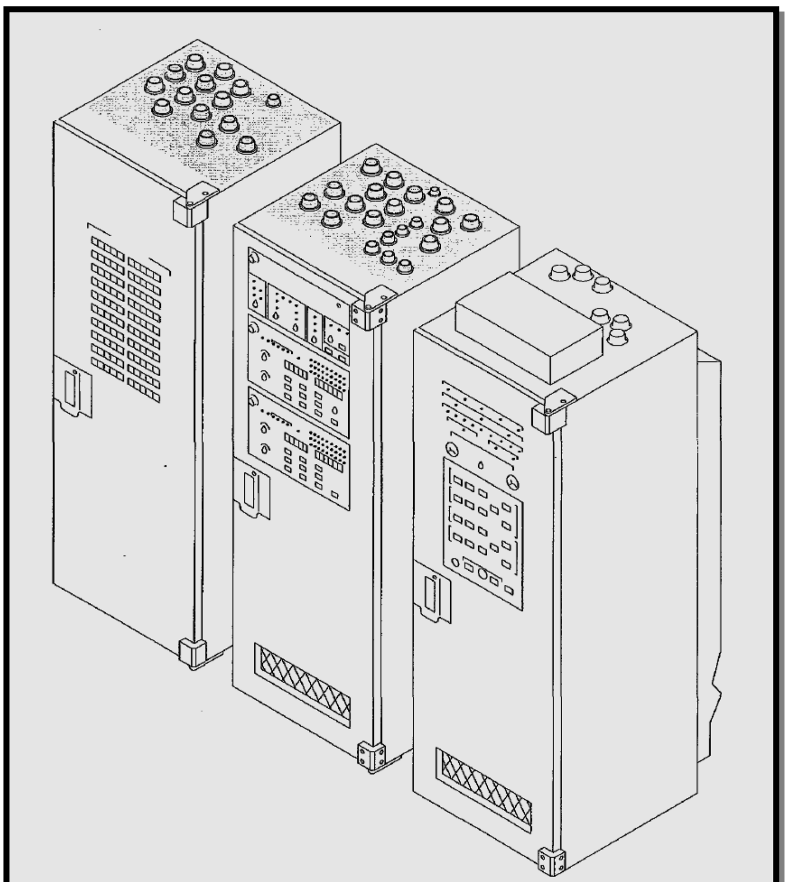


Figure 6-42.—Interior Communications Switching Center.

Communication System Control (CSC) Cabinet C-10924(V)/STC-2(V) Unit 1

The CSC (figure 6-43) houses an eight-row logic nest. The logic nest contains virtually all electronics for the ICSC, including dual processors; dual TDMX; dual solid-state memories; line, trunk, and net terminating circuits; interface circuits; and switchover control and fault register circuitry. Two fans are mounted in bottom of cabinet for equipment cooling. A thermostat is mounted at top rear of cabinet to detect cabinet overheating. Power to logic nest is controlled by circuit breakers on circuit breaker panel assembly.

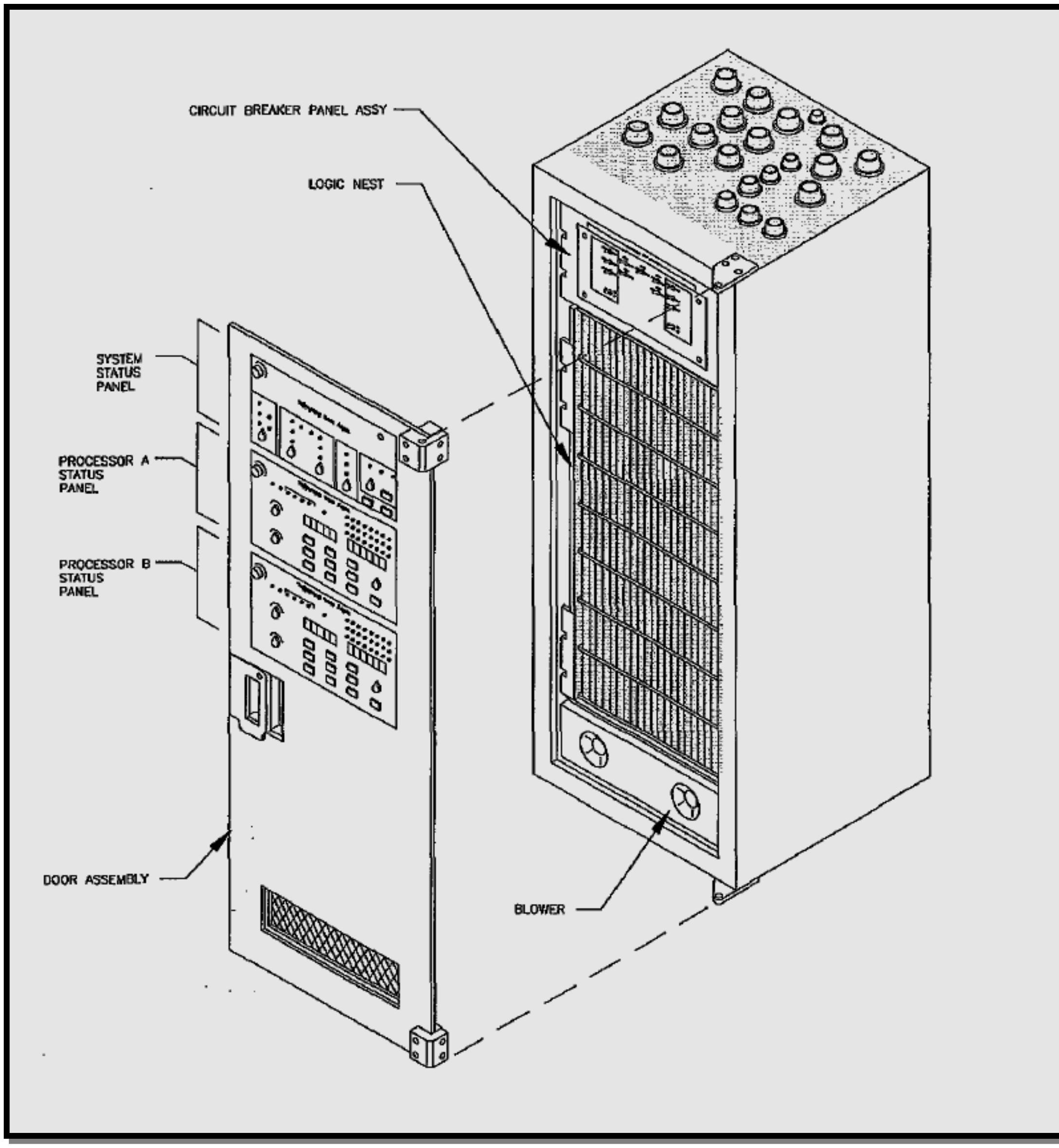


Figure 6-43.—Communication System Control Cabinet, C-10924(V)/STC-2(V).

Power Supply Group (PSG) OP-140(V)/STG-2(V) Unit 2

The PSG (figure 6-44) houses one -48V AC/DC power supply, one +24V AC/DC power supply, three +5V DC/DC converters, two +18V DC/DC converters, two -18V DC/DC converters, distribution circuit breakers, and a front door assembly (with meters, alarm circuitry, indicators, and control switches). The AC/DC power supplies operate from 440VAC, 3-phase, 60Hz ship's power. The DC/DC converters operate from -48VDC provided by -48V AC/DC supply. The converters provide necessary voltages for CSC logic nest. The +24V AC/DC power supply provides power for STG-2 terminals, lamps, and relays for line circuit Printed Wiring Assemblies (PWA).

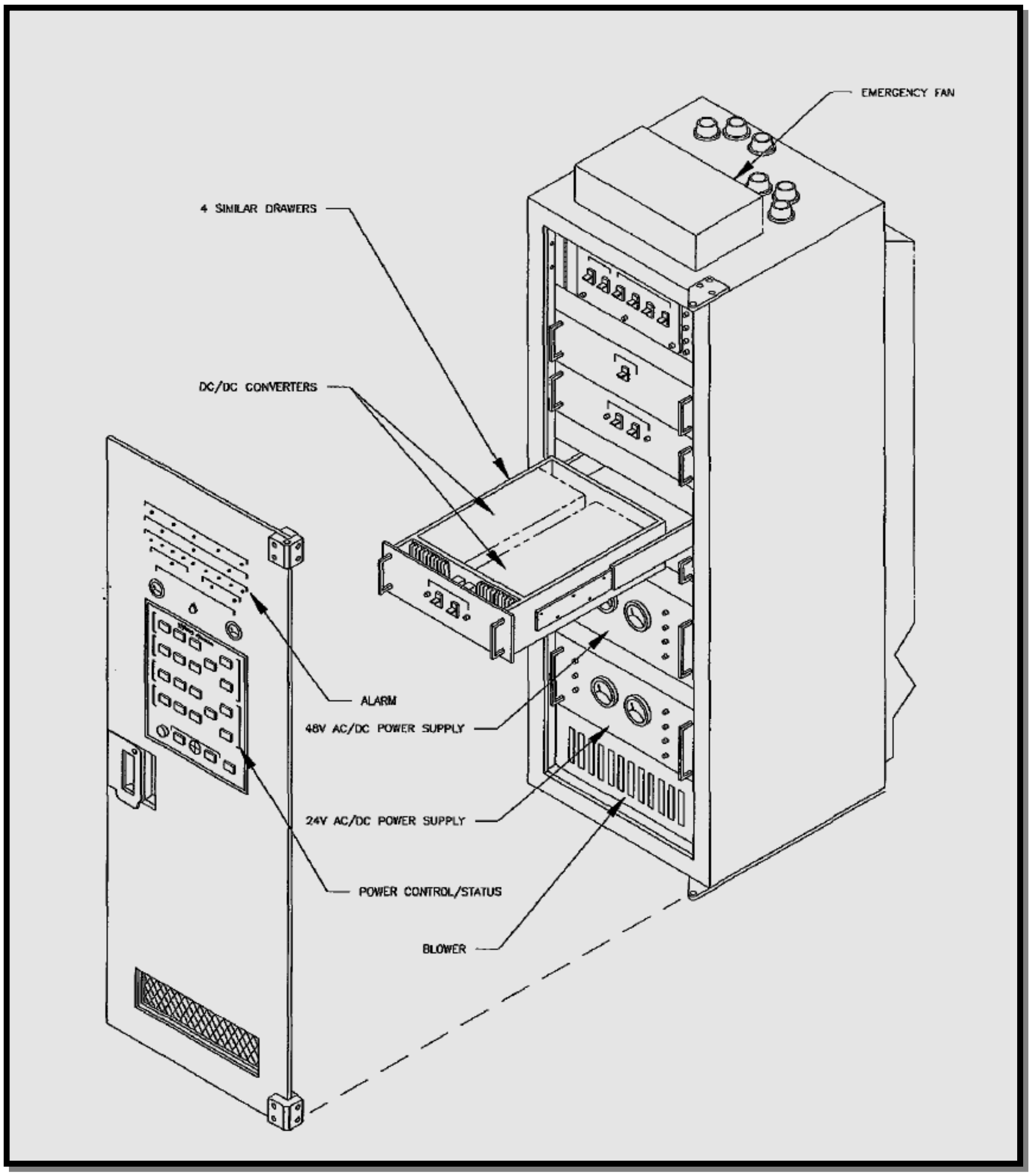


Figure 6-44.—Power Supply Group Cabinet, OP-140(V)/STC-2(V).

Main Distribution Frame (MDF) SB-4090(V)/STG-2(V) (FWD), Unit 3-1

The FWD MDF (figure 6-45) terminates ship's cables from STC-2 terminals, the remote ICSC, and external interfaces. A manually operated net switching matrix, 20 groups of 5 nets each (5 x 20), is located on front door of FWD MDF only. Net interconnect dialups supersede the switch panel net connections. ECP 132 (FC 4) deletes the FWD MDF switch panel. A single logic nest is located at top inner side of FWD MDE The logic nest accommodates relay PWAs jackbox and net test relays (JTR and NTR)) for STG-2 net testing and provides cutout switches for STC-2 jackbox terminals.

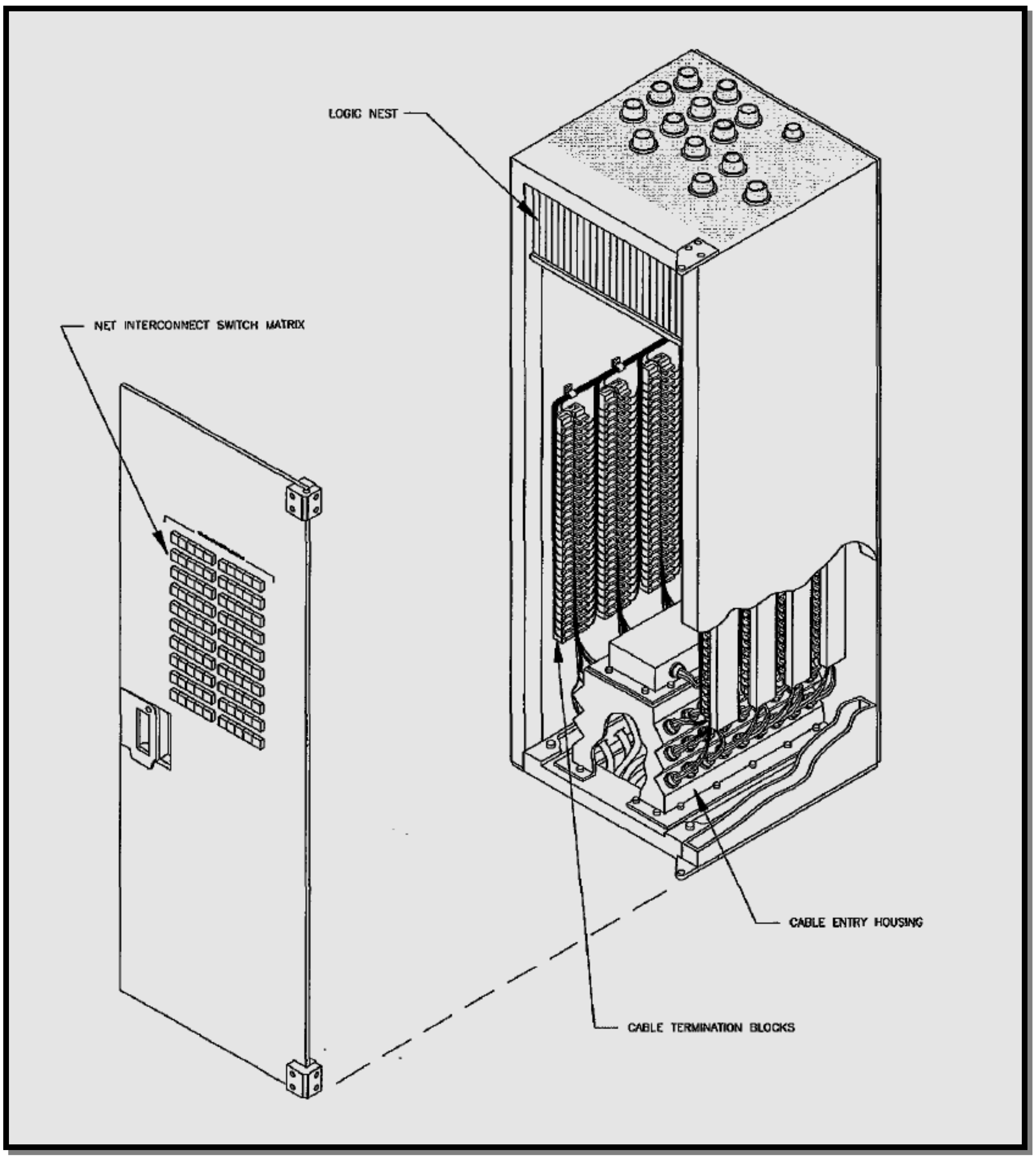


Figure 6-45.—Main Distribution Frame (FWD), SB-4090(V)/STC-2(V).

Main Distribution Frame (MDF) SB-4091(V)/STG-2(V) (AFT) Unit 3-2

The AFT MDF (figure 6-46) is functionally identical to the FWD MDF.

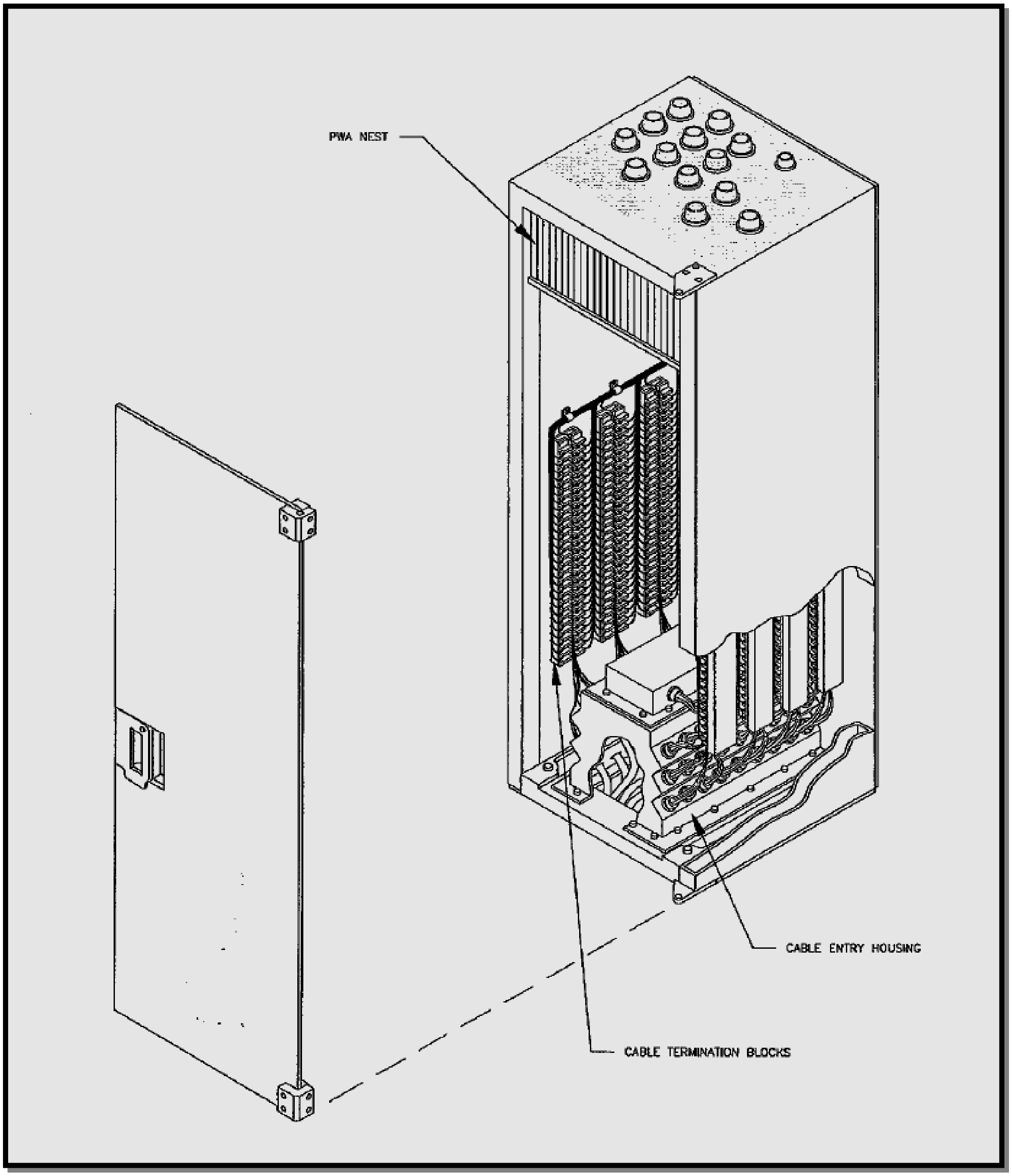


Figure 6-46.—Main Distribution Frame (AFT), SB-4091(V)/STC-2(V).

AC Power Distribution Panel (AC Panel) SB-4092/STC-2(V) Unit 4

The AC Panel (figure 6-47) contains circuit breakers to control ship's AC power to the PSG, RRU, HSP, and cooling fans located in the CSC and the PSG. If the AC Panel is stamped with Field Change #5, no circuit breaker is provided to control ship's AC power to a RRU. Instead, CB5 is provided as a spare breaker, with no connections exiting the AC Panel. The AC Panel is bulkhead mounted and contains two three-pole circuit breakers and four two-pole circuit breakers. The circuit breakers contain auxiliary contacts connected into the PSG to indicate status of circuit breakers.

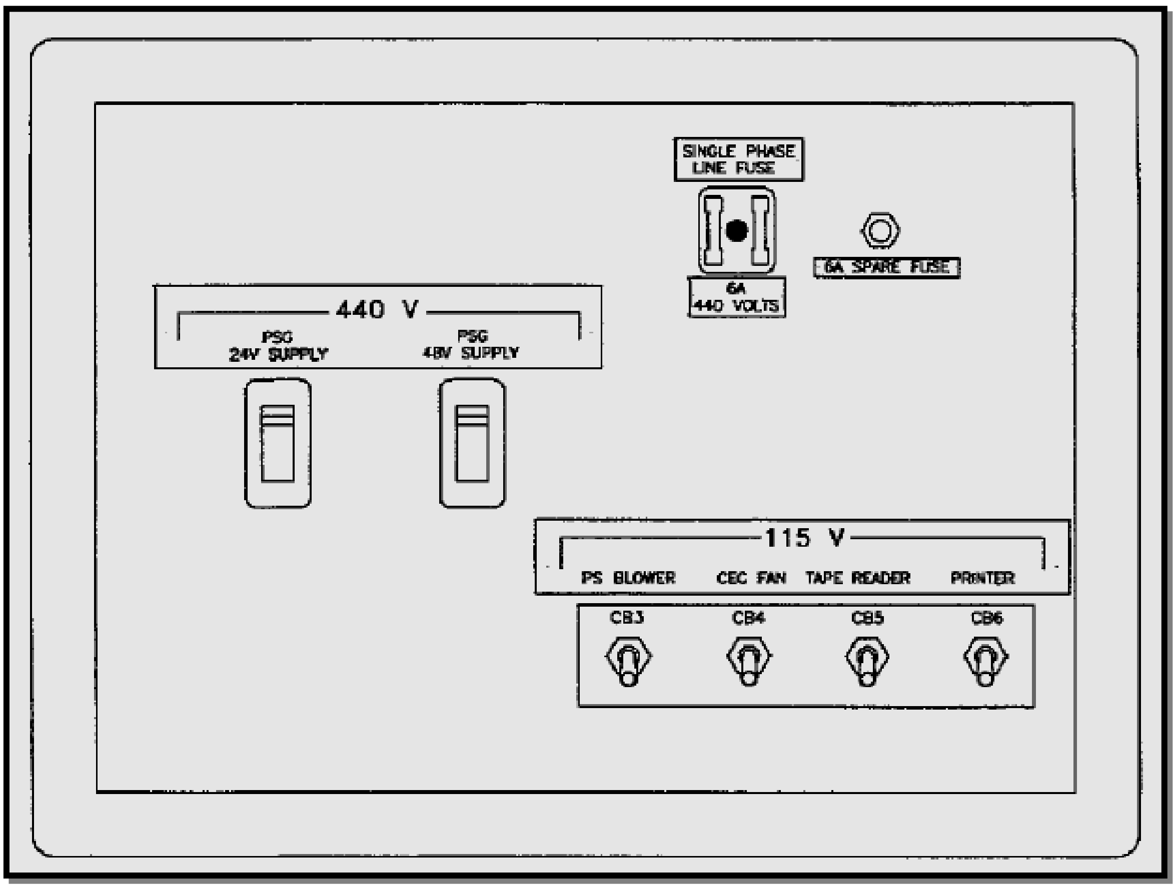


Figure 6-47.—AC Power Distribution Panel, SB-4092/STC-2(V).

DC Power Distribution Panel (DC Panel) SB-4096/STC-2(V) Unit 5

The DC Panel (figure 6-48) is bulkhead mounted and contains four three-pole circuit breakers and one relay. Two circuit breakers control DC power from 24V and 48V batteries to the PSG, and the other two circuit breakers control 24V and 48V power to the remote ICSC.

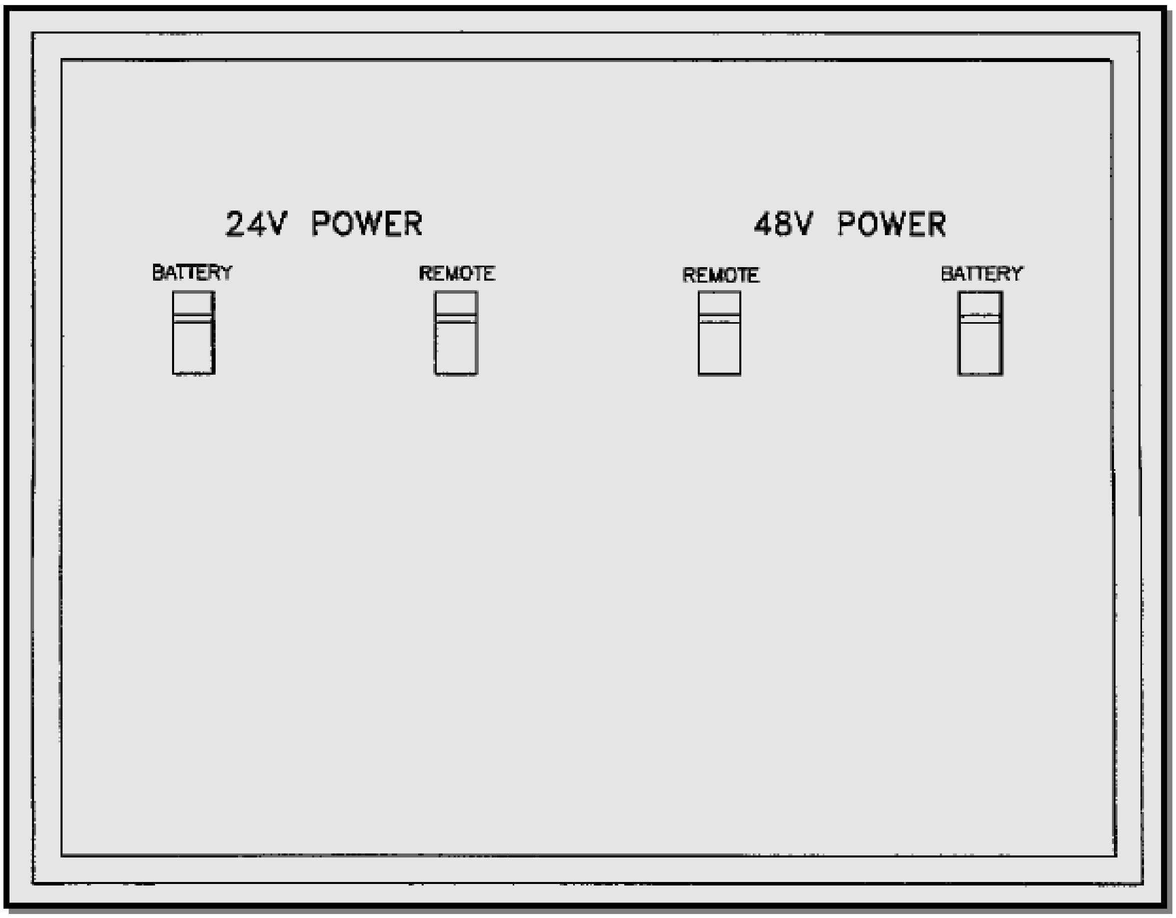


Figure 6-48.—DC Power Distribution Panel, SB-4096/STC-2(V).

The circuit breakers contain auxiliary contacts connected to the PSG to indicate status of circuit breakers. The circuit breakers are rated for 100 amperes. Transfer of power to the remote ICSC is controlled by a relay located in each DC Panel. The relay in the FWD DC Panel transfers 48V power. The relay in the AFT DC Panel transfers 24V power.

High-Speed Printer (HSP) RP-248A/U Unit 6

The HSP (figure 6-49) is used to print test and status messages generated by STG-2 Control subassembly. The HSP receives data from the CSC. The HSP operates from 115VAC, single-phase, 60Hz power supplied by AC Panel.

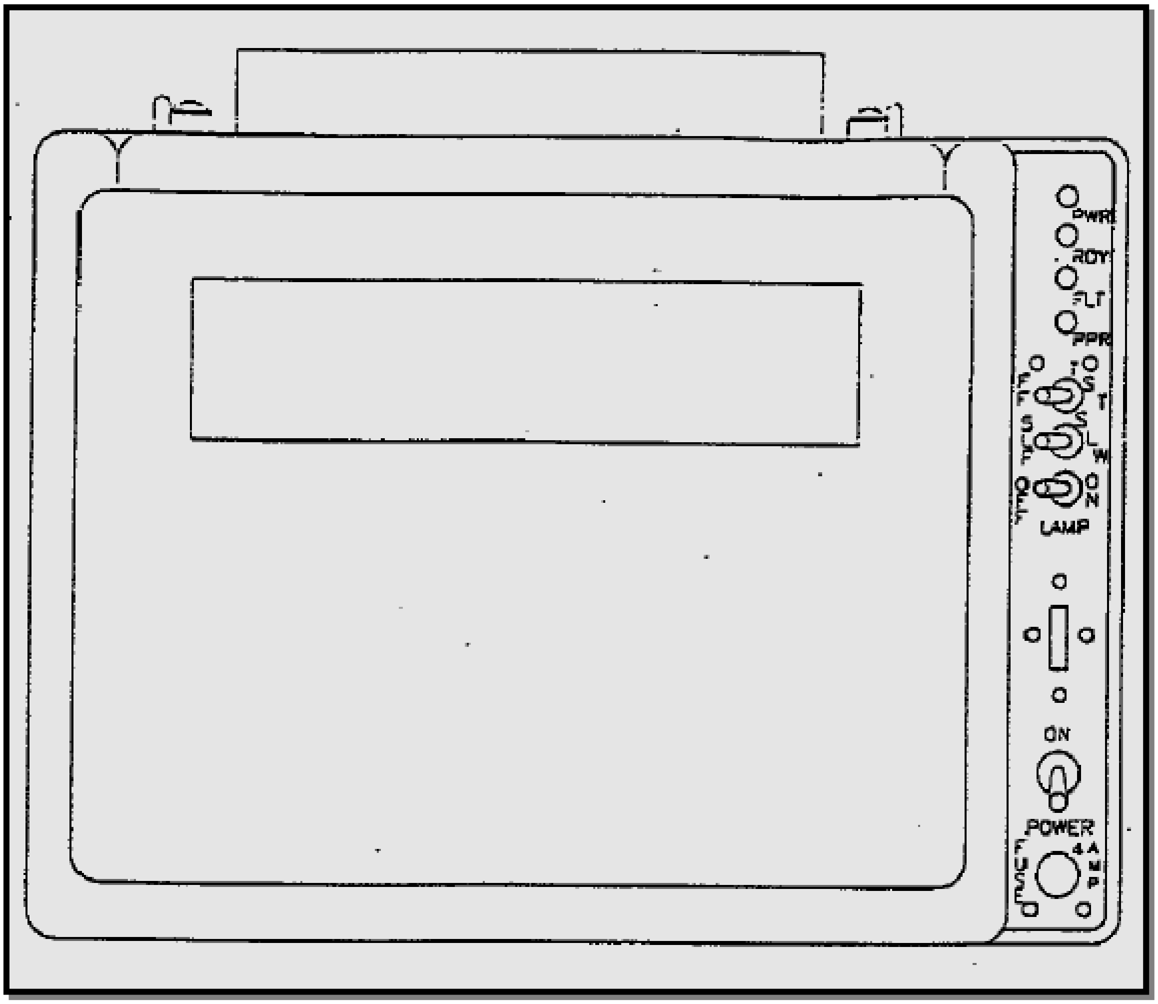


Figure 6-49.—High-Speed Printer RP-248A/U.

Recorder-Reproducer Unit (RRU) RD-473/STC-2(V) Unit 7

The RRU (figure 6-50) is used to load Main Traffic Programs, subscriber equipment tables, on-line maintenance routines, and processor Test and Maintenance (TM) routines. The RRU uses a 3M-DC300A-type tape cartridge (or equivalent) with a capacity of 23 megabits. Read speed is 30 inches-per-second (ips) and high-speed rewind speed is 90 ips in both FWD and REV directions. Data transfer rate is 6K-bytes (1 byte =8 bits) per second parallel. Connectors are provided on RRU to accept power, input/output data, and control signals from the CSC. The RRU is operated either manually from front panel controls or automatically under control of signals generated by STG-2 Control subassembly.

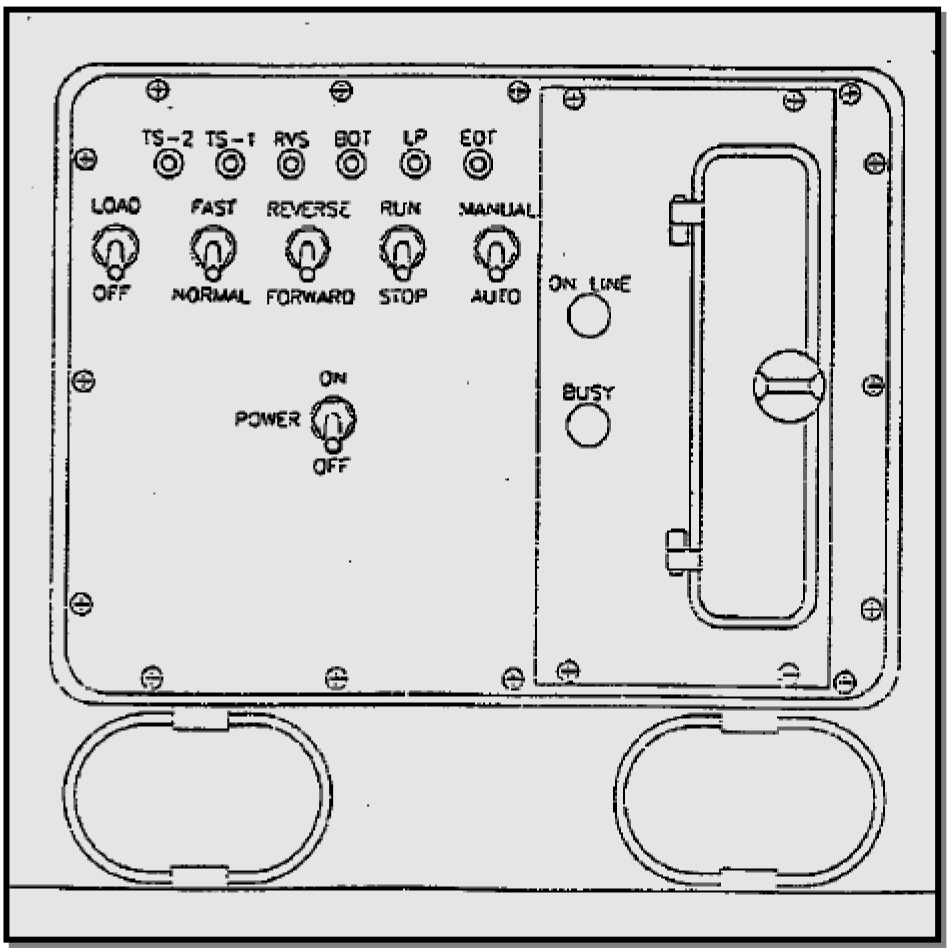


Figure 6-50.—Recorder-Reproducer Unit, RD-473/STC-2(V).

Recorder-Reproducer Emulator Card (RRE)

If CSC cabinet, C-10924M/STC-2(V) contains Field Change #11, a Recorder Reproducer Emulator card is used to load Main Traffic programs, subscriber equipment tables, on-line maintenance routines, and processor Test and Maintenance (TM) routines. The RRE uses a Centennial Technologies iMC002FLSA type Flash Memory Card (or equivalent) with a capacity of 2 Megabytes (8-bits). The data transfer speed is directly dependent upon the speed of the interface hardware within the STC-2 but is at least 6 Kbytes per second parallel. A connector is provided on the RRE to accept power from and to interface input/output data and control/status signals from/to the CSC backplane. The RRE also has a PCMCIA card port accessible from the front of the CSC rack into which the Flash Memory Card is inserted for operation. The RRE has no manual controls, other than insertion and removal of the Flash Memory Card, and is operated entirely under control of signals generated by the STC-2 Control subassembly.

Interrack Cables, Unit 20

The Interrack cables (figure 6-51) are used to connect the CSC, PSG, and MDF cabinets within the ICSC.

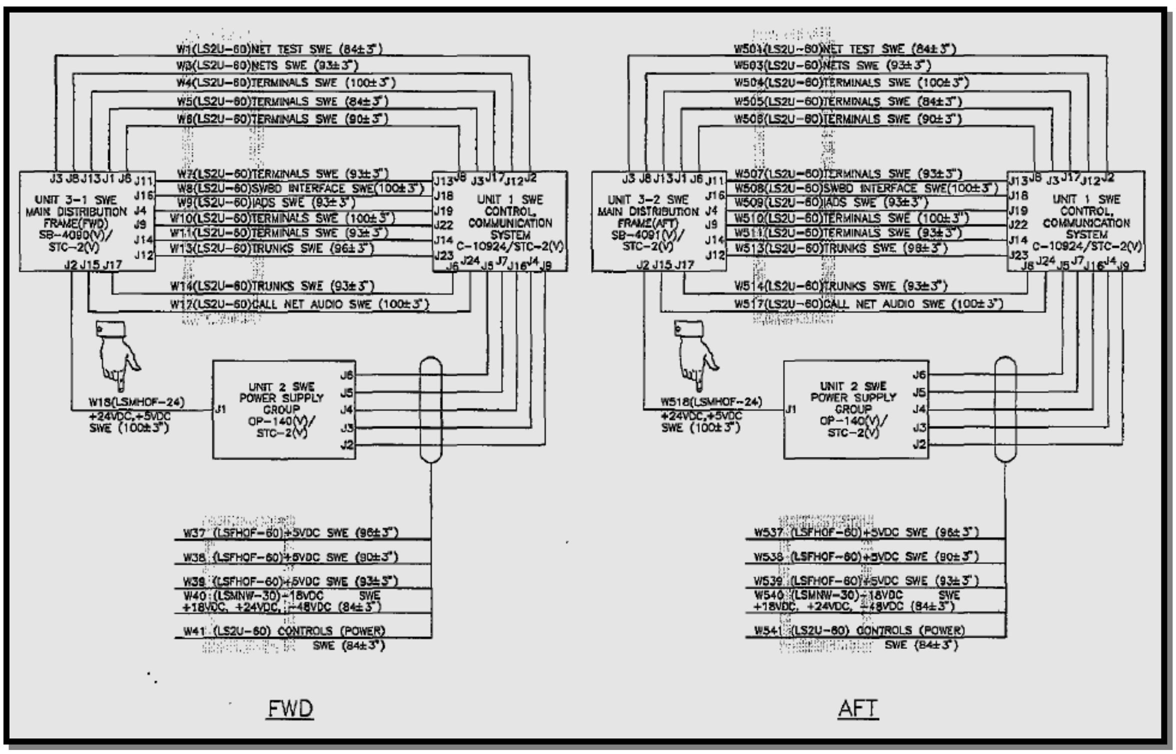


Figure 6-51.—Interrack Cables, Unit 20 FWD and AFT.

Miscellaneous, Unit 21

Miscellaneous items used to support the STC-2 system are listed in figure 6-40, sheet 2. These items are not furnished equipment except for computer programs.

Maintenance Assistance Module (MAM) Kit, Unit 26

The MAM aids the technician during corrective maintenance on the ICSC and STC-2 terminals. The MAM contains one each of all the different PWAs located in the CSC, MDF, HSP, RRU, and STG-2 terminals.

IVCS/PA Interface Modem Unit 27

The IVCS/PA Interface Modem is used to interface the STC-2 with the 1MC circuit. There are three models in use: SP000373, 24000-206, and J-4928/STC (figure 6-52). The SP000373 and 24000-206 are identical in form, fit, and function. The three models are designed to interface with the AN/SIA-114B amp-osc group utilized by the 1MC circuit. One IVCS/PA Modem is used to interface both ICSCs with the 1MC circuit.

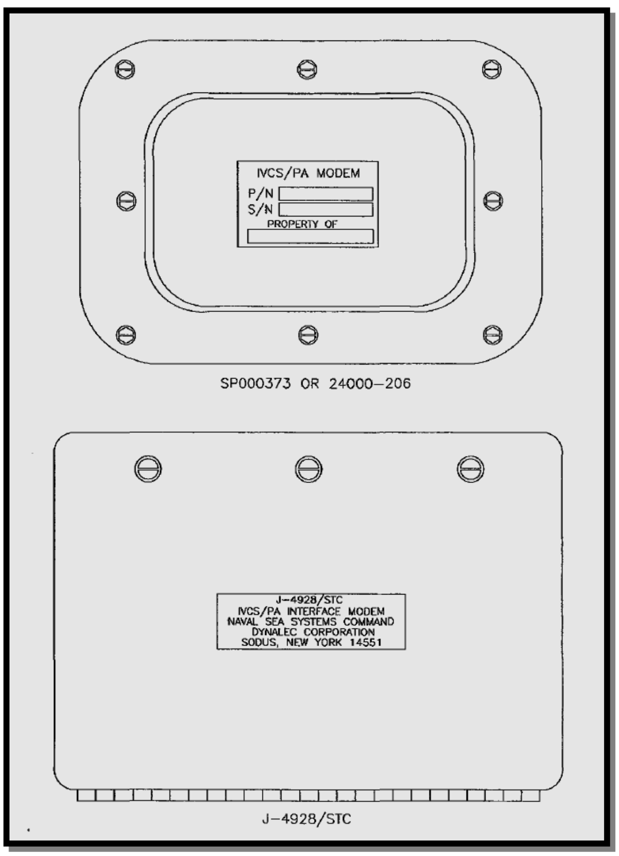


Figure 6-52.—IVCS/PA Interface Modems, Unit 27.

6.4.4 STC-2 Terminals and Accessories

The STG-2 utilizes three types of dial terminals to interface with the TDMX: TA-866B/ STC-1, Standard Dial Terminal (DS); TA-997/STC-2(V), Automatic Dial Terminal (Al); and TA-998/STC-2(V), Multiline Dial Terminal (DM). An Electromagnetic Interference (EMI) shielded version of the DS and AT, TA-866C/STC-1 (DSC) and TA-997A/STC-2(V) (ATA) respectively, are also included in STG-2. The STC-2 internal net terminal, TA-1002/STC-2(V), Jackbox Terminal (NJ), is dedicated to pre-designated STC-2 nets. An EMI shielded version of NJ, TA-1002A/STC-2(V) (NJN), is included in STC-2. The accessories used in STG-2 are as follows: Intercommunication Station, LS-613A/STC-1 (LS-613); Handsfree Intercommunication Station, LS-614A/STC-1 (LS-614); H-319/U, Handset; H-320/U, Headset; and J3063/STC-1, Interconnecting Box (J-3063).

Automatic Dial Terminal TA-997/STC-2(V) (AT) Unit 8

The AT (figure 6-53) contains a DS and an LS-614 in one common housing. These units are defined in subsequent paragraphs as units 15 and 19, respectively. The operation of these two units in the common housing is the same as if they were interconnected externally. The detection circuitry in the LS-614 is used to turn on the OS automatically when the LS-614 is in the handsfree mode. All other operations of the automatic terminal are similar to the combined operation of the DS and LS-614.

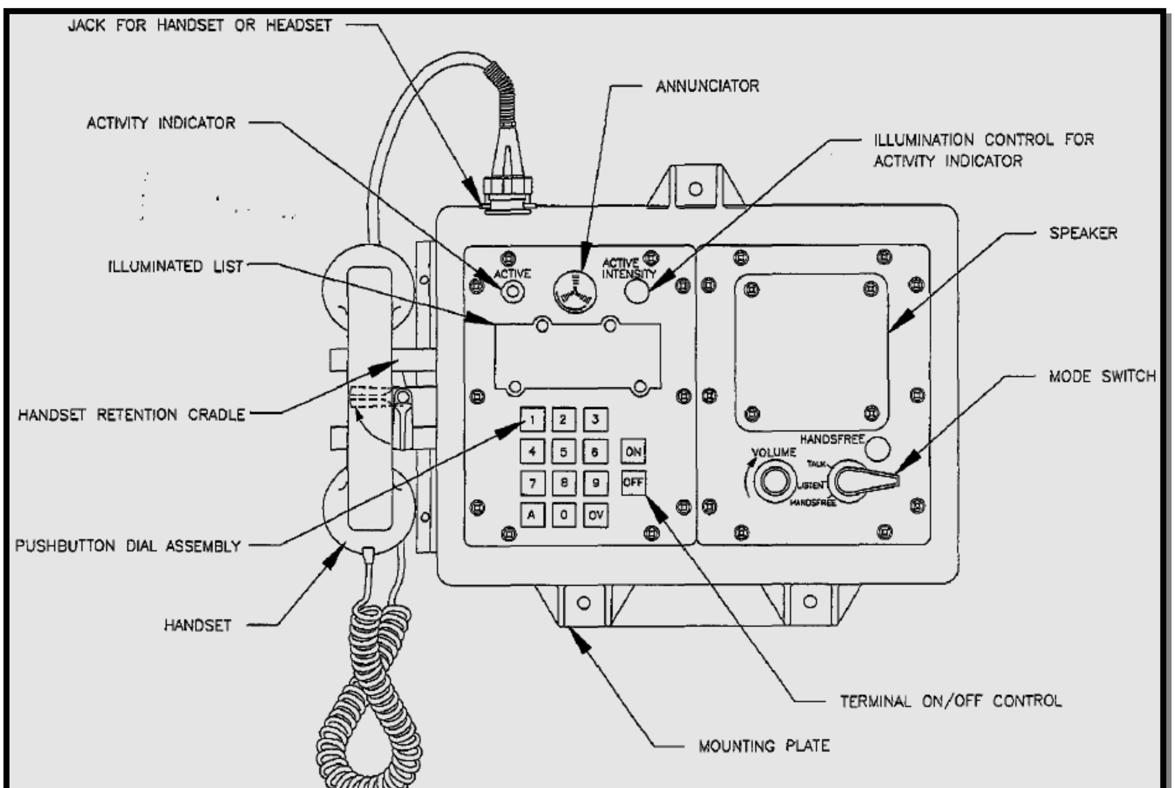


Figure 6-53.—Automatic Dial Terminal, TA-997/STC-2(V).

Multiline Dial Terminal TA-998/STC-2(V) (DM) Unit 9

The DM (table 6-9, figure 6-54) houses five separate STC-2 telephone lines in one common chassis. Six jacks on the chassis accommodate H-319/U Handsets; H-320/U Headsets; and LS-613 Intercommunication Station. Jack J2 allows operator to transmit/receive to/from all five lines. Jacks J3 through J7 can transmit/receive to/from one line only (J3=line 1, J4=line 2, J5=line 3, J6=line 4, J7=line 5). Lines may be selected in any combination for monitoring purposes. Talk selectivity is possible on all lines. In normal mode, the user can initiate and receive calls, or can monitor calls on any of the five lines.

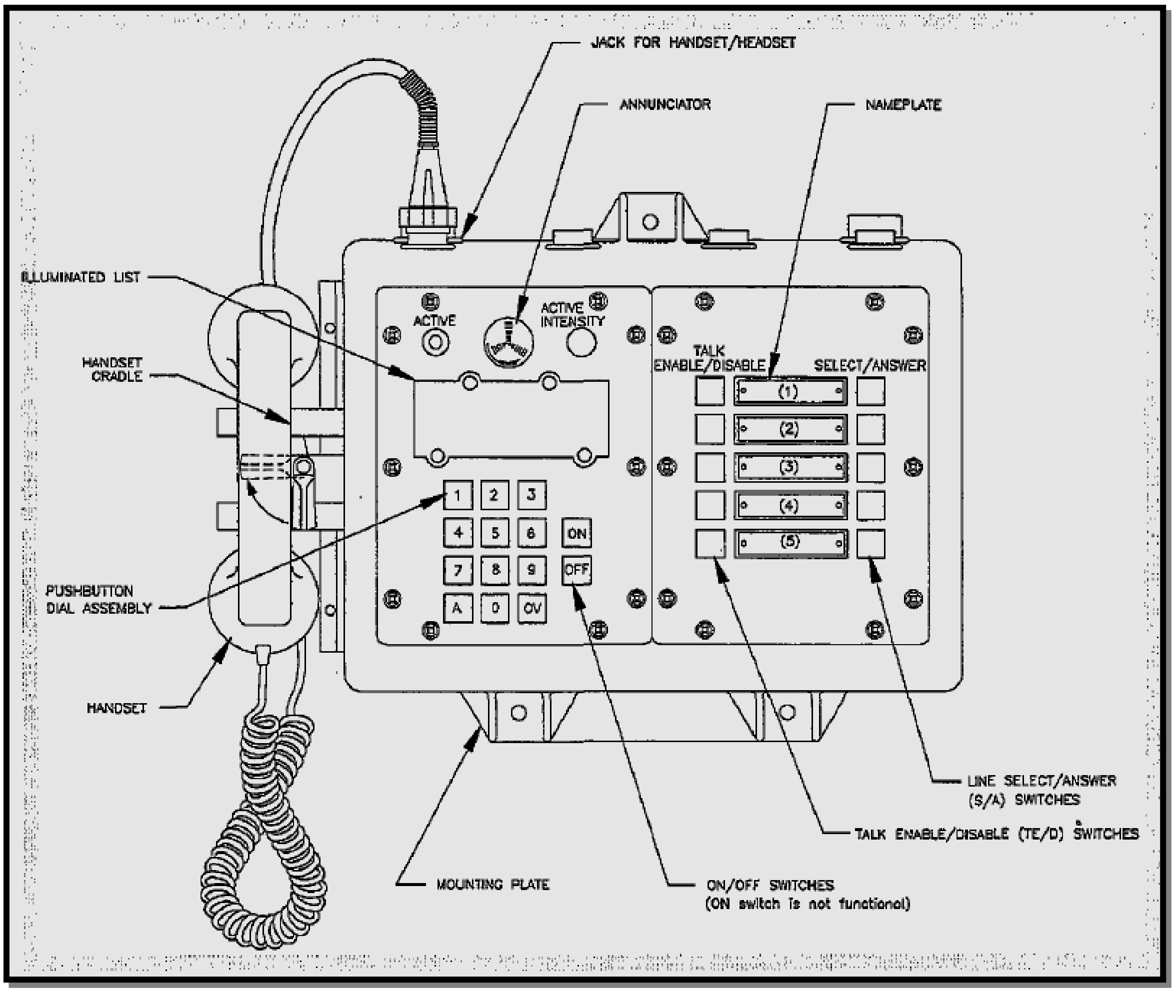


Figure 6-54.—Multiline Dial Terminal, TA-998/STC-2(V).

Fig. 6-54 Index No.	Control/Indicator	Function
1	ACTIVE indicator	Not used.
2	Annunciator	Emits pulsating tone to announce an incoming call. (The annunciator is inhibited while a call is in progress.) Additional incoming calls are announced by the flashing SELECT/ANSWER pushbutton indicators.
3	ACTIVE INTENSITY control	Not used.
4	TALK ENABLE/DIS-ABLE pushbutton indicator	Illuminates when an incoming call has been answered by pressing a SELECT/ANSWER pushbutton indicator. Talk is inhibited from going out on the line (DISABLE) when the pushbutton indicator is pressed. If connected to dial terminal, associated loudspeaker remains active in listen mode. This function can be selected for each of the five lines.
5	Nameplate	Nameplate for terminal number identification.
6	SELECT/ANSWER pushbutton indicators	Pushbutton indicators are used to select a line for placing an outgoing call or to answer an incoming call. An incoming call is identified by pushbutton indicator associated with line flashing on and off at ring rate. The pushbutton indicator is pressed to answer call, and indicator illuminates. When a dial terminal is connected in parallel with multiline dial terminal, SELECT/ANSWER pushbutton indicator illuminates when parallel terminal is active. Pressing an idle pushbutton indicator activates associated line and indicator illuminates. It also illuminates associated TALK ENABLE/DISABLE pushbutton indicator and enables talk and listen on line. Pressing an illuminated pushbutton indicator extinguishes indicator and deactivates line.
7	ON pushbutton	Not used.
8	OFF pushbutton	When pressed, deactivates all lines and places terminal in idle mode.
9	OV pushbutton	When pressed, initiates an override (OV) call if selected line if assigned OV capability.
10	A pushbutton	When pressed, initiates an abbreviated addressing call, if authorized.
11	1, 2, 3, 4, 5, 6, 7, 8, 9, 0 pushbuttons	When pressed in selected order, generate DTMF tones used by the ICSC to interpret number dialed.
12	J8	Connector for ship's cables between the MLDT and the ICSC.
13	J7	Operator's accessory connector for line five.
14	J5	Operator's accessory connector for line three.
15	J6	Operator's accessory connector for line four.
16	J3	Operator's accessory connector for line one.
17	J4	Operator's accessory connector for line two.
18	J2	Operator's accessory connector; may receive/transmit on all five lines.
19	J1	Connector for ship's cable between the MLDT and the ICSC.

Table 6-9.—Multiline Dial Terminal, TA-998/STC-2(V).

Jackbox Terminal (NJ) TA-1002/STC-2(V) Unit 14

The NJ (figure 6-55) is hardwired to a single net. An ON/OFF toggle switch and an ON/OFF indicator are the only controls and indicators. The NJ cannot request or receive calls. Placing toggle switch to ON position illuminates ON/OFF indicator and places NJ on its pre-designated net. The NJ and OS audio characteristics are identical.

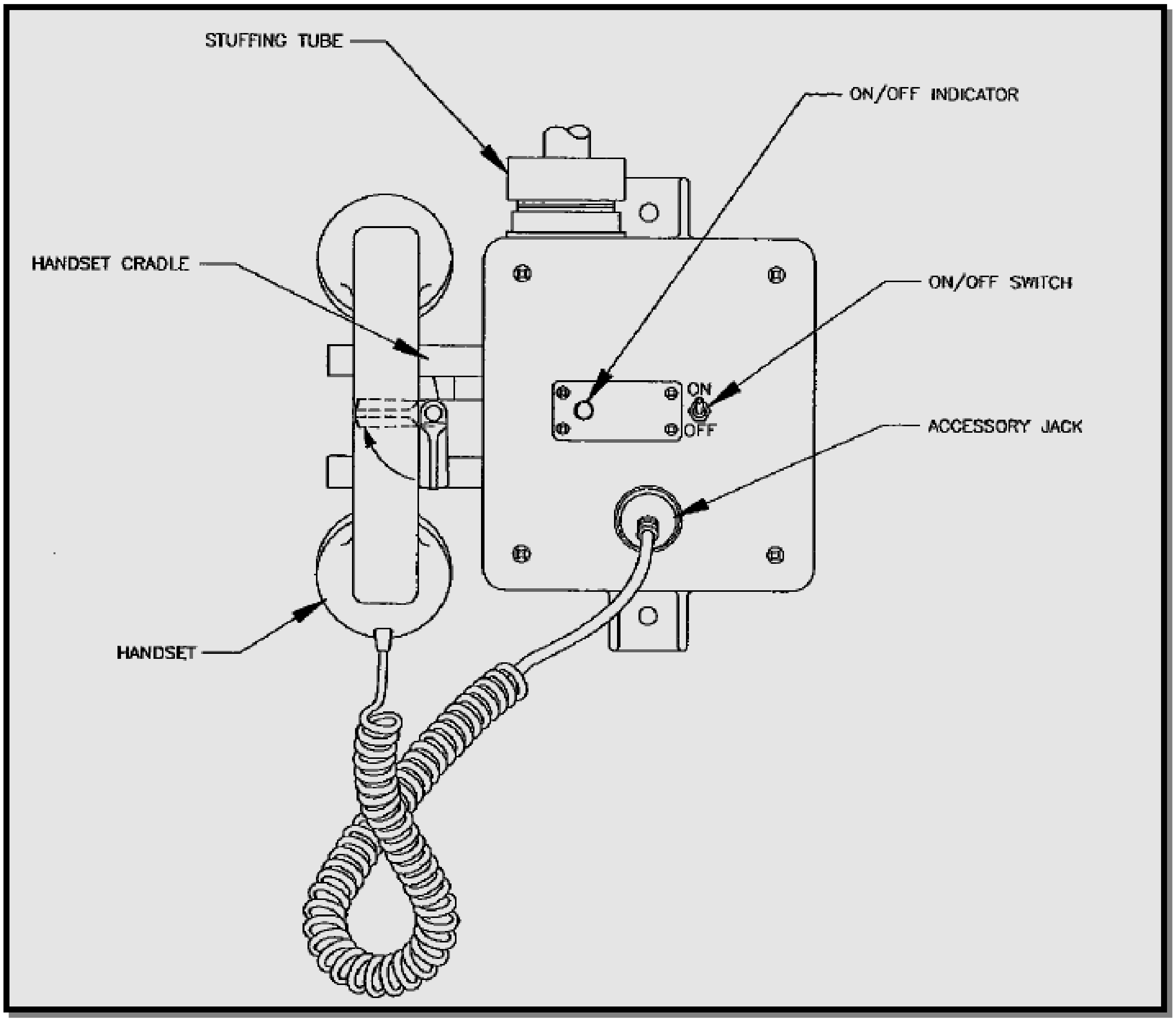


Figure 6-55.—Jackbox Terminal, TA-1002/STC-2(V).

Standard Dial Terminal TA-866B/STC-1 (DS), Unit 15

The DS (figure 6-56) utilizes a 12-button Dual-Tone Multiple Frequency (DTMF) key sender to initiate calls to other STC-2 terminals, STC-2 nets, and external interfaces. A primary lamp illuminates when +24VDC is provided from the ICSC, ensuring the terminal, specifically the ON pushbutton and directory plate, is visible in a darkened area. Secondary lamps (three) are provided to illuminate entire keypad when DS is active. An annunciator and ACTIVE lamp are provided to alert users of incoming calls. The ACTIVE lamp flashes at ring rate when OS is called and remains illuminated when OS is active (ON). A remote ringing device may be connected to DS. This is advantageous in high-noise spaces to alert personnel of incoming calls. The remote ringing device and cabling are not provided.

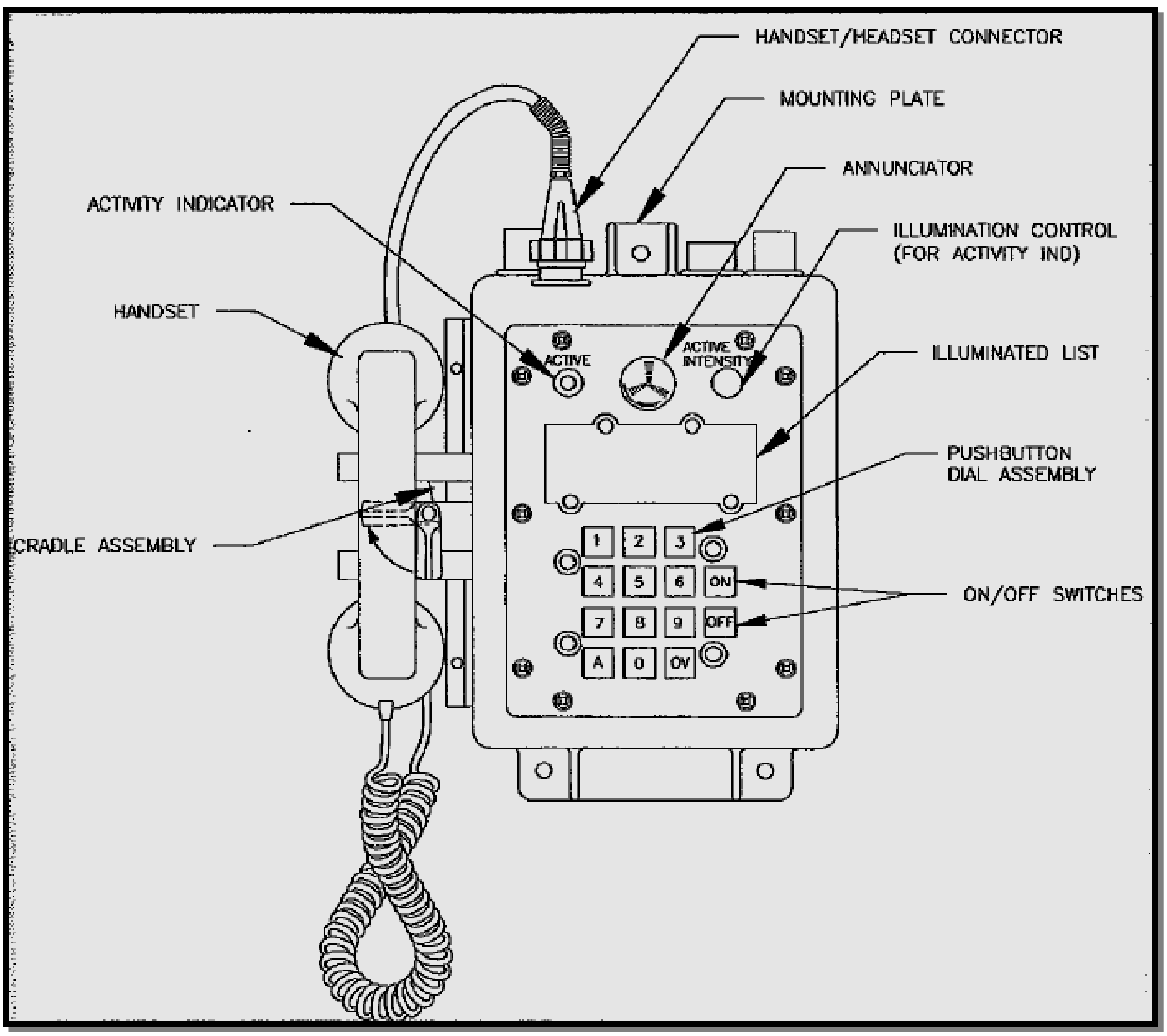


Figure 6-56.—Standard Dial Terminal, TA-866B/STC-1.

Maintenance Terminal (MD)

A DS is located in each ICSC and class marked as MT. The Main Traffic Program allows the MT to request status of STC-2 terminals, and run test and utility routines. The MT provides control and current status of the ICSC. The MT is given all calling permits, allowing terminal to generate and receive all types of calls.

Advance Maintenance Control System (AMCS)

The purpose of the AMCS (figure 6-57) is to provide an alternative and enhanced means of monitoring and controlling the AN/STC-2(V) operational program to the primary means currently provided by the Maintenance Terminal (MT). AMCS uses a microcomputer, referred to as a Visual Maintenance Terminal (VMT), hosting a Graphical User Interface (GUI) and provides a visual means to monitor both the FWD and AFT centers simultaneously. The AMCS is capable of monitoring and/or controlling any ICSC, regardless of location, as long as the ICSC is connected to a VMT. A single VMT is connected to each ICSC and communicate with each other over a serial interface as well as via modem to VMT's external to the ship.

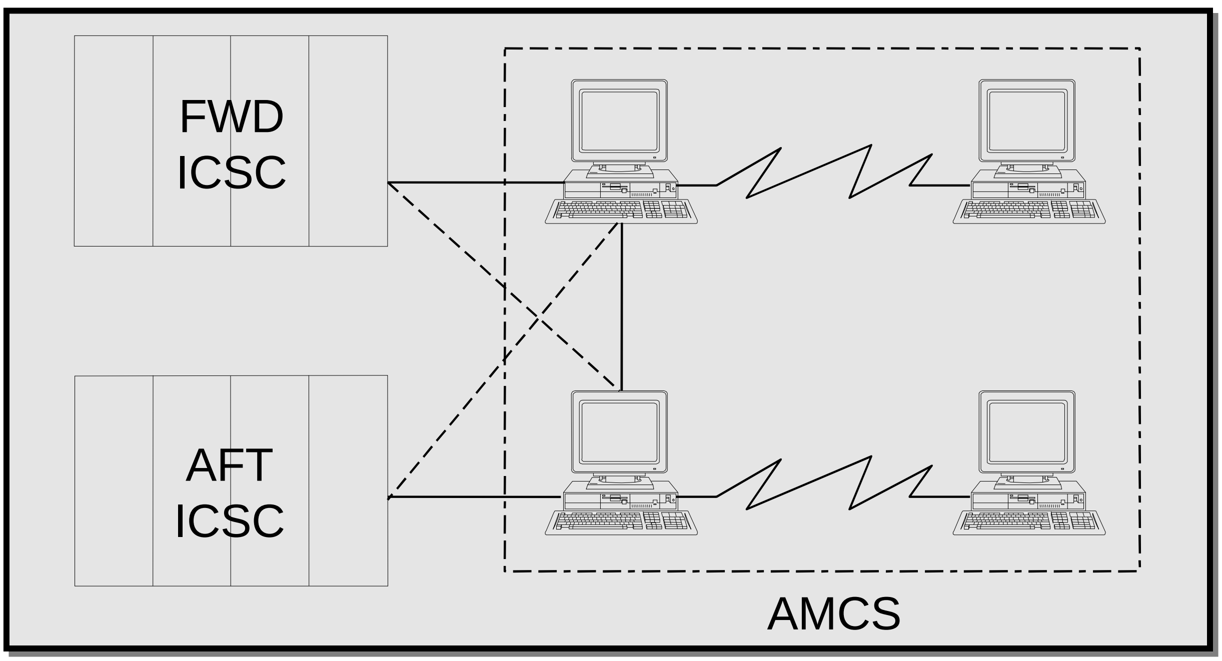


Figure 6-57.—Standard AMCS Configuration.

Jackbox Terminal – Electromagnetic Interference Hardened TA-1002N STC-2(V) (NJA), Unit 23

The NJA (figure 6-58) is functionally identical to the NJ. The NJA does not contain an ON/OFF toggle switch or an ON/OFF indicator. The terminal is hardwired to a pre-designated net and is always on net. Watertight integrity is increased due to the absence of toggle switch and indicator. The NJA is installed at weatherdeck and EMI-sensitive areas. The Input/ Output Board Assembly in the NJA is identical to board assembly in the NJ.

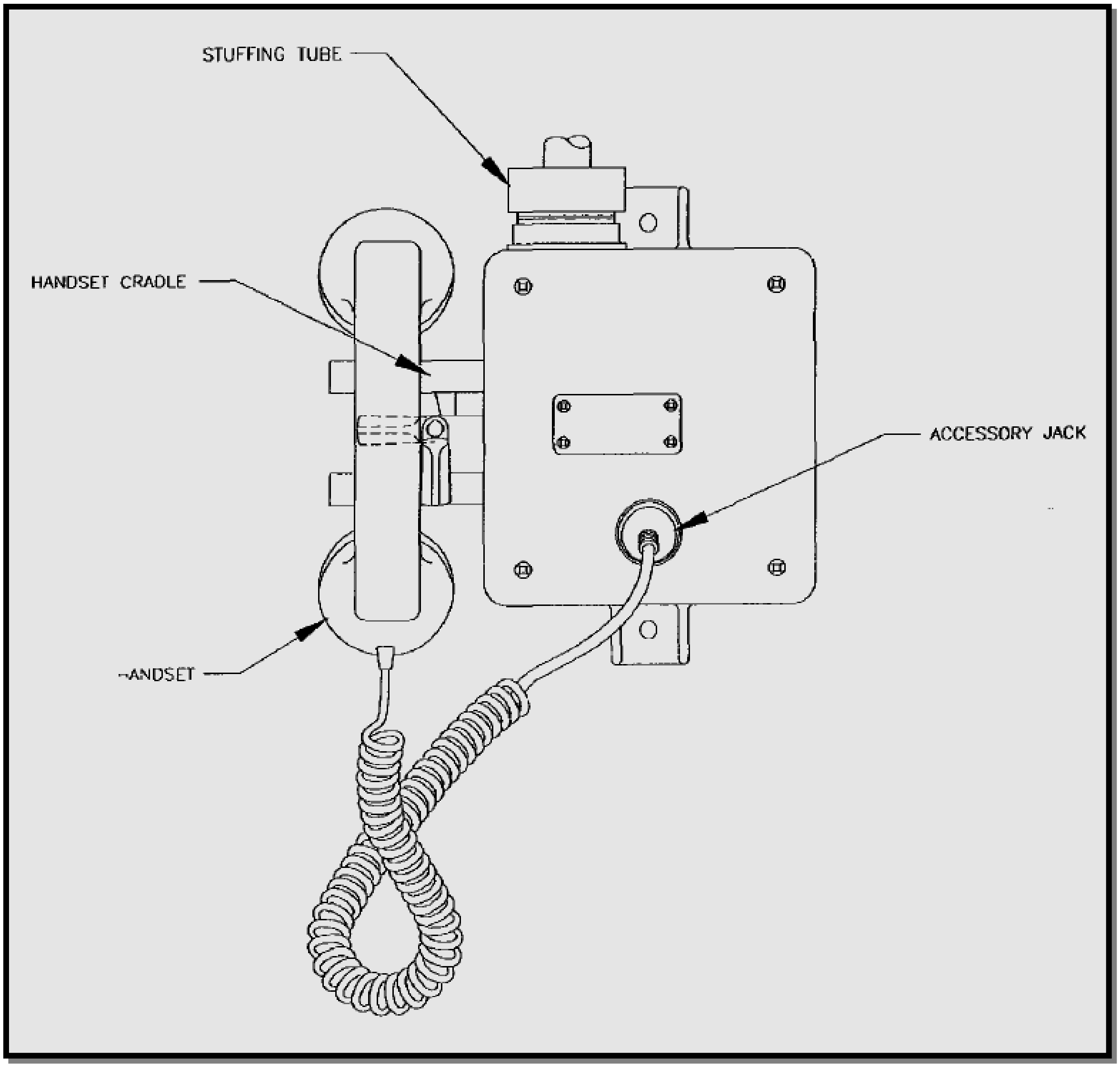


Figure 6-58.—Jackbox Terminal, TA-1002A/STC-2(V).

Standard Dial Terminal- Electromagnetic Interference Hardened (DSC), TA-866C/STC-1 Unit 24
The function, operation, and physical appearance of the DSC and the DS are identical. The DSC is installed in EMI-sensitive areas (e.g., pilot house).

Automatic Dial Terminal- Electromagnetic Interference Hardened (ATA), TA-997A/STC-2(V) Unit 25
The function, operation, and physical appearance of the ATA and the AT are identical. The ATA is installed in EMF-sensitive areas (e.g., pilot house).

Intercommunication Station LS-613A/STC-1 (LS-613) Unit 16
The LS-613 (figure 6-59) provides Talk-Listen-Off capabilities when connected to a STC-2 terminal. The volume control adjusts sound level from speaker during listen mode. The speaker is used as a microphone during talk mode.

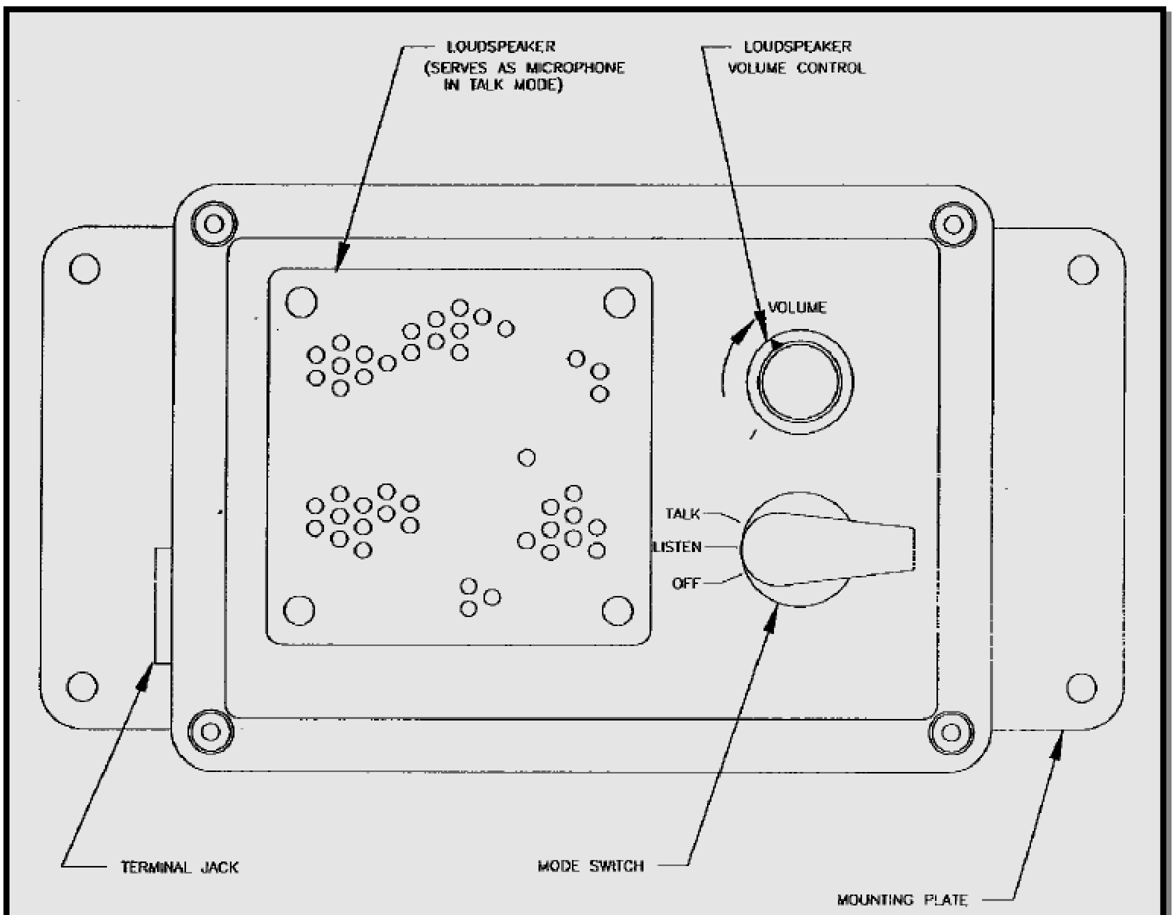


Figure 6-59.—Intercommunication Station, LS-613A/STC-1.

Handset H-319/U (Handset) Unit 17

The handset (figure 6-60) contains a push-to-talk switch, 5-foot cord, microphone, and earphone element. The handset is used in low-to-medium noise level areas onboard ship.

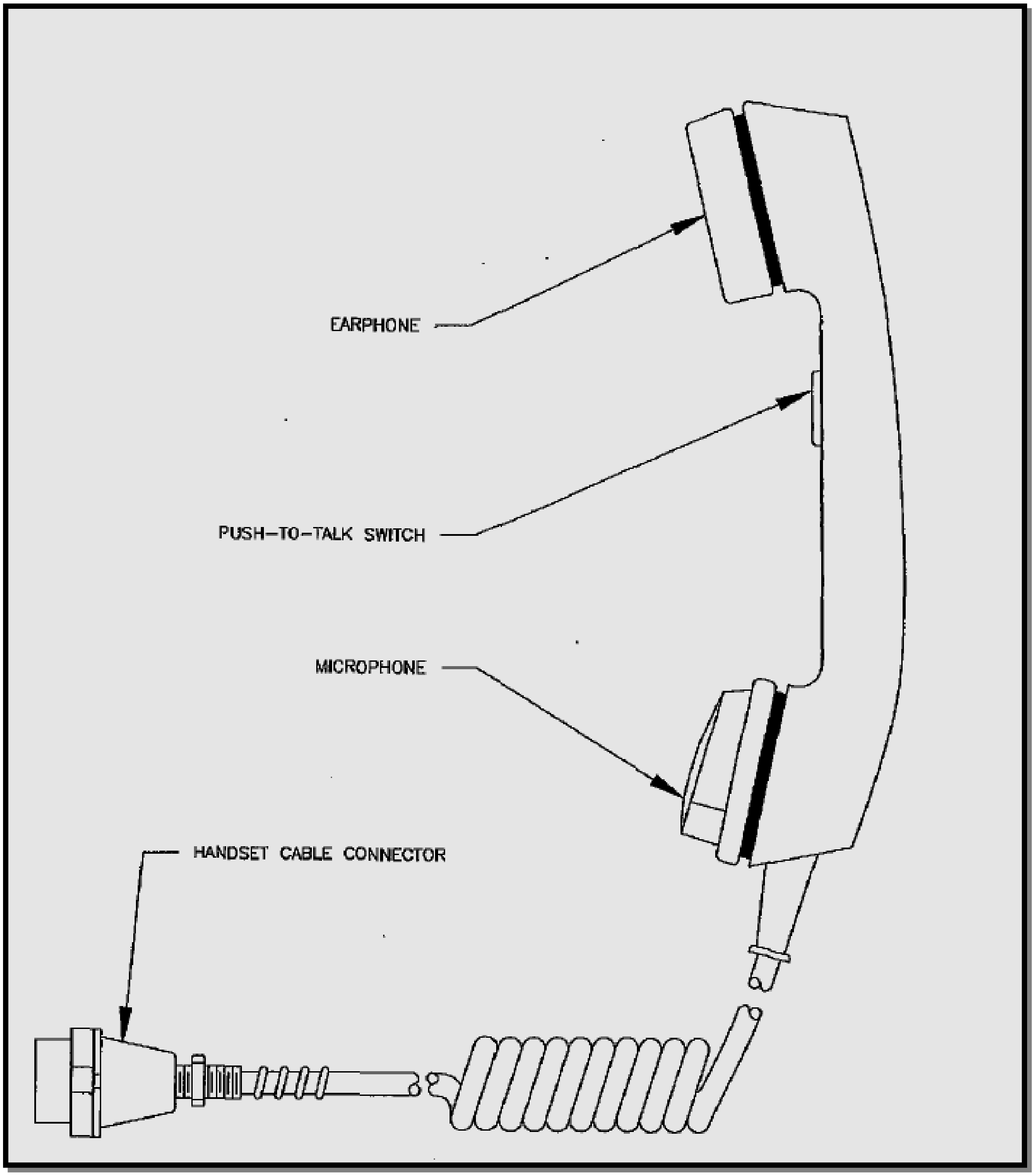


Figure 6-60.—Handset, H-319/U.

Headset H-320/U (Headset), Unit l8

The headset (figure 6-61) is utilized with STC-2 terminals where repeated use, high ambient noise, and use without restricting the user's hands are primary considerations.

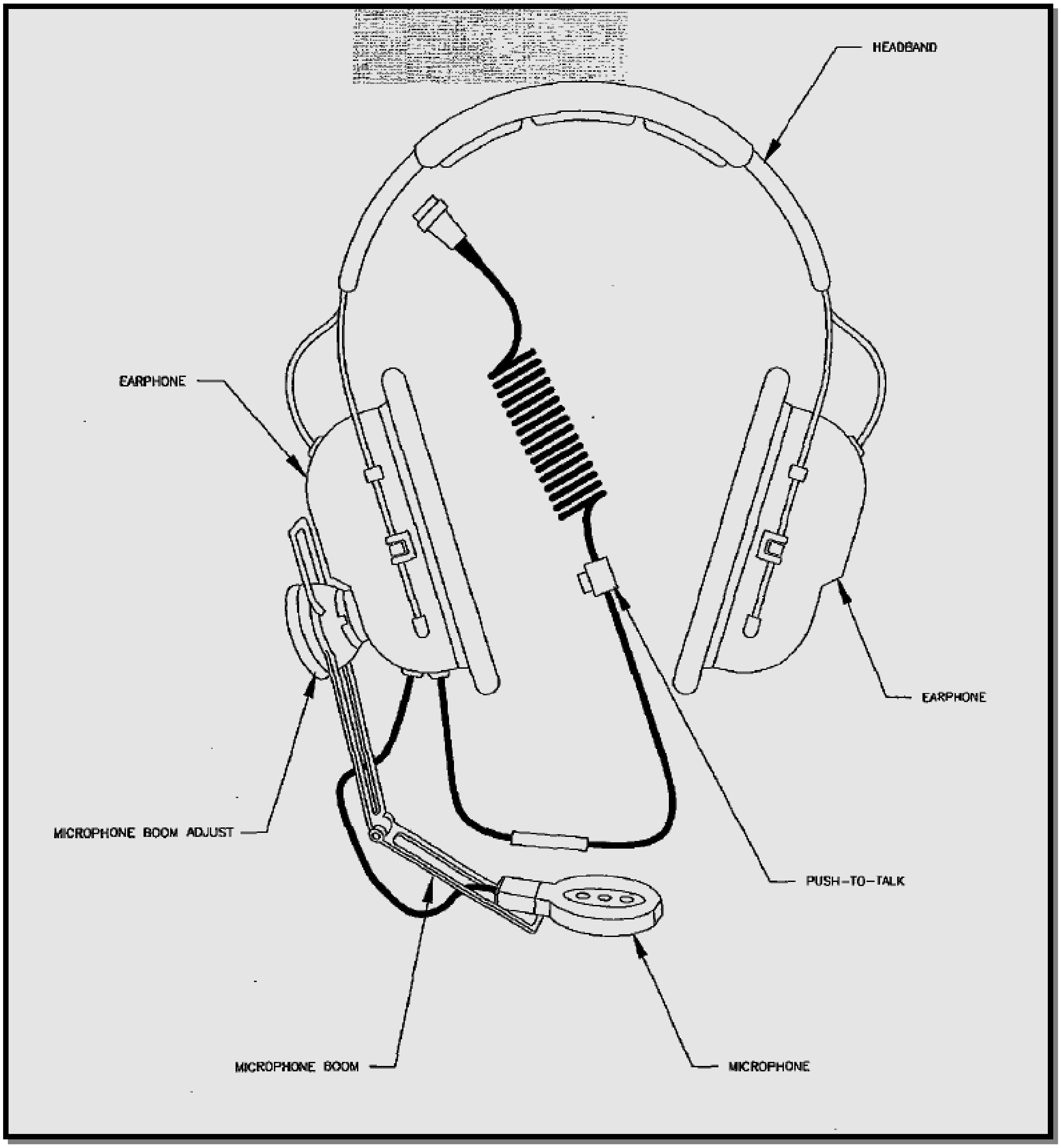


Figure 6-61.—Headset, H-320/U.

Handsfree Intercommunication Station, LS-614A/STC-1 (LS-614) Unit 19

The LS-614 (figure 6-62) provides the same capability as LS-613, but has the capability of transmitting without operator holding talk switch in TALK position. The user may use either the normal or handsfree mode, as desired. In handsfree mode, the speaker acts as a microphone or loudspeaker as determined by the calling party's Push-to-Talk status. The associated terminal becomes automatic In operation (automatic ON or OFF via central processor commands) and handsfree Indicator on LS-614 illuminates.

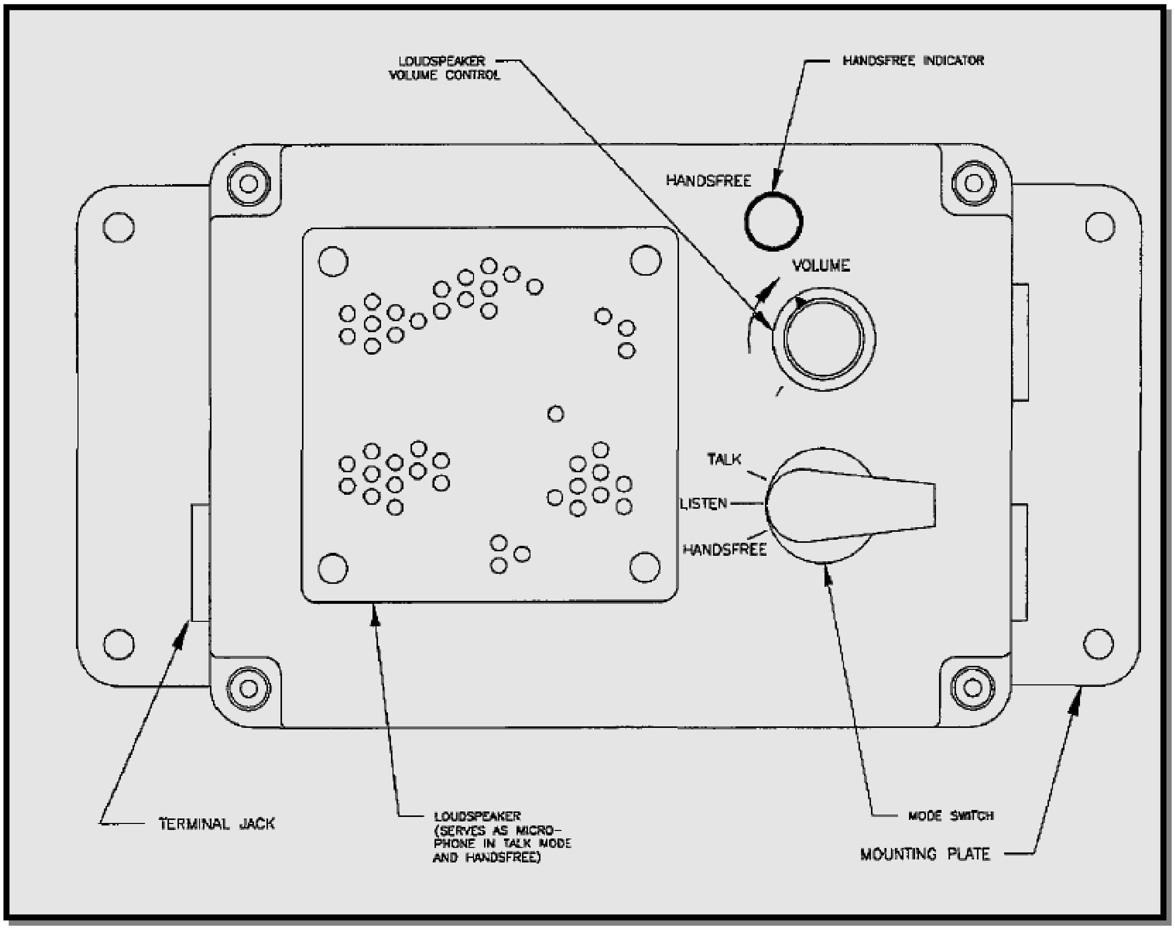


Figure 6-62.—Handsfree Intercommunication Station, LS-614A/STC-1.

Interconnecting Box, J·3063/STC-1 (J-3063), Unit 22

The J-3063 (figure 6-63) is designed for use in areas exposed to changing climatic conditions. These areas are usually found on main deck (or above) outside main structure of ship.

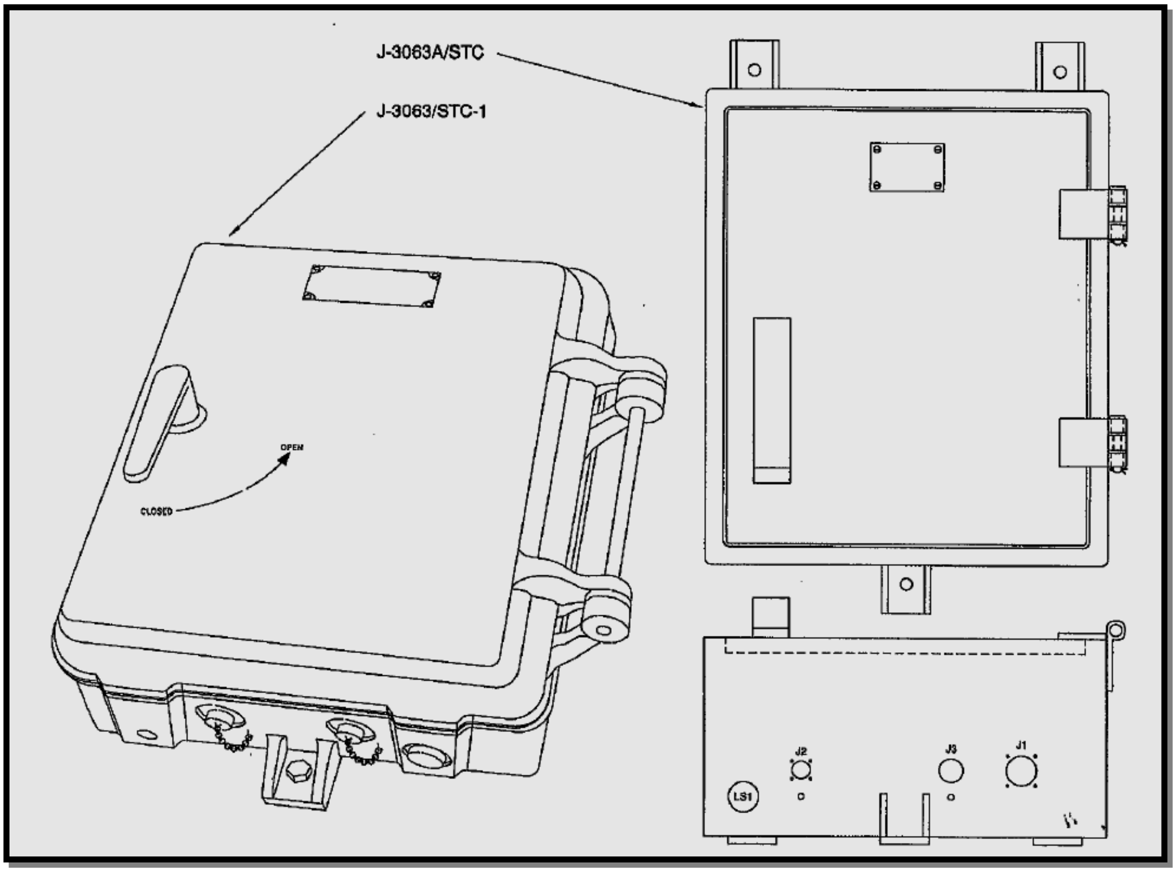


Figure 6-63.—Interconnecting Boxes, J-3063/STC-1 and J-3063A/STC.

Split Headset H-320A/U Unit 28

The split headset monitors two STC·2 terminals simultaneously; the left earphone monitors one terminal, while the right earphone monitors the other terminal. The split headset also transmits to either terminal as selected by the Split Headset Interlace Box. The split headset is similar in appearance to the H-320/U Headset; however, these headsets are not electrically compatible. Connecting a split headset to a STC-2 terminal accessory jack will damage the split headset, rendering it inoperable. The split headset is identified by blue earphones and does not contain a Push-to-Talk (PIT) switch on the belt clip.

Split Headset Interlace Box (SHIB) J-4950/STC Unit 29

The SHIB provides the common connecting point for two STC-2 terminals, a split headset and a foot switch. The SHIB contains two switches which control the split headset operation. Switch 81 selects the STC-2 terminal to which the operator transmits. Switch 82 mutes the right earphone in the OFF position. The foot switch enables the operator to transmit to the selected STC-2 terminal.

6.4.5 Equipment and Publications Required, But Not Supplied

Test and maintenance support equipment required, but not supplied with equipment, are listed in table 1-8 of SE105-AQ-MMO-010/STC-2(V).

6.4.6 Electrostatic Discharge Sensitivity

Some electrical components and assemblies in STC-2 units are Electrostatic Discharge Sensitive (ESDS). ESDS components are extremely susceptible to damage from static charges generated by personnel, equipment, and packing materials that come in contact with or near ESDS components. These parts demand special usage requirements for protection from ESDS damage. The requirements include specific handling, transportation, packaging, and labeling of items and associated hardware. Refer to ESDS Handbook, MIL-HDBK-263, for more information.

6.4.7 Field Changes and Equipment Proposals

Tables 1-9 through 1-20 of SE105-AQ-MMO-010/STC-2(V) identify field changes for STC-2 equipment. The tables include the Equipment Change Proposal (ECP) number corresponding to the indicated Field Change (FC) number and a brief description of the filed change. Test, tables, and figures throughout this technical manual reflect the implementation of these field changes unless otherwise stated in the description column of the filed change table.

6.5.0 MARCOM INTEGRATED VOICE COMMUNICATION SYSTEM (MARCOM/IVCS)

The MarCom Product Line is a set of basic building blocks that can be flexibly configured for a variety of applications to manage all voice communications in an integrated fashion. This results in significant benefits to the users of the system, while reducing procurement, installation, and maintenance costs through the elimination of unnecessary features and equipment.

6.5.1 System Operational Overview

Operationally, the heart of the MarCom system is the MarCom Integrated Voice Communication System (IVCS) Wired Enclosure and the MarCom Compact IVCS (CIVCS) Wired Enclosure, commonly referred to as the IVCS and CIVCS Switches, and/or the MarCom Baseband Switch (BBS). These switches are capable of fulfilling all the functions typically performed by separate voice systems for telephone services of all kinds, including intercoms and internal voice nets, radio access and netting, microphone input to announcing or public address systems, initiation of alarms, secure intercom and interphone, and all conferencing services. It is an Integrated Services Digital Network (ISDN) with fundamental enhancements not found in a commercial ISDN PBX. The most important of these enhancements include security provisions for handling classified voice traffic, efficient support for large scale netting and conferencing, and efficient support to users who need to simultaneously actively communicate on one or more circuits or nets while monitoring any number or additional circuits or nets. Other enhancements include environmental risk mitigation, high availability, survivability alternatives, and other parameters of a system used to support military missions.

For most users, this means a single instrument can be used to access all voice services. This is in contrast to typical communications systems, one in which an individual may be surrounded by as many as a dozen individual voice instruments tied into separate systems. Conversely, communications effectiveness is greatly improved with an integrated MarCom approach as the user now has a single place to look to see what voice circuits are being monitored and one place from which to contact anyone. A single headset, handset or microphone can provide the operator the ability to attend to incoming calls on any of the other systems, as opposed to switching between headsets, handsets, microphones or other redundant devices dedicated to individual communication systems. Additionally, this integrated system allows the user to monitor multiple circuits simultaneously, putting the user in control of his communications environment.

From a procurement, installation, and maintenance standpoint, an integrated system requires less of everything including space and volume for user instruments, cable plant, space and volume for switching equipment, power, cooling, technical manuals, training, and spares.

Important attributes of the integrated system elements are that they are flexible, scalable, adaptable, and expandable, ready to meet changing use requirements. A relatively small number of circuit card types support interfaces to a wide variety of ISDN and analog equipment and systems. This helps to reduce the spare parts complement required to support any system. The elements can be applied to small systems with a dozen users as well as large systems with hundreds of users. A single MarCom Switch can operate alone or within a network of switches operationally functions as if it was a single large switch.

The MarCom Switch can perform all of the switching functions by itself or it can interoperate with other equipment, such as PBX applications for very large systems with many administrative users who only need telephone services. MarCom systems are inherently expandable. They have virtually no internal wiring harness and capability can be added incrementally by plugging in additional circuit cards as needed. Additional MarCom Switches can always be added with available Trunk Interfaces that provide Internodal Trunking.

As illustrated in Figure 6-64, Figure 6-65 and Figure 6-66, the elements of the MarCom system complement other voice components to provide for a truly integrated communications capability. These figures show a few of the ways in which systems can be configured, depending on the size of the platform, the quantity of users, redundancy requirements for survivability, and other factors.

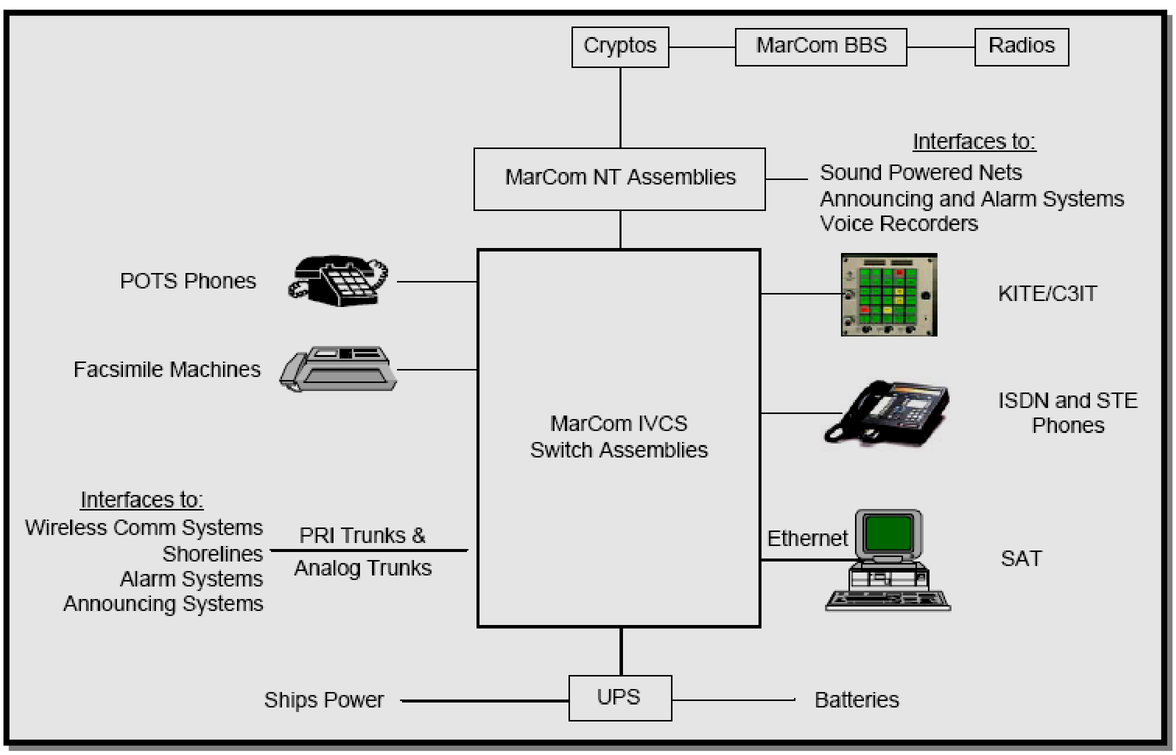


Figure 6-64.—Typical Single Switch (Node) System Application.

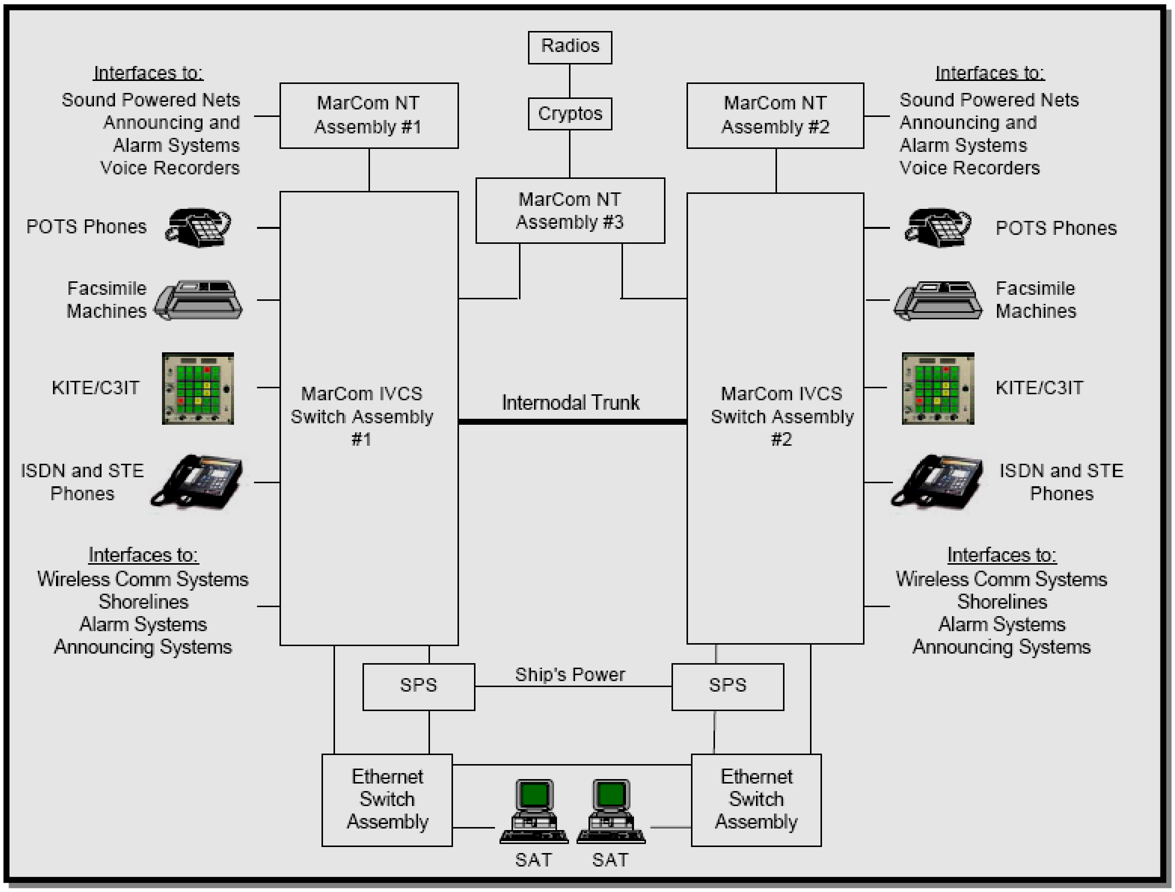


Figure 6-65.—Typical Two-Node Application.

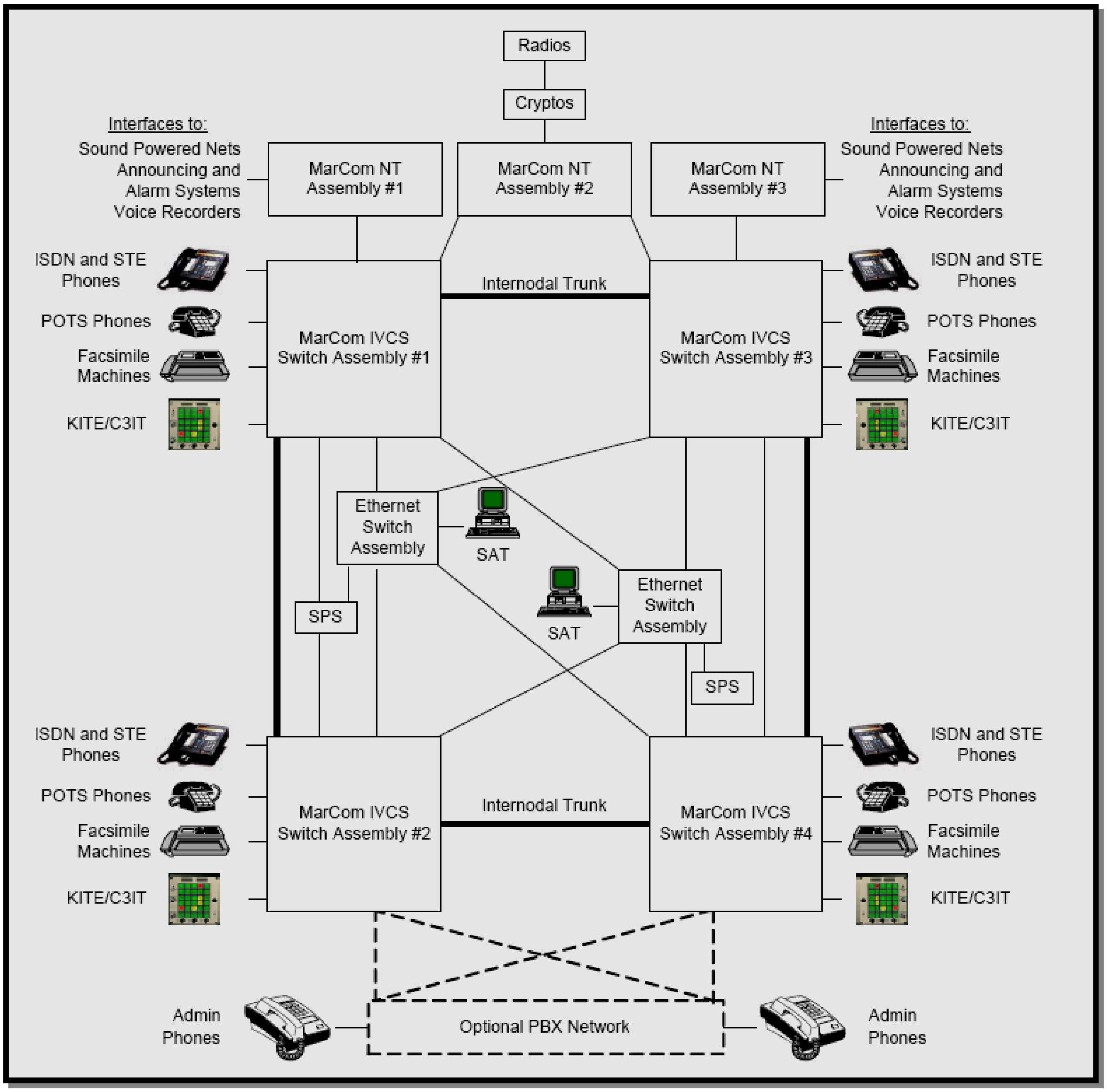


Figure 6-66.—Typical Large System Application.

The MarCom IVCS switches and their associated Integrated Terminals are able to handle both secure and plain voice communications. They provide plain interfaces to the PBXs, Sound Powered Nets and Alarms/Announcing systems, and a controlled mix of secure and plain voice circuits to the Radio Communication System.

6.5.2 Safety Precautions

The following safety precautions apply for use of the MarCom products:

WARNING:
Operator and maintenance personnel must observe all recommended and posted equipment safety precautions. Personnel must be aware of the dangers that exist when reaching into equipment enclosures having internal equipment voltages.

Before performing maintenance on electrical or electronic equipment where unsafe voltages exist, personnel must ensure that any necessary main supply switch is secured in an open or “safety” position. In addition, personnel must NEVER perform maintenance work alone. For safety reasons, another qualified person should always be present during maintenance activities. Unsafe AC power is present in the CIVCS switch, System Power Supply (SPS) and in the Uninterrupted Power Supply (UPS) rectifier drawer.

WARNING:
In the UPS, toggling the “AC POWER ON” switch to the Off position removes the AC input to the DC distribution but does not completely remove AC power from the UPS drawer. Input AC power must be disconnected at its source to completely remove it from the MarCom equipment.

However, to simplify MarCom IVCS maintenance and provide for maximum system operational capability, the IVCS has been designed to allow circuit cards that plug into the switches and Network Termination Drawers to be safely removed or replaced while power is present. There is no AC power in the IVCS switch or NT Drawers or at any of the user terminals.

6.5.3 Technical Characteristics

ELECTRICAL CHARACTERISTICS

IVCS Switch:

1. Input power:
    a. -48 VDC (nominal). Used by redundant power supplies in the IVCS to generate operating voltages of +5 VDC and +12 VDC for installed circuit cards. The –48 VDC is also applied to the J2 connectors on the backplane for use by installed circuit cards and for distribution to attached devices.

    b. +24 VDC (nominal). Applied to the J3 connectors on the backplane for use by installed circuit cards and for distribution to attached devices.

2. Power Consumption:
    a. A fully populated IVCS switch consumes 500 watts maximum internally. Each circuit card consumes 6 watts maximum. Attached KITE terminals consume 8 watts maximum – other devices consume less. Calculate power requirements for your system to determine loading.

CIVCS Switch:

1. Input power:
    a. 120 VAC, 60 Hz, single Ø feeds integral power supplies within the Compact IVCS. Power supplies include a standard 5/12VDC unit and an optional +24VDC or -48VDC unit that generate operating voltages needed for various internal circuit cards and external devices where applicable.

2. Power Consumption:
    a. A fully populated compact CIVCS consumes 500 watts maximum internally. Each circuit card consumes 6 watts maximum. Attached KITE terminal consumes 8 watts maximum – other devices consume less. Calculate power requirements for your system to determine loading.

NT Drawer Assembly:

1. Operational power: +24 VDC nominal (from IVCS/CIVCS Switch, SPS, or UPS).
2. Power Consumption: No internal power supply.

MECHANICAL CHARACTERISTICS

IVCS Switch/BBS:

1. Cube: 19 in. (48.26 cm) Wide x 22.75 in. (57.785 cm) High x 20.5 in. (52.07 cm) Deep (excluding handles and connectors)
2. Format: 9-U Eurocard (VME)
3. Weight: 140 lbs (63.503 kg) (full 20-card complement)
4. Cooling: Fans, air filters; - air enters front, exhaust rear

CIVCS Switch:

1. Cube: 19 in. (48.26 cm) Wide x 10.47 in. (26.954 cm) High x 20.5 in. (52.07 cm) Deep (excluding handles and connectors)
2. Format: 9-U Eurocard (VME)
3. Weight: 75 lbs (34.02 kg) (full 7 card complement)
4. Cooling: Fans, air filters; air enters front, exhaust rear

NT Drawer Assembly, 20 Slot:

1. Cube: 19 in (48.26 cm) Wide X 12 in. (30.48 cm) High x 20.5 in. (52.07 cm) Deep (excluding handles and connectors)
2. Format: 3-U Eurocard (VME) – MarCom® J3 Backplane, 20 slots
3. Weight: 80 lbs (36.29 kg) (20-card complement)
4. Cooling: Natural Convection

NT Drawer Assembly, 60 Slot:

1. Cube: 19 in. (48.26 cm) Wide x 22.75 in. (57.785 cm) High x 20.5 in. (52.07 cm) Deep (excluding handles and connectors)
2. Format: 3-U Eurocard (VME) – three MarCom J3 Backplanes, 20 slots each
3. Weight: 150 lbs (68 kg) (60 card complement)
4. Cooling: Fans, air filters; - air enters front, exhaust rear

ENVIRONMENTAL

1. OPERATING AMBIENT TEMP: 0^0 C TO $+50^0$ C
2. STORAGE AMBIENT TEMP: -25^0 C TO $+75^0$ C
3. RELATIVE HUMIDITY: 5% TO 95% (NON-CONDENSING)

SYSTEM SPECIFICATIONS

1. Shock: Per MIL-S-901D, Grade A, Class I, Type A.
2. Vibration: Per MIL-STD-167-1, Type I, frequency range 5 to 55 Hz.
3. Workmanship: Per ISO 9000

6.5.4 MARCOM IVCS Theory of Operation

The MarCom IVCS is a voice switching system capable of satisfying operational requirements for administrative and tactical voice communications on an around-the-clock basis. These systems provide:

- Computer-controlled, automatic switching service for line-to-line, line-to-net (e.g., platform based nets like Network Jack Box and Sound Powered Telephone nets) and line-to-external (external to the platform on which the IVCS is installed) voice connections, and also for net and user

- Service functions which include, but are not limited to: Conferencing, abbreviated addressing, call forwarding, call waiting, call transfer, call override, speed calling, hotline, call hold, and calling line identification.

The IVCS employs a modular design in both hardware and software, thus providing a family of compatible switching configurations using time division switching technology. Modularity is achieved through design techniques that distribute system functions among assemblies between which hardware and software interfaces are clearly and flexibly defined.

6.5.5 System Architecture

The MarCom IVCS consists of four primary elements. They are the MarCom Switch Assemblies, the MarCom Network Termination (NT) Assemblies, a set of user terminals/instruments, and the System Administration Terminal (SAT). These elements are utilized in varying quantities to complement other shipboard equipment and systems, which include PBXs, Announcing and Alarms, Sound Powered Nets and Radio Communication circuits. Figure 6-67 shows pictures of the IVCS switch, NT and Integrated Terminal components.

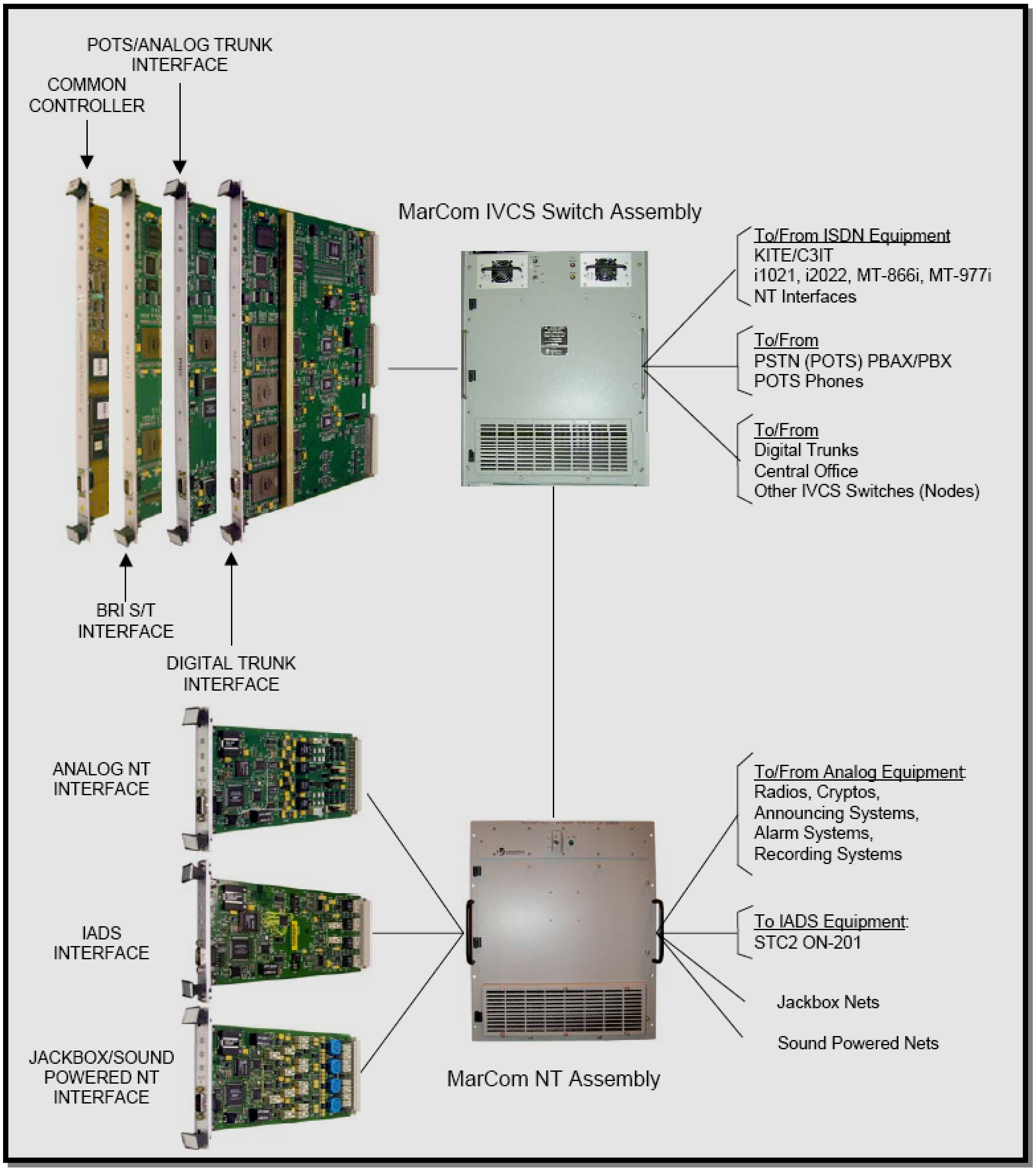


Figure 6-67.—MARCOM System Architecture Components.

6.5.6 System Equipment Units

The principal equipment elements of MarCom system are further identified in the summary of system elements contained in Table 6-10 that follows. These equipment elements are described in more detail later in this document.

Element	Function	Classification
MarCom Switch Assembly	Performs digital switching, call processing, conferencing / netting, system control and security control. Directly supports ISDN telephones, Integrated Terminals, and digital trunks. Supports analog interfaces through Network Termination PWAs.	Switches and controls both secure and plain voice traffic
MarCom IVCS Network Termination Assembly	Interfaces analog circuits to the digital ISDN MarCom IVCS Switch.	Interfaces circuits that can be secure or plain at any given time and must remain isolated from one another
Integrated Terminals: (KITE/C3IT)	User instrument with controls, handset, headset, speakers, and microphones supplying telephone, intercom, radio, announcing and alarm system access, secure and non-secure services.	Handles a mix of secure and plain voice in a controlled manner
MarCom System Administration Terminal	Software in a PC used to maintain configuration databases and user permits for the Switches and terminals.	Unclassified but sensitive since it determines which users and interfaces are permitted access to secure voice traffic

Table 6-10.—Summary of System Elements.

6.5.7 MARCOM System Interfaces

The principal system interfaces (customer systems) and their related security classifications are listed in Table 6-11.

Element	Function	Classification
User Subsystems	Telephones, jack-boxes, loudspeakers, external ringers, visual signaling devices, etc.	Various
Radio Communication System	External to IVCS. Provides access to radios and voice cryptos.	Handles circuits which may be cipher or plain, often under control of the User
PBX	In large systems, provides telephone switching and access to shorelines, wireless systems and Commercial SATCOM. A small PBX may also be used as an international shoreline interface in small systems.	Plain always. When applicable, STE encryption allows secure Black circuits to pass through the PBX.

Table 6-11.—Related Customer Systems.

6.5.8 System Interface Description

A summary of interfaces is provided in Table 6-12. The Information carried on the MarCom Switch TDM backplane bus (see Figure 6-68) is communicated to external devices via either ISDN (Integrated Digital Services Network) Basic Rate Interfaces or digital trunks.

Each ISDN BRI interface logically consists of two full duplex 64 Kbps Bearer (B) channels and one full duplex 16 Kbps Data (D) channel. This is commonly referred to as 2B+D. BRI S/T lines are connected in the MarCom® switch to two classes of devices. One class consists of user instruments, such as the KITE, STE and ISDN telephones/telesets.

The other class consists of adapters to convert between ISDN signals and analog signals. These adapters are the Network Termination (NT) devices. They are typically used to connect the non-ISDN (analog) devices, such as radios, voice cryptos, Sound Powered Nets, Announcing and Alarm systems, and POTS Telephones to a digital (ISDN) network. The NTs can also be used to support an analog trunk connection to an older commercial analog PBX.

Trunk Interface Circuit Card Assemblies (CCAs) and their associated Trunk I/O CCAs are available, if required, for both high rate trunking between multiple MarCom IVCS Switches (nodes) and for interfacing to an external commercial PBX or Central Office.

The Internodal Interface is used to connect multiple MarCom Nodes. This Internodal Trunking in effect increases the port capacity within a MarCom system by allowing devices connected to one MarCom Switch to communicate with devices connected to another MarCom Switch.

The use of the Internodal Trunking permits MarCom Nodes to be geographically distributed, in order to enhance survivability while reducing overall system cabling. The E1/T1 selectable Primary Rate Interfaces are used to interface the MarCom Switch with a commercial PBX. A Central Office or PABX may also be connected to the MarCom Switch by analog trunks on the POTS Interface CCA.

From	To	Interface Type	Classification
MarCom Switch & NT	PBX or Central Office or Shorelines	ISDN PRI Trunks	Plain; always
		Analog Trunks GS/LS	Plain; always
	Sound Powered Nets	Analog	Plain; always
	Alarms and Announcing	Analog plus Simple Control Lines	Plain; always
	Voice Recorder	Analog	Dependent on classification of circuits selected for recording. Generally mixed.
	Radio Communication Systems	ISDN E1/T1 PRI Trunks	Each Bearer Channel may be Secure or Plain at any given time. Switch knows which.
		Analog Trunks, one per Radio or Voice Crypto with controls	Each trunk may be Secure or Plain at any given time. Switch knows which.
	Another MarCom IVCS Switch	Proprietary High Speed Digital Serial Link (Internodal Trunk)	TDM mix of Secure and Plain. Both switches know classification of each time slot.
	Integrated Terminal (KITE/C3IT)	ISDN BRI, S/T	Controlled mix of Secure and Plain.
	System Administration Terminal (SAT)	EIA-232	Plain, but sensitive.
	ISDN Telephones, including Secure Terminal Equipment (STE)	ISDN BRI S/T	Plain or encrypted (STE).
	POTS Telephone	Analog, DTMF	Plain.

Table 6-12.—Summary of System Interfaces.

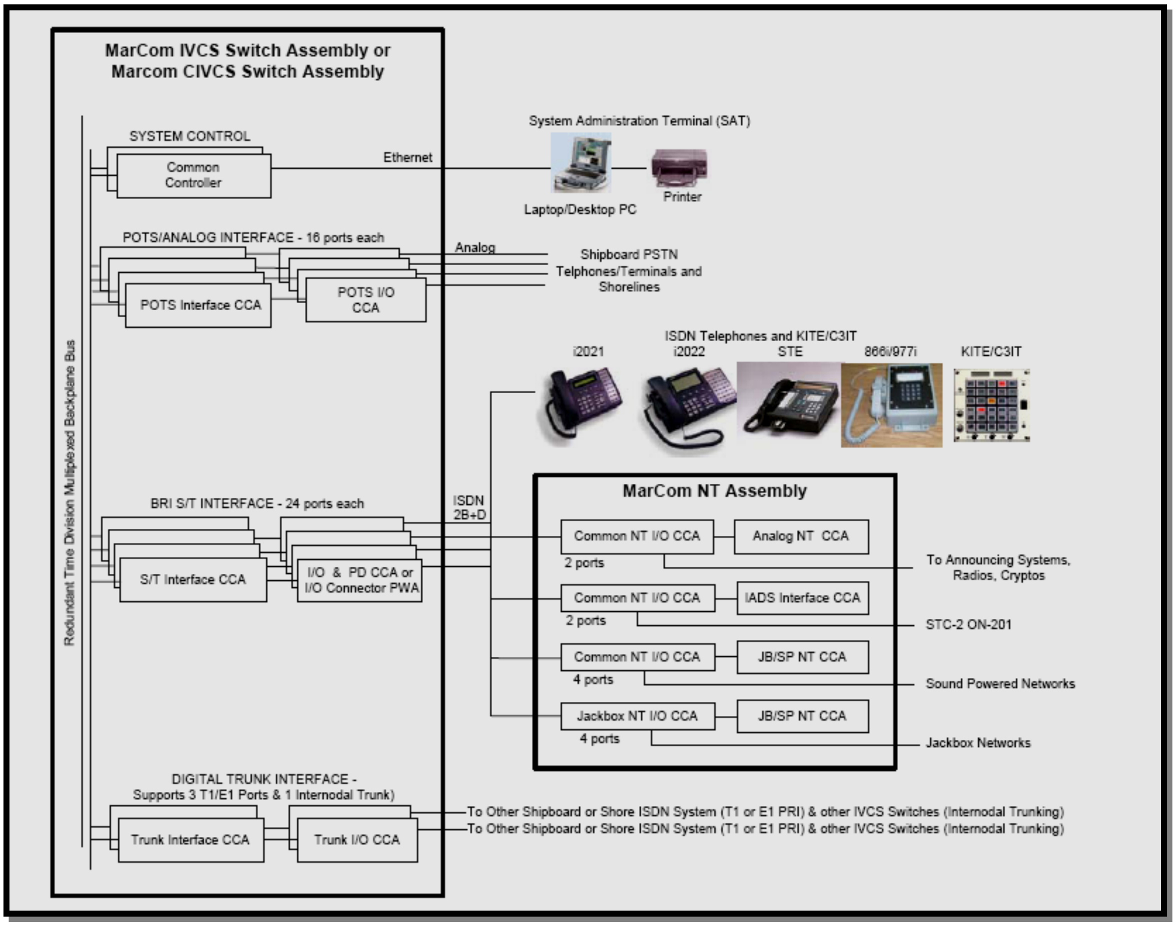


Figure 6-68.—MARCOM Switch Architecture Diagram.

The System Administration Terminal (SAT) is connected to the MarCom® Switches via an Ethernet to download software to the Common Controller PWAs (and to the Interface CCAs via the Common Controller) for configuration setup, error reporting, corrective/preventative maintenance and event logging. The SAT is also used to download Keyswitch Integrated Terminal Equipment (KITE or C3IT) configurations. In the event of an Ethernet failure, the SAT can be connected directly to the switches via the front panel EIA-RS-232 connector on the Common Controller.

6.5.9 MARCOM IVCS Equipment List Description

ENCLOSURES AND ACCESSORIES

MarCom IVCS Switch Wired Enclosure Assembly
A 19-inch wide by 21-inch high rack mount drawer housing with inherent high speed Time Division Multiplex (TDM) backplane with 2,048 time slots, two "–48VDC to +5.1/12VDC" power supplies and internal power distribution, and five cooling fans. Contains twenty slots that accept MarCom VME 9U format Circuit Card Assemblies (CCAs), Printed Wiring Assemblies (PWAs) or MarCom Paired Network Termination (NT) Assemblies, in various combinations dependent upon specific system requirement.

–48VDC to +5.1/12VDC Power Supply
Converts the –48 VDC applied to the IVCS Switch Wired Enclosure Assembly, from the System Power Supply, to the +5VDC and +12 VDC operating voltages of the CCAs, PWAs and Paired NT Assemblies used in the switch. Nominal output is 300 Watts @ 5.1 VDC and 75 Watts @ 12 VDC.

MarCom Compact IVCS Wired Enclosure Assembly
A 19-inch wide by 11-inch high rack mount drawer with an inherent high speed TDM Backplane with 2,048 time slots, two cooling fans, a +5/12V power supply and a power distribution system. The –501 version also contains a +24V power supply while the –502 version contains or a -48V. Contains seven slots that accept MarCom VME 9U configuration CCAs, PWAs, or Paired NT Assemblies in various combinations dependent upon specific system requirement.

+5/12V Power Supply
The +5/12VDC power supply is used in both versions of the CIVCS. It converts 115VAC to +5 and +12VDC, at 350 Watts, sufficient to operate the CCAs, PWAs and Paired NT Assemblies used in the CIVCS.

+24V Power Supply
The +24VDC power supply is used in the -501 versions of the CIVCS. It converts 115VAC to the +24VDC, at 500 Watts, sufficient to power 24 KITEs or other external devices connected to the CIVCS.

–48V Power Supply
The -48VDC power supply is used in the –502 version. It converts 115VAC to the -48VDC, at 500 Watts, sufficient to power 12 KITEs or other external devices connected to the CIVCS.

MarCom NT Assembly Wired Enclosure, 60 Slot, Part Number
A 19-inch rack mount drawer containing three rows of twenty slots (sixty total) that accept VME 3U format MarCom NT CCAs or PWAs in various combinations dependent upon specific system requirements.

MarCom NT Assembly Wired Enclosure, 20 Slot
A 19-inch rack mount drawer containing a single row of twenty slots that accept VME 3U format MarCom NT CCAs or PWAs in various combinations dependent upon specific system requirements.

MarCom Fabricated Equipment Rack
A standard 19” rack console cabinet of nominal 72” height used for housing MarCom Switches, network terminations, power supplies, circuit breaker and other control panels. Assemblies are mounted in the cabinet as required for each system delivered.

Ethernet Switch Assembly
A 19-inch by 3.5-inch high rack mount drawer that provides the interface link between the SAT and the Common Controller PWAs in the IVCS/CIVCS Switch or BBS within the IVCS. It also provides the interface link between the SPS and the Alarm Panel.

Alarm Panel Assembly
Two versions of the alarm panel are available to report alarms within the MarCom system alerting users of minor and major faults and requiring subsequent acknowledgement of faults reported. The assembly provides audio and visual alerts and maybe mounted in the rack door or at other locations desired by the user.

SYSTEM POWER EQUIPMENT

System Power Supply (SPS)
A 19-inch rack mounted nominal 2000 watt rugged power supply assembly that converts 450 VAC 3 phase (Delta) connected shipboard power to the +24VDC and –48VDC needed by the typical MarCom IVCS switch applications. When used with the associated Battery Rack, the SPS will provide sufficient back up power to keep the MarCom IVCS operational for a minimum of 60 minutes after loss of primary power. Rugged unit construction is qualified to military grade shock and vibration requirements in operational environments of 0° to 50°C and 95% non-condensing relative humidity. Three Power Modules, in the SPS provide redundant architecture with shared operation allowing for hot swap maintenance capability under nominal output loads.

Power Module
Power Module replacement for the SPS. Three required per system.

Battery Assembly
A freestanding rack of six low-maintenance emergency backup batteries typically used in conjunction with the SPS. It supplies emergency +24VDC and –48VDC power to sustain system operation in the event primary power is lost to the SPS. It will provide an hour or more of backup power, depending on the IVCS configuration.

COTS System Power Supply
A commercial-off-the-shelf (COTS) complete power supply typically used with MarCom Compact IVCS or other smaller MarCom system applications. Converts 115 VAC, 60 Hz input power to +24 VDC and —48 VDC at 1,250 watts.

9-U FORMAT S/T CONFIGURATION INTERFACES, CIRCUIT CARD ASSEMBLIES (CCAs) AND PRINTED WIRING ASSEMBLIES (PWAs)

Common Controller PWA
The Common Controller (CC) is a full height VME 9U format PWA that performs system administrative functions and call processing in the IVCS Switch in slots 19 (primary) and 20 (secondary). When used in pairs, they ensure uninterrupted control and communications (redundant back-up) and permit the hot changeover of CC PWAs without the interruption of system functions.

BRI S/T Interface
The Basic Rate Interface (BRI) S/T Interface provides ISDN signal processing for up to 24 BRI S/T digital ports in two configurations: BRI S/T Interface with Power and BRI S/T Interface without Power. The BRI S/T Interface with Power is made up of the S/T Interface CCA and a BRI Input/Output and Power Distribution CCA (BRI I/O & PD CCA. The BRI S/T Interface without Power is made up of the S/T Interface CCA and an I/O Connector Printed Wiring Assembly (PWA).

S/T Interface CCA
The S/T Interface CCA, a full height VME 9U format S/T configuration basic rate processing card, provides 24 ISDN port for performing audio and control signal switching between user devices and the switch backplane TDM. Permits unlimited conferencing, for all channels, while supporting both µ-Law and A-Law based devices (user selected via the SAT).

BRI I/O & PD CCA

The BRI I/O & PD PWA, a half height VME 9U format interface card, operates with a S/T Interface CCA when power to the remote S/T devices is provided via the IVCS Switch.

I/O Connector PWA

The I/O Connector PWA, a half height VME 9U format interface card, operates with the S/T Interface CCA when a main distribution frame (MDF) distributes power to the remote S/T devices.

POTS/Analog Trunk Interface

The Plain Old Telephone (POTS)/Analog Trunk Interface provides connections for up to 16 analog telephones or 16 analog trunks that are required to interface with the digital networks in the MarCom IVCS. The interface is made up of the POTS Interface CCA, and the POTS Input/Output (I/O) CCA.

POTS Interface CCA

The POTS Interface CCA, a full height VME 9U format card, provides up to 16 ports for two wire analog devices (telephones, fax machines) or analog switch systems (loop start ring down (LS/RD)) shorelines. You can have any mix of POTS or analog trunks adding up to 16.

POTS I/O CCA

The POTS I/O CCA, a half height VME 9U format interface card, operates wit the POTS Interface CCA to provide connectivity to external analog devices (telephones, fax machines) or analog trunks.

Digital Trunk Interface

The Digital Trunk Interface provides primary trunk digital interfaces between the MarCom IVCS and external E1/T1 Digital/ISDN switches and Internodal Trunking between IVCS Switches within the system. The interface is made up of the Trunk Interface CCA, and the Trunk I/O CCA.

Trunk Interface CCA

The Trunk Interface CCA, a full height VME 9U format card, provides processing for three ISDN PRI E1/T1 ports that uses the same conferencing port control FPGA as the S/T Interface CCA and a fiber optic Internodal Port. The Internodal Port provides a non-blocking interface between system IVCS Switches or nodes (for multi node systems) while performing interface and control of G-Link transmitter and receiver (located on the Trunk I/O CCA).

Trunk I/O CCA

The Trunk I/O CCA, a half height VME 9U format interface card, operates with a Trunk Interface CCA to provide connectivity to external ISDN/digital systems or switches and other IVCS Switches.

3-U FORMAT S/T CONFIGURATION INTERFACES, CIRCUIT CARD ASSEMBLIES (CCAs) AND PRINTED WIRING ASSEMBLIES (PWAs)

Analog NT Interface

The Analog NT Interface provides signal processing between the MarCom IVCS Switch and external analog/audio circuits. The interface is made of an Analog Network Termination (NT) CCA and a Common NT I/O CCA.

Analog NT CCA

The Analog NT CCA, a full-height VME 3U format card, provides analog-to-digital (A/D) and digital-to-analog (D/A) processing between digital signals within the IVCS Switch and analog signals used by radios, crypto devices and similar devices connected to the switch. This board serves as an adapter to do the conversion between ISDN BRI electrical interfaces/protocols and the appropriate analog interfaces. The Analog NT CCA is normally installed in a NT Drawer but may be installed in an IVCS or CIVCS Switch when mounted in a paired assembly.

Common NT I/O CCA

The Common NT I/O CCA, a half height VME 3U card, provides the interface between an Analog NT CCA in the IVCS and external analog devices. The Common NT I/O CCA is normally installed in a NT Drawer but may be installed in an IVCS or CIVCS Switch when mounted in a paired assembly.

IADS Interface

The Integrated Audio Distribution System (IADS) Interface provides an analog interface between existing AN/STC-2 audio systems (ON-201) and other analog or digital systems connected to the MarCom IVCS. The interface is made up of an Integrated Audio Distribution System Interface CCA and a Common NT I/O CCA.

Integrated Audio Distribution System Interface CCA

The Integrated Audio Distribution System Interface CCA is commonly called the IADS CCA. The IADS CCA a full height VME 3U format card provides the processing of signals between the IVCS Switch and the ON-201 secure voice system (SVS). This board serves as an adapter to do the conversion between ISDN BRI electrical interfaces/protocols and the appropriate analog interfaces. The IADS CCA is normally installed in a NT Drawer but may be installed in an IVCS or CIVCS Switch when mounted in a paired assembly.

Common NT I/O CCA
The Common I/O CCA, a half-height VME 3U card, provides the interface between an IADS CCA in the IVCS and external analog devices. The Common I/O CCA is normally installed in a NT Drawer but may be installed in an IVCS or CIVCS Switch when mounted in a paired assembly.

Jackbox NT Interface
The Jackbox NT Interface provides an interface between the MarCom IVCS and shipboard Jackbox Networks and is made up of a Jackbox/Sound Powered NT CCA and a Jackbox NT I/O CCA.

Jackbox/Sound Powered NT CCA
The Jackbox/Sound Powered NT CCA is commonly called the JB/SP NT CCA. The JB/SP NT CCA is a VME 3U format card that provides the processing of analog signals for the Navy Jackbox terminals. This board serves as an adapter to do the conversion between ISDN BRI electrical interfaces/protocols and the appropriate analog interfaces. The JB/SP NT CCA is normally installed in a NT Drawer but may be installed in an IVCS or CIVCS Switch when mounted in a paired assembly.

Jackbox NT I/O CCA
The Jackbox I/O CCA, a half height VME 3U card, provides the interface between a JB/SP NT CCA and external Jackbox Terminals. The Jackbox NT I/O CCA is normally installed in a NT Drawer but may be installed in an IVCS or CIVCS Switch when mounted in a paired assembly.

Sound Powered NT Interface
The Sound Powered NT Interface provides an interface between the MarCom IVCS and shipboard sound powered telephone systems and is made up of a Jackbox/Sound Powered NT CCA, and a Common NT I/O CCA.

Jackbox/Sound Powered NT CCA
The Jackbox I/O CCA, a half height VME 3U card, provides the interface between a JB/SP NT CCA and external sound powered analog devices/circuits. The Jackbox NT I/O CCA is normally installed in a NT Drawer but may be installed in an IVCS or CIVCS Switch when mounted in a paired assembly.

Common NT I/O CCA
The Common NT I/O CCA, a half height VME 3U card, provides the interface between the SP/JB NT CCA in the IVCS and external sound powered analog devices. The Common NT I/O CCA is normally installed in a NT Drawer but may be installed in an IVCS or CIVCS Switch when mounted in a paired assembly.

PAIRED NT AND PAIRED NT I/O ASSEMBLIES

The Paired NT Assembly and Paired NT I/O Assembly are 9U format frame assemblies that adapt the 3U format NT circuit cards for use in the 9U format IVCS or Compact IVCS (CIVCS) switches.

The Paired NT Assemblies series, consist of a full-height 9U format mechanical mounting and one or two full-height 3U format circuit cards that are mounted therein to perform specific processing functions in a MarCom IVCS.

The Paired NT I/O Assemblies consist of a half-height 9U format mechanical mounting and one or two half-height 3U format circuit cards that are mounted therein to provide specific input/output capabilities in a MarCom IVCS.

Paired NT Assemblies

Jackbox/Sound Powered – Jackbox/Sound Powered Paired NT Assembly

The Jackbox/Sound Powered – Jackbox/Sound Powered Paired NT Assembly is comprised of two Jackbox/Sound Powered NT CCAs (A2 & A3) mounted in a full height VME 9U mechanical form for use in a MarCom IVCS/CIVCS Switch. This assembly is used with the Jackbox/Jackbox Paired NT I/O Assembly.

Integrated Audio Distribution System — Jackbox/Sound Powered Paired NT Assembly

The Integrated Audio Distribution System — Jackbox/Sound Powered Paired NT Assembly is comprised of an Integrated Audio Distribution System Interface CCA (A2) and a Jackbox/Sound Powered NT CCA (A3) mounted in a full height VME 9U mechanical form for use in a MarCom IVCS/CIVCS Switch. This assembly is used with the Common – Jackbox Paired NT I/O Assembly.

Analog – Jackbox/Sound Powered Paired NT Assembly

The Analog – Jackbox/Sound Powered Paired NT Assembly is comprised of an Analog NT CCA (A2) and a Jackbox/Sound Powered NT CCA (A3) mounted in a full height VME 9U mechanical form for use in a MarCom IVCS/CIVCS Switch. This assembly is used with the Common – Jackbox Paired NT I/O Assembly.

Integrated Audio Distribution System — Integrated Audio Distribution System Paired NT Assembly

The Integrated Audio Distribution System — Integrated Audio Distribution System Paired NT Assembly is comprised of two Integrated Audio Distribution System Interface CCAs (A2 & A3) mounted in a full height VME 9U mechanical form for use in a MarCom IVCS/CIVCS Switch. This assembly is used with the Common – Common Paired NT I/O Assembly.

Integrated Audio Distribution System — Analog Paired NT Assembly
The Integrated Audio Distribution System — Analog Paired NT Assembly is comprised of an Integrated Audio Distribution System Interface CCA (A2) and an Analog NT CCA (A3) mounted in a full height VME 9U mechanical form for used in a MarCom IVCS or CIVCS Switch. This assembly is used with the Common – Common Paired NT I/O Assembly.

Analog — Analog Paired NT Assembly
The Analog – Analog Paired NT Assembly is comprised of two Analog NT CCAs (A2 & A3) mounted in a full height VME 9U mechanical form for use in a MarCom IVCS or CIVCS Switch. This assembly is used with the Common – Common Paired NT I/O Assembly.

Blank — Jackbox/Sound Paired NT Assembly
The Jackbox/Sound Powered – Blank Paired NT Assembly is a Jackbox/Sound Powered NT CCA (A3) mounted in a full height VME 9U mechanical form for use in a MarCom IVCS or CIVCS Switch. This assembly is used with the Blank - Jackbox NT I/O Assembly.

Blank — Integrated Audio Distribution System Paired NT Assembly
The Integrated Audio Distribution System – Blank Paired NT Assembly is an Integrated Audio Distribution System Interface CCA (A3) mounted in a full height VME 9U mechanical form for use in a MarCom IVCS or CIVCS Switch. This assembly is used with the Blank - Common Paired NT I/O Assembly.

Blank — Analog Paired NT Assembly
The Analog – Blank Paired NT Assembly is an Analog NT CCA (A3) mounted in a full height VME 9U mechanical form for use in a MarCom IVCS or CIVCS Switch. This assembly is used with the Blank - Common Paired NT I/O Assembly.

Paired NT I/O Assemblies

Jackbox – Jackbox Paired NT I/O Assembly
The Jackbox – Jackbox Paired NT I/O Assembly is comprised of two Jackbox NT I/O CCAs (A2 & A3) mounted in a half-height VME 9U mechanical form for use in a MarCom IVCS or CIVCS Switch. This assembly is used with the Jackbox/Sound Powered – Jackbox/Sound Powered Paired NT Assembly.

Common – Jackbox Paired NT I/O Assembly
The Common – Jackbox Paired NT I/O Assembly is comprised of a Common NT I/O CCA (A2) and a Jackbox NT I/O CCA (A3) mounted in a half-height VME 9U mechanical form for use in a MarCom IVCS or CIVCS Switch. This assembly is used with the Integrated Audio Distribution System – Jackbox/Sound Powered Paired NT Assembly or the Analog – Jackbox/Sound Powered Paired NT Assembly.

Common - Common Paired NT I/O Assembly
The Common – Common Paired NT I/O Assembly is comprised of two Common NT I/O CCAs (A2 & A3) mounted in a half-height VME 9U mechanical form for use in a MarCom IVCS or CIVCS Switch. This assembly is used with the Integrated Audio Distribution System – Integrated Audio Distribution System Paired NT Assembly the Integrated Audio Distribution System – Analog Paired NT Assembly and the Analog – Analog Paired NT Assembly.

Blank - Jackbox Paired NT I/O Assembly
The Jackbox – Blank Paired NT I/O Assembly is a Jackbox NT I/O CCA (A3) mounted in a half-height VME 9U mechanical form for use in a MarCom IVCS or CIVCS Switch. This assembly is used with the Jackbox/Sound Powered – Blank Paired NT Assembly.

Blank - Common Paired NT I/O Assembly
The Common – Blank Paired NT I/O Assembly is a Common NT I/O CCA (A3) mounted in a half-height VME 9U mechanical form for use in a MarCom IVCS or CIVCS Switch. This assembly is used with the Integrated Audio Distribution System – Blank NT Assembly and the Analog – Blank Paired NT Assembly.

SYSTEM ADMINISTRATION

COTS System Administration Terminal (SAT)
The SAT is the human-machine interface for system configuration data entry, system configuration reports, system status reports and failure alerts. The SAT is a standard commercial-off-the-shelf (COTS) laptop personal computer running the Microsoft XP operating system, Microsoft Windows and MarCom system administration software application. The SAT is used to program the IVCS/CIVCS Common Controller PWAs, KITEs and manages system numbering plans, conference definitions, radio circuits, sound powered nets, announcing interfaces, and trunk configurations.

Rugged System Administration Terminal (SAT)
A ruggedized standard Microsoft Windows based PC performing all of the same functions as the COTS SAT. Special features include dual AC input power compatible (110/220VAC), a backlit keyboard and a docking station.

MARCOM TERMINALS AND TELEPHONES

Keyswitch Integrated Terminal Equipment (KITE)

The KITE is an efficient, programmable user interface to the MarCom system that replaces legacy terminals used for radio communications (plain and secure), sound powered telephones, shipboard telephones, call stations, and announcing systems. Four mounting options are available: Bezel (Model V3M1), Bulkhead (Model V3M2), Adjustable (V3M3), and Environmental (Model V3M4).

Model V3M1, Bezel (Console) Mount

This model in used in an operator's console or other similar mounting needs. The interface connectors penetrate the back of the enclosure. Two versions of the Bezel mount are available:

KITE Model V3M1-24

The V3M1-24 is intended for use in +24 VDC, single homed systems. It can be used in dual homed systems by adding an external junction box to terminate the switches and provide a feed to the KITE.

KITE Model V3M1-24/48

The V3M1-24/48 is intended for use in –48 VDC, dual homed systems. It can also be used in –48 VDC single homed systems, or in +24 VDC single or dual homed systems. Both switches can be connected directly to the KITE.

Model V3M2, Bulkhead Mount

This model is primarily mounted on a bulkhead or wall but may also be mounted on any vertical or horizontal surface. When the enclosure is directly mounted to the bulkhead or other surface, the front panel is presented at a 10° angle. When attached to the C3IT Bulkhead Mounting Plate and then mounted, the front panel is presented at a 20° angle. The mounting footprint is the same as the MT-866i ISDN terminal. The interface connectors penetrate the top of the enclosure. Two versions of the Bulkhead Mount are available.

KITE Model V3M2-24, Bulkhead Mount (C3IT)

The V3M2-24 is intended to use in +24 VDC, single homed systems. It can be used in dual homed systems by adding an external junction box to terminate the switches and provide a feed to the KITE.

KITE Model V3M2-24/48, Bulkhead Mount

The V3M2-24/48 is intended to use in -48 VDC, dual homed systems. It can be used in –48 VDC single homed systems, or in +24 VDC single or dual homed systems. Both switches can be connected directly to the KITE.

KITE Model V3M3, Adjustable Mount

When available, this model is intended for mounting on a bulkhead or wall at or just above eye level. The mount allows the KITE to swivel 45° both horizontally and vertically. The interface connectors penetrate the back of the enclosure. Two versions (V3M3-24 and V3M3-24/48) will be available.

Environmental KITE, Model V3M4-24/48

The Environmental KITE (E-KITE) V3M4-24/48 provides a weather proof housing that is normally mounted in exterior environment or any area where an excessively high humidity condition exists. The housing is mounted on a bulkhead, at eye level. It contains a heating element, a circulation fan and temperature control circuits. The interface connectors penetrate the bottom of the enclosure. The Topside Mount KITE is intended to use in -48 VDC, dual homed systems. It can be used in –48 VDC single homed systems, or in +24 VDC single or dual homed systems.

JACK BOX TERMINALS

Jack Box Terminal, Model TA-1002

A low cost, hardened single-circuit (no dialing) terminal typically linked together in “meet-me” nets. Required 24 VDC input power for function.

Jack Box Terminal, Model TA-1002A

An EMI shielded version of the Jack Box Terminal, Model TA-1002. It provides a hardened single-circuit (no dialing) terminal, typically linked together in “meet-me” nets. Required 24 VDC input power for function.

TELEPHONES

Rugged ISDN Terminal, Model MT-866I

A standard, Class A, 16-button, ISDN line terminal for administrative and normal operational use. The terminal permits a single channel connection to all MarCom circuits authorized and unclassified networks using a standard IDSN BRI S/T interface.

Automatic Dial Terminal, Model MT-997I

A standard, Class A, 16-button ISDN line terminal for administrative and normal operational use. Similar to MT-866I terminal except with an integrated loudspeaker capable of being activated automatically providing hands-free operational capability.

POTS Telephone, Model 6221

A COTS analog voice telephone using standard POTS loop start signaling interface protocol. Includes speakerphone functionally and standard handset.

Rugged POTS Telephone, Model 6221

A ruggedized version of the Model 6221 POTS Telephone with a standard handset.

Rugged POTS Telephone with PTE Handset, Model 6221

A ruggedized version of the Model 6221 POTS Telephone with a PTE (Push To Enable) handset.

ISDN Telephone, Model i2021

A COTS, multi-featured, ISDN voice telephone terminal using the standard ISDN BRI S/T interface. Functions as a normal telephone or as a semi-duplex speakerphone for complete hands-free operation. Features include a liquid crystal display, 16 programmable call appearance/function buttons and a standard handset.

Ruggedized ISDN Telephone, Model i2021

A ruggedized version of the ISDN telephone with a standard handset featuring a stainless steel armored enclosure, a heavy duty mounting base plate and handset retention bracket.

Ruggedized ISDN Telephone with PTE Handset, Model i2021

Same as the Ruggedized ISDN telephone with a PTE (Push To Enable) handset.

Enhanced ISDN Telephone, Model i2022

A COTS, multi-featured, ISDN voice telephone terminal using the standard ISDN BRI S/T interface. Functions as a normal telephone or as a semi-duplex speakerphone for complete hands-free operation. Also may be used with a user provided headset for hands-free operation. Features include a larger liquid crystal display, 32 programmable call appearance/function buttons and standard handset.

Ruggedized Enhanced ISDN Telephone, Model i2022

A ruggedized version of the Enhanced ISDN telephone with a standard handset featuring a stainless steel armored enclosure, a heavy duty mounting base plate and a handset retention bracket.

Ruggedized Enhanced ISDN Telephone with PTE Handset, Model i2022
Same as the Ruggedized Enhanced ISDN telephone with a PTE (Push To Enable) handset.

LOUDSPEAKERS, INTERCOMS

Intercom/loudspeaker, Model LS-613A
An Intercommunication Station used for interior communications that interfaces with MarCom via the Analog NT Interface. It is comprised of a loudspeaker, a Talk/Listen/Off switch and a Volume Control.

Intercom/loudspeaker, Model LS-614A
Same as the LS-613A but in addition it provides "Hands Free" operation.

Intercom/loudspeaker, Model LS-1010
A remote 12-Watt loudspeaker unit used with a KITE. It requires a separate +24 VDC supply.

MARCOM OPERATOR INTERFACE EQUIPMENT

HEADSETS

Headset, Binaural, Noise Canceling, Model SK-7853
Binaural headset with boom microphone, equipped with a Lemo connector for use with a KITE.

Headset, Model H-320/U
Monaural headset with two earpieces, a boom microphone and fitted with a U-77/U connector. Used with the MT-866i (and similar) ISDN telephone.

Headset, Lightweight, Single Earpiece, Model SDS1040-02
A lightweight monaural headset with a single earpiece, a boom microphone and fitted with a Lemo connector for use with the KITE.

Headset, Lightweight, Binaural, Model SDS1031-05
A lightweight, binaural headset with two earpieces, a boom microphone and fitted with a Lemo connector for use with the KITE.

Headset, Lightweight, Single Earpiece, Model SDS1022-05
A lightweight, monaural headset with a single earpiece, a boom microphone and fitted with a Plantronics Quick Disconnect (QD) connector. Used with the MT-866i (and similar) ISDN telephone. Use with PTT assembly.

Headset, Lightweight, Dual Earpiece, Model SDS1041-01
A lightweight, monaural headset with two earpieces, a boom microphone and fitted with a Plantronics Quick Disconnect (QD) connector. Used with the MT-866i (and similar) ISDN telephone. Use with PTT assembly.

Headset, Lightweight, Starset with Eartip, Model 90169-01
A lightweight, monaural headset with a single Eartip, a boom microphone and fitted with a Plantronics Quick Disconnect (QD) connector. Used with the MT-866i (and similar) ISDN telephone. Use with PTT assembly.

Headset, Assembly, Model SDS2237-01
A line cord assembly containing a Push-To-Talk (PTT) switch, a Plantronics Quick Disconnect (QD) connector on one end and a U-77/U connector on the other. Use with headsets and the MT-866i (and similar) ISDN telephone.

Headset, Lightweight, Single Earpiece with Adapter
A lightweight headset with a single earpiece with a 3.5mm plug to 2.5mm plug adapter cable and Plantronics Quick Disconnect (QD) connectors. Can be used with the i2022 ISDN telephones. This headset may be used with the PTT assembly if a Push-To-Talk (PTT) capability is needed.

Headset, Lightweight, Dual Earpiece without Adapter
A lightweight headset with two earpieces and a mike fitted with a Plantronics Quick Disconnect (QD) connector. Can be used with the i2022 ISDN telephones. This headset is used in conjunction with a 3.5mm to 2.5mm plug adapter cable. It can also used with a PTT assembly if a Push-To-Talk (PTT) capability is needed.

Headset, Push-To-Talk Assembly, Model SSP1051-03
A Push-To-Talk (PTT) assembly fitted with Plantronics Quick Disconnect (QD) connectors on both ends. Can be used with the i2022 ISDN telephones. This headset PTT assembly is used in conjunction with Telephone Headsets.

Headset, Adapter Cable, Model SSP40288-01
A 3.5mm to 2.5mm plug adapter cable for i2022 ISDN telephone applications. This adapter cable is used in conjunction with the Telephone Headset Push-To-Talk assembly and with Telephone Headset.

Headset, Medium Duty, Monaural, Model SHR2262-01
A medium duty, single earpiece, monaural headset with an integral boom microphone fitted with a Lemo connector for use with KITEs.

Headset, Medium Duty, Binaural, Model SHR2263-01
A medium duty, dual earpiece, monaural headset with an integral boom microphone fitted with a Lemo connector for use with KITEs.

HANDSETS

Handset with Push-to-Talk
Monaural handset with Push-to-Talk (PTT) button and fitted with a Lemo connector for use with the KITE.

Handset, Model H-319/U
Monaural handset with Push-to-Talk (PTT) button and fitted with a U-77/U connector for use with the MT-866i terminal.

Handset Hanger Bracket
Handset hanger bracket for KITE handsets that may be panel or bulkhead mounted.

MICROPHONES

Microphone, Handheld, Type 519
Handheld audio microphone with Lemo Connector for KITE applications

Microphone, Handheld, Type 519
Handheld audio microphone with U-77/U Connector for MT-866i terminal applications

Hand Microphone Bracket
Mounting bracket for Type 519 handheld microphones.

MISCELLANEOUS OPERATOR INTERFACE EQUIPMENT

Microphone Footswitch
A PTT footswitch, with integral cable, used with the KITE to activate the internal microphone.

MARCOM MAINTENANCE/REPAIR KITS

Maintenance/Repair Kit, MarCom IVCS Switch Wired Enclosure Assembly

Kit includes all standard consumable hardware that may be needed by the user during periodic switch overhaul and rehab maintenance functions. Generic repair kits typically include fuses, bulbs, fastening hardware, gaskets, labels and tags, cleaning solution with accompanying instructions. Kit is not for operational troubleshooting.

Maintenance/Repair Kit, MarCom CIVCS Switch Wired Enclosure Assembly

Kit includes all standard consumable hardware that may be needed by the user during periodic switch overhaul and rehab maintenance functions. Generic repair kits typically include fuses, bulbs, fastening hardware, gaskets, labels and tags, cleaning solution with accompanying instructions. Kit is not for operational troubleshooting.

Maintenance/Repair Kit, MarCom NT Assembly Wired Enclosure

Kit includes all standard consumable hardware that may be needed by the used during periodic switch overhaul and rehab maintenance functions. Generic repair kits typically include fuses, bulbs, fastening hardware, gaskets, labels and tags, cleaning solution with accompanying instructions. Kit is not for operational troubleshooting.

Maintenance/Repair Kit, MarCom SPS

Kit includes all standard consumable hardware that may be needed by the used during periodic overhaul and rehab maintenance functions. Generic repair kits typically include fuses, bulbs, fastening hardware, gaskets, labels and tags, cleaning solution with accompanying instructions. Kit is not for operational troubleshooting.

Maintenance/Repair Kit, SPS Battery Rack

Kit includes all standard consumable hardware that may be needed by the used during periodic switch overhaul and rehab maintenance functions. Generic repair kits typically include fuses, bulbs, fastening hardware, gaskets, labels and tags, cleaning solution with accompanying instructions. Kit is not for operational troubleshooting.

Maintenance/Repair Kit, Alarm Panel Assembly

Kit includes all standard consumable hardware that may be needed by the used during periodic switch overhaul and rehab maintenance functions. Generic repair kits typically include fuses, bulbs, fastening hardware, gaskets, labels and tags, cleaning solution with accompanying instructions. Kit is not for operational troubleshooting.

Maintenance/Repair Kit, KITE

Kit includes all standard consumable hardware that may be needed by the used during periodic switch overhaul and rehab maintenance functions. Generic repair kits typically include fuses, bulbs, fastening hardware, gaskets, labels and tags, cleaning solution with accompanying instructions. Kit is not for operational troubleshooting.

Maintenance/Repair Kit, BBS

Kit includes all standard consumable hardware that may be needed by the used during periodic switch overhaul and rehab maintenance functions. Generic repair kits typically include fuses, bulbs, fastening hardware, gaskets, labels and tags, cleaning solution with accompanying instructions. Kit is not for operational troubleshooting.

6.5.10 TERMS, ACRONYMS AND ABBREVIATIONS

Special terms used within this section are listed in Table 6-13.

Term	Meaning
Add-on Conference	Also known as "Progressive Conference" - The ability to add additional stations one at a time, often up to a particular limit, to an existing connection.
Auto-answer	A phone that automatically answers when called without a physical response from the called party. An auto-answer phone can also be hot-miked allowing eavesdropping.
Binaural audio	The ability to direct the audio from different circuits to the left and right ears, independently.
Blocking	A call is blocked when there are insufficient switching resources to connect a called station to a calling station even when the called station is not busy. This usually happens when the trunks between multiple switch nodes are all busy with other calls.
Dual Homed	A dual homed KITE/C3IT is one that is connected to two switches (Nodes) to provide automatic backup operation if one of the switches fails.
Executive Break-in	The ability to over-ride a busy signal to make a one-way announcement.
Full-duplex channel	A communications channel that can send signals in both directions at the same time.
Half-duplex channel	A communications channel that can send signals in both directions, but not at the same time.
Hands-free operation	Usually means auto-answer and hot miked. (Then the called party does not have to drop what they are doing to answer the call). Sometimes the called station's mike is controlled by the PTT switch in the caller's station. (Useful in high noise areas.)
Hot-line	A phone line that always dials a single pre-determined number when the phone is taken off-hook.
Hot-miked	An open phone connection that does not require a physical push to talk action before the voice is transmitted to the other end of the connection. Usually used in a full-duplex channel.

Table 6-13.—Definition of Terms.

Term	Meaning
Intercom	One-button, never-busy, non-blocking, direct access to another station, usually auto-answer.
Interphone	Multi-digit dial or one button speed dial through a PABX to another station. The destination station may be busy with another call, and then the PABX will return a busy signal to the caller.
Meet-me Net	A circuit that is created when the first party dials into it and is torn down when the last party leaves it. When additional parties call into the conference by dialing the same net number, they are directly connected.
Multi-channel monitor	The ability to monitor (listen to) multiple circuits simultaneously. The local user's audio is not returned to the circuits being monitored.
Never-busy	The ability to connect the caller's audio to the called station received audio, independent of other active connections to the called station.
Pre-set Conference	All members of the specific pre-set conference dialed are called to the conference by the normal ringing of their stations. They are directly connected when they answer. The members of a particular conference are predetermined by the system administrator.
Progressive Conference	Also known as "Add-on Conference" - The ability to add additional stations one at a time, often up to a particular limit, to an existing connection.
Progressive Over-ride	The ability to over-ride a busy signal to make full two-way connection. The existing connections could be bridged (also connected in) or abandoned (disconnected). Systems usually abandon calls and usually the abandoned party is given a tone signal to indicate the break-in.
Restriction and Class Marks	Control data entered by the system administrator and checked by the switch before each connection is made, which prohibits connections between particular stations or trunks. Class marks also enable features.
Single Homed	A single homed KITE/C3IT is one that is connected to only one switch (Node) and has no automatic backup capability.
Speakerphone	A telephone that uses a loudspeaker and microphone as the user interface, and incorporates a VOX circuit to disable the loudspeaker when local acoustic energy is supplied to the microphone. The VOX prevents feedback oscillations known as "singing."
Speed dial	Convenient telephone access via a single button for frequently called numbers by stored multi-digit destination codes.
VOX (Voice Operated Switch)	An electronically operated switch, activated by an audio signal, that takes control of and sends that audio on a half-duplex channel.

Table 6-13(Cont'd).—Definition of Terms.

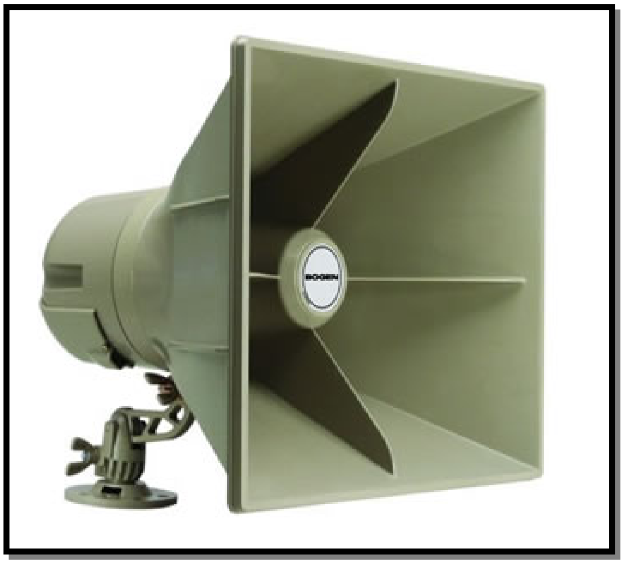
6.5.11 SUMMARY

In this chapter, we have discussed the purpose of the automatic dial telephone system, IVN, IVCS, and MARCOM IVCS. We have explained how the type G telephone sets used with the system operate and how they are maintained. We have also identified some of the more common troubles associated with the telephone sets and the procedures for correcting the troubles.

We have discussed the functions of the automatic dial telephone switchboards and identified the various switchboards and the automatic switching equipment used in the switchboards. We have described the function of the attendant's cabinet used with the switchboards. We have also discussed the various alarms associated with the switchboards and the procedures for isolating and clearing these alarms.

We have discussed some of the procedures used in performing preventive maintenance on the switchboard and the attendant's cabinet, and we have discussed shore lines and how they are connected to the system.

7 AMPLIFIED VOICE SYSTEMS



Upon completion of this chapter, you will be able to do the following:

- Explain the purpose of amplified voice systems installed on Navy ships.
- Identify the various types of amplified voice systems.
- Identify the various announcing system circuits by their designations.
- Describe the types and characteristics of microphones and loudspeakers.
- Describe the components, operation, and maintenance procedures of a central amplifier system (one-way) and the additional sound equipment used with the system.
- Describe the components, operation, and maintenance procedures of a central amplifier system (two-way) and the additional sound equipment used with the system.
- Describe the components, operation, and maintenance procedures of the intercommunication systems and the additional sound equipment used with the systems.
- Briefly describe the integrated intercommunication system used on Navy submarines.
- Identify the types of public address sets and describe the components, operation, and maintenance procedures of the public address sets.

7.0.0 INTRODUCTION

If you should look for the source of a sound, you will find that something had been set in vibratory motion. It may be that someone shouted or struck or dropped an object. In each case something vibrated and caused the sensation of sound. One sound that human beings produce is voice. Although air is the usual medium for carrying voice to your ears, any elastic material in the form of a solid, liquid, or gas can serve as well or better. Like any other sound, voice cannot travel in a vacuum.

In today's Navy, amplified voice systems amplify and transmit the voice so it can reach and be heard by the personnel aboard ship. With these systems, which are the heart of interior communications, the "word" is passed quickly and clearly.

Several types of amplified voice systems are installed in most ships. These types include the following:

- Central amplifier systems that provide one-way communications
- Central amplifier systems that provide two-way communications
- Intercommunication systems that provide two-way communications between selected stations
- Integrated intercommunication systems that provide both central amplifier and intercommunication systems
- Portable public address systems

Circuit	System	Importance	Readiness Class
*1MC	General	V	1
*2MC	Propulsion plant	V	1
*3MC	Aviators'	V	1
4MC	Damage Control	V	1
*5MC	Flight Deck	SV	2
*6MC	Inter-ship	SV	1
*7MC	Submarine Control	V	1
8MC	Troop administration and control	SV	2
*9MC	Underwater troop communication	SV	2
*10MC	Dock Control (obsolete)	SV	1
*11-16MC	Turret (obsolescent)	SV	3
*17MC	Double Purpose Battery (obsolescent)	SV	3
18MC	Bridge	NV	2
19MC	Aviation Control	SV	2
*20MC	Combat Information (obsolescent)	SV	1
21MC	Captain's Command	SV	1
22MC	Electronic Control	NV	1
23MC	Electrical control	SV	1
24MC	Flag Command	SV	1
25MC	Ward Room (obsolescent)	NV	4
26MC	Machinery Control	SV	1

27MC	Sonar and Radar Control	SV	1
*28MC	Squadron (obsolescent)	NV	4
*29MC	Sonar Control and Information	SV	2
30MC	Special Weapons	SV	2
31MC	Escape trunk	SV	2
32MC	Weapons control	SV	3
33MC	Gunnery Control (obsolescent)	SV	3
34MC	Lifeboat (obsolescent)	SV	1
35MC	Launcher Captains'	SV	1
36 MC	Cable Control (obsolete)	NV	4
37MC	Special Navigation (obsolete)	SV	2
38MC	Electrical (obsolete)	NV	1
39MC	Cargo Handling	NV	4
40MC	Flag Administrative	NV	1
41MC	Missile Control and Announce (obsolete)	SV	3
42MC	CIC Coordinating	SV	2
43MC	Unassigned		
44MC	Instrumentation Space	NV	1
45MC	Research operations	NV	1

Table 7-1.—Shipboard Announcing Systems

Circuit	System	Importance	Readiness Class
*46MC	Aviation Ordnance and Missile Handling	SV	2
47MC	Torpedo Control	SV	2
48MC	Stores conveyor (obsolescent)	NV	1
49MC	Unassigned		
50MC	Integrated operational intelligence center	SV	2
51MC	Aircraft Maintenance and handling control	SV	2
52MC	Unassigned		
53MC	Ship Administrative	NV	4
54MC	Repair officer's control	NV	4
55MC	Sonar Service	NV	4
56MC	Unassigned		
57MC	Unassigned		
58MC	Hanger Deck Damage Control	V	1
59MC	SAMID Alert	SV	3

* - Central amplifier systems.

Table 7-1(Cont'd).—Shipboard Announcing Systems

Each installed announcing system aboard ship is assigned an IC circuit designation in the MC series. Table 7-1 lists the systems and their circuit designations and the importance and readiness classification for each circuit. These systems, however, are not all installed in any one ship.

In this chapter, we will discuss some of the more common systems that are installed on board ship today and the announcing equipment used with the systems.

7.1.0 Announcing Equipment

All amplified voice systems consist basically of an amplifier, a microphone, and a loudspeaker. The microphone converts the sound energy into electrical energy having the same waveform as the sound energy. The output from the microphone is applied as a signal voltage to the amplifier. The output power from the amplifier has the same waveform as the sound energy that is applied to the microphone. The loudspeaker reconverts the electrical energy from the amplifier into sound energy at a higher volume level than the original sound. In shipboard installations, many loudspeakers are operated from the same amplifier. Each loudspeaker produces sound having the same waveform as the original sound applied to the microphone.

7.1.1 Microphones

A microphone is a device that converts sound energy into electrical energy. All types of microphones have a metal diaphragm that responds to the vibrations of the sound waves, and some means of changing this mechanical vibration into corresponding electrical signals. The most widely used microphones are the (1) magnetic, (2) dynamic, (3) crystal, and (4) carbon types.

7.1.1.1 Magnetic Microphone

The magnetic, or moving-armature, microphone (fig. 7-1) consists of a permanent magnet and a coil of wire, inside of which is a small armature. Sound waves impinging on the diaphragm cause the diaphragm to vibrate. This vibration is transmitted through the drive rod to the armature, which vibrates in a magnetic field, thus changing the magnetic flux through the armature.

When the armature is in its normal position, midway between the two poles, the magnetic flux is established across the air gap with no resultant flux in the armature.

When a compression wave strikes the diaphragm, the armature is deflected to the right. The flux path is directed from the north pole of the magnet across the reduced gap at the upper right, down through the armature, and round to the south pole of the magnet.

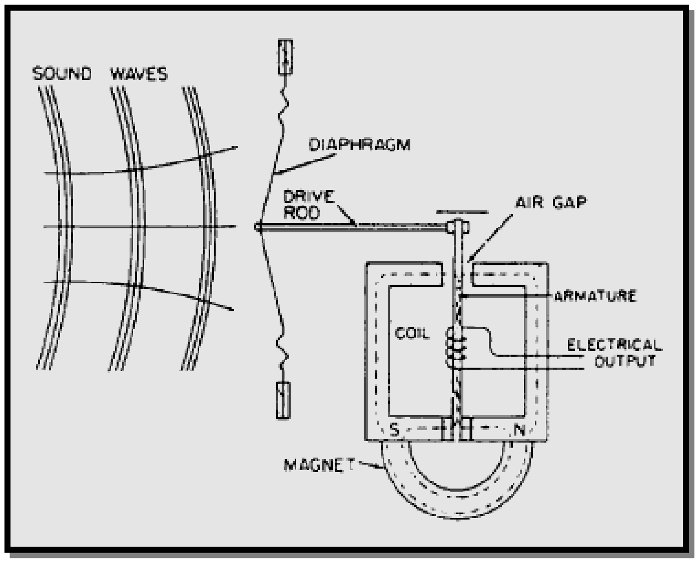


Figure 7-1.—Magnetic Microphone.

When a rarefaction wave strikes the diaphragm, the armature is deflected to the left. The flux path now is directed from the north pole of the magnet, up through the armature through the reduced gap at the upper left, and back to the South Pole.

Thus, the vibrations of the diaphragm cause an alternating flux in the armature. The alternating flux cuts the stationary coil wound around the armature and induces an alternating voltage (approximately 10 millivolts at a 150-ohm load) in it. This voltage has the same waveform as the sound waves striking the diaphragm.

The magnetic microphone is the type most widely used in shipboard amounting and intercommunicating systems because it is more resistant to vibration, shock, and rough handling.

7.1.1.2 Dynamic Microphone
The dynamic, or moving-coil, microphone (fig. 7-2) consists of a coil of wire attached to a diaphragm, and a radial magnetic field in which the coil is free to vibrate. Sound waves impinging on the diaphragm cause the diaphragm to vibrate. This vibration moves the voice coil through the magnetic field so that the turns cut the lines of force in the field. This action generates a voltage in the coil that has the same waveform as the sound waves striking the diaphragm.

The dynamic microphone requires no external voltage source. It has good fidelity and produces an output volt age of about 0.05 volt when spoken into in a normal tone within a few inches of the diaphragm.

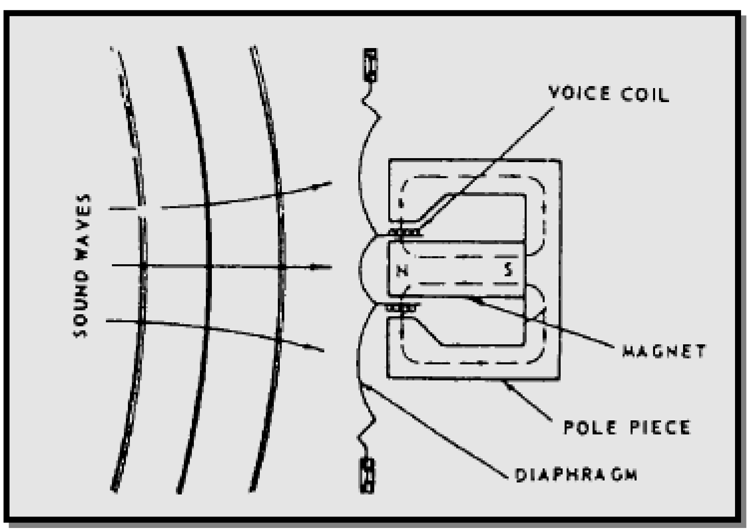


Figure 7-2.—Dynamic Microphone.

7.1.1.3 Crystal Microphone

The crystal microphone utilizes a property of certain crystals, such as quartz, Rochelle salt, sugar, or coal, known as the piezoelectric effect. The bending of the crystal resulting from the pressure of the sound wave produces an electromotive force (emf) across the faces of the crystal. This emf is applied to the input of an amplifier.

The crystal microphone (fig. 7-3) consists of a diaphragm that is cemented to one surface of the crystal. Metal plates, or electrodes, are attached to the other surface of the crystal. When sound waves strike the diaphragm, the vibration of the diaphragm produces a varying pressure on the surface of the crystal and induces an emf across the electrodes. The emf has the same waveform as the sound waves striking the diaphragm.

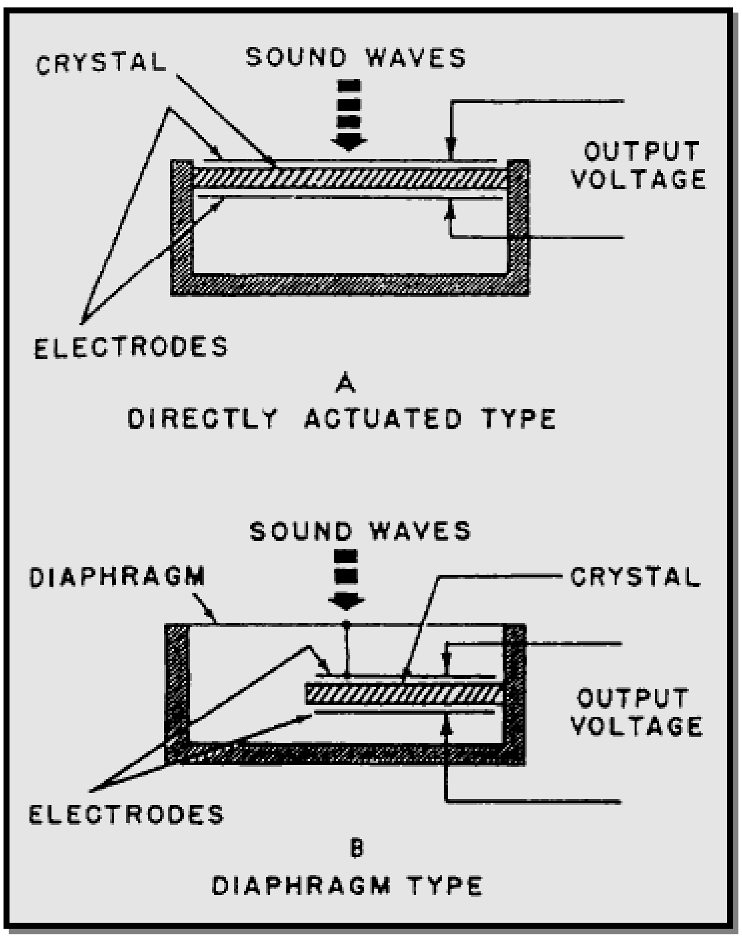


Figure 7-3.—Crystal Microphone.

Rochelle salt is most commonly used in crystal microphones because of its relatively high-voltage output. The crystal microphone can produce an output voltage of from 0.01 to 0.03 volt into a load of 1 megohm or more, when subjected to a sound pressure of a normal tone within a few inches of the crystal. However, this crystal microphone is seldom used in naval announcing and intercommunicating systems because of the sensitivity of the crystal element to high temperature, humidity, and rough handling.

7.1.1.4 Carbon Microphone

The carbon microphone (fig. 7-4) operates on the principle that a changing pressure of a diaphragm applied to a small volume of carbon granules changes its electrical resistance according to the vibrations of the sound waves striking the diaphragm.

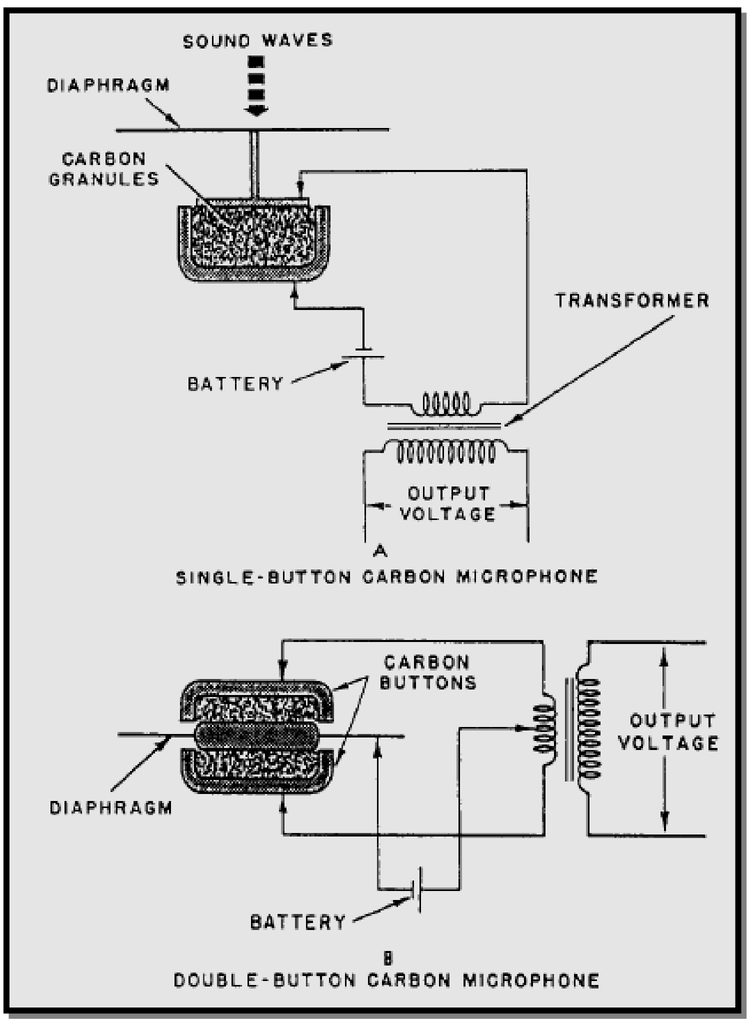


Figure 7-4.—Carbon Microphone.

The carbon microphone consists of a diaphragm mounted against a mass of carbon granules that are contained in a small cup. To produce an output voltage, this microphone is connected in a series circuit containing a battery and the primary of a transformer.

When a direct current follows through the carbon granules, the varying resistance changes the amplitude of the current and produces an alternating voltage in the secondary of the transformer. This voltage has the same waveform as the sound waves striking the diaphragm. The current through this microphone may be as great as 0.1 ampere. The resistance may vary from about 50 to 90 ohms. The voltage developed across the secondary depends upon the ratio of the transformer primary and secondary turns and also upon the change in primary current. Normal output voltage of a typical circuit is from 3 to 10 volts peak at the secondary terminals.

The carbon microphone is not used in shipboard announcing equipment because it requires a polarizing current and has a tendency to amplify certain frequencies more than others.

CHARACTERISTICS OF MICROPHONES

Microphones are rated according to their (1) frequency response, (2) impedance, and (3) sensitivity.

FREQUENCY RESPONSE.— Shipboard announcing and intercommunicating systems are designed to produce maximum speech intelligibility under conditions of high background noise. To achieve this objective, the overall frequency response characteristic of the system is altered by cutting off the system response at some lower limit, such as 500 Hz, and by employing an emphasized frequency response characteristic that rises with increasing frequency at a rate of approximately 6 dB per octave. The output sound pressure is doubled each time the frequency is doubled for a constant level input to the system. The emphasized speech tends to sound thin and sometimes harsh, but when the masking due to background noise is almost as high as the speech level, the speech appears to cut through the noise.

For good quality, a microphone must convert sound waves into electrical waves that have the same relative magnitude and frequency without introducing any new frequencies. The frequency range of the microphone must be at least as wide as the desired overall response limits of the system with which it is used.

Except in the case of the emphasized system in which it may be desirable for the microphone to have a rising frequency-response characteristic, the microphone response should be uniform or flat, within its frequency range, and free from sharp peaks or dips, such as those caused by mechanical resonances.

IMPEDANCE.— Crystal microphones have impedances of several hundred thousand ohms, whereas the magnetic and dynamic microphones have impedances that range from 20 to 600 ohms. The impedance of a microphone is usually measured between its terminals at some arbitrary frequency within the useful range, such as 1000 Hz.

The impedance of magnetic and dynamic microphones varies with frequency in much the same manner as that of any coil or inductance; that is, the impedance rises with increasing frequency. The actual impedance of the microphone in shipboard applications is of importance only as it relates to the input load impedance into which the microphone is designed to operate. If the microphone is mismatched with the input impedance, the microphone input is reduced and distortion occurs. All specifications and acceptability tests for naval microphones are based on the designed input load impedance.

SENSITIVITY.— The sensitivity or efficiency of a microphone is usually expressed in terms of the electrical power level that the microphone delivers to a terminating load, the impedance of which is equal to the rated impedance of the microphone, compared to the acoustical intensity level or pressure of the sound field that is being picked up.

Most systems rate the microphone in the electrical power level (in decibels below 1 milliwatt (mW) produced by an acoustical pressure of 1 dyne per square centimeter. For example, a crystal microphone rated at 80 dB means that for an input acoustical pressure of 1 dyne per square centimeter, the electrical output is 80 dB below 1 mW, or 10 mW. Other systems rate the microphone in terms of the voltage delivered to a specified terminating load impedance for an acoustical pressure input of 1 dyne per square centimeter.

It is important to have the sensitivity of the microphone as high as possible. High sensitivity means a high electrical power output level for a given input sound level. High microphone output levels require less gain in the amplifiers used with them and thus provide a greater margin over thermal noise, amplifier hum, and noise pickup in the line between the microphone and the amplifier.

When a microphone must be used in a noisy location, it should favor sounds coming from a nearby source over random sounds coming from a relatively greater distance. Microphones of this type cancel random sounds and pick up only those sounds originating a short distance away. When talking into this type of microphone, hold your lips as close as possible to the diaphragm. Directional characteristics that favor sound coming from one direction only also aid a microphone in discriminating against background noise.

7.1.2 Loudspeakers

A loudspeaker is a device that converts electrical energy into sound energy and radiates this energy into the air in the form of waves. The loudspeakers in general use in the Navy are (1) the direct radiator type, which radiates sound directly from a vibrating member into the air, and (2) the horn type, which consists of a driving unit combined with a horn to couple the unit to the air. All loudspeakers consist essentially of a driving mechanism.

7.1.2.1 Driving Mechanism

The driving mechanism changes electrical vibrations into mechanical vibrations that are transmitted to a diaphragm or other vibrating source. This vibrating source is coupled to the air, either directly or by a horn, and causes sound to be radiated. The dynamic, or moving-coil, driving mechanism is the basic type used in Navy loudspeakers. The design of this unit is similar to that of the dynamic microphone, but the principle of operation is the reverse of that of the dynamic microphone.

A coil of wire is attached to a diaphragm and rests in a magnetic field. When a varying electric current flows through the coil, a force is exerted on the coil, causing it to move back and forth in the magnetic field. The consequent motion of the diaphragm causes the radiation of sound waves that correspond to the variations in the electric current. The electrodynamics and the permanent-magnet types are the two variations in the dynamic loudspeaker. These types differ only in the method employed for obtaining the magnetic field.

In the electrodynamics loudspeaker, the magnetic field is established by passing a direct current through a field coil that is wound on an iron core. This type requires a source of filtered direct voltage and two additional conductors to carry the field current to the loudspeaker.

In the permanent-magnet dynamic loudspeaker, a permanent magnet establishes the magnetic field. All loudspeakers used by the Navy are of the permanent magnet dynamic type.

7.1.2.2 Direct-Radiator Loudspeaker

The direct-radiator loudspeaker, sometimes called a cone loudspeaker, is the simplest form of loudspeaker. In this type of loudspeaker (fig. 7-5), the diaphragm acts directly on the medium, which is air. Both sides of the diaphragm are open to the air so sound radiates behind as well as in front of the loudspeaker. At the instant the diaphragm is moving in an outward direction, the front surface of the diaphragm produces a compression wave and the back surface produces a rarefaction wave.

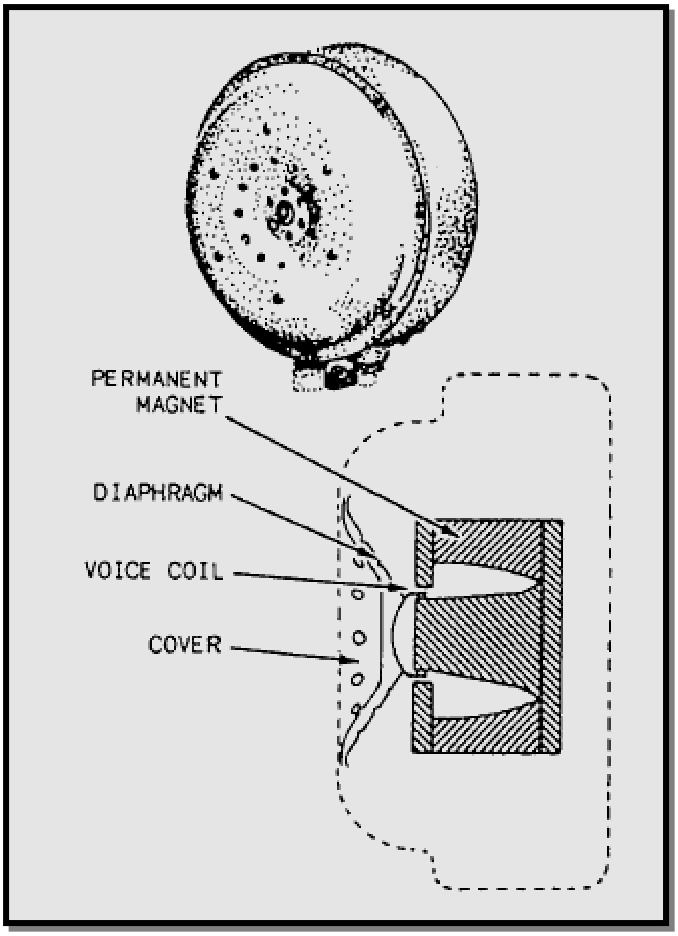


Figure 7-5.—Direct-radiator loudspeaker.

At low frequencies, where the wavelength is large compared with the dimensions of the loudspeaker, the rarefaction wave from the back of the diaphragm meets the compression wave from the front of the diaphragm and neutralizes it because the waves are in opposite phase relation. Thus, low frequencies are not reproduced from this type of direct radiator.

At higher frequencies, where the wavelength of the sound is small compared with the dimensions of the loudspeaker, the sound waves from the front of the diaphragm have time to travel an appreciable distance away from the loudspeaker (in terms of wavelength), and the phase of vibration of the diaphragm changes before the interfering wave from behind can traverse the distance around the diaphragm. Hence, a baffle is necessary only to reproduce low frequencies from a direct radiator. The purpose of the baffle is to delay the meeting of the front and back waves by artificially increasing the distance of the sound-wave path from the front to the back of the diaphragm.

The simplest form of baffle is a flat board with a hole in the center to accommodate the loudspeaker. This type of baffle is effective down to a frequency the wavelength of which is approximately four times the diameter of the baffle. If the loudspeaker is mounted in a wall or is completely enclosed, the baffle is called an infinite baffle. When a cabinet is used as a baffle, it is desirable to line the inside with a sound-absorbing material to minimize the effect of cabinet resonances produced by standing waves within the enclosure.

7.1.2.3 Horn Loudspeaker

The use of the direct radiator loudspeaker is limited because of its low radiation efficiency. When it is necessary to produce high sound intensities or to cover large areas with sound, the radiation efficiency of the loudspeaker must be increased to keep the size of the amplifier within reasonable limits. Horns with appropriate driver units provide a practical solution to the problem. A horn maybe considered as an impedance matching device for coupling a relatively heavy vibrating surface at the horn throat to a relatively light medium (the air) at the mouth of the horn. Figure 7-6 is an illustration of a straight-horn loudspeaker.

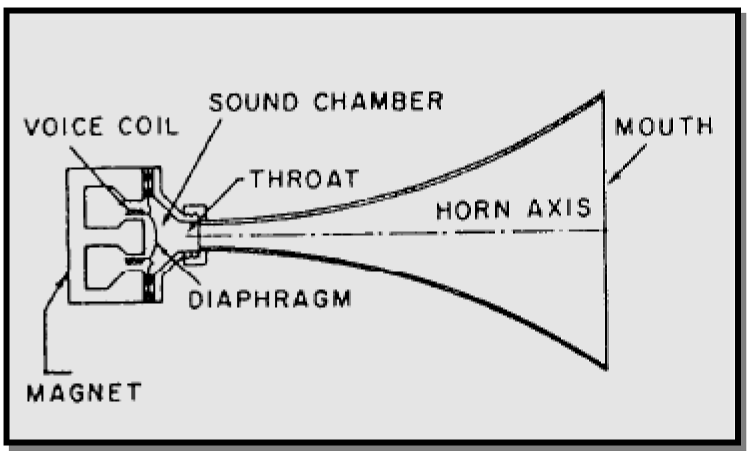


Figure 7-6.—Straight-horn loudspeaker.

For a horn to operate effectively, the mouth must be sufficiently large in comparison with the longest wavelength (lowest frequency) of sound that is to be transmitted. Low-frequency horns often are considered to be useful at frequencies above that for which the mouth diameter is about one-third wavelength. The performance of a horn loudspeaker near the low-frequency cutoff point depends to a great extent upon the flare or shape of the horn.

The function of the horn contour is to produce a smooth and continuous increase in cross-sectional area in progressing from the small throat to the large mouth. The shape most commonly employed is the exponential horn in which the diameter increases progressively by a fixed percentage for each equal-distance increment along the horn axis. For the horn to be of a practical size and shape, a folded-horn loudspeaker (fig. 7-7) is employed in preference to a straight horn. There is a practical limit to the power that can be handled by a conventional driver unit. When extremely high sound intensities must be produced, multiunit loudspeakers are employed in which the units are coupled to individual horn sections that are combined mechanically into a common loudspeaker assembly.

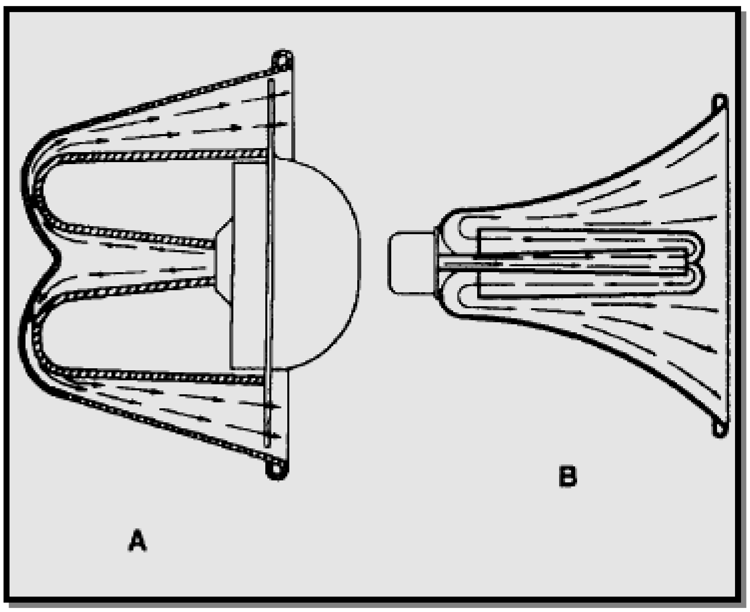


Figure 7-7.—Folded-horn loudspeaker.

7.1.2.4 Flight Deck Speaker

- Designed to provide clear and intelligible reproduction of speech and alarm signals.
- Designed to meet stresses common to sea-going vessels such as humidity, salt, spray, temperature, shock and vibration.
- Can be used in either a 50 or 70 volt audio system. Provides for external volume adjustment from -24dB to full volume via coil taps on unit's output transformer.
- Speaker assembly includes loudspeaker driver assembly, audio line matching transformer, and a terminal board.
- Enclosure is of aluminum construction and is designed for deck mounting.

Input level	50 or 70 Vrms (10.0 Volt Amp)
Input Impedance	490 Ohms at 70 Volts
Frequency Response	320 to 4000 Hz
Output Sound Pressure	108 dB at 10 feet*

Figure 7-8.—Flight Deck Speaker.

CHARACTERISTICS OF LOUDSPEAKER

Loudspeakers are rated according to their (1) frequency response, (2) directivity, (3) capacity, (4) efficiency, and (5) impedance.

FREQUENCY RESPONSE.— In the majority of cases, the frequency response of the loudspeaker is the limiting factor in the overall response of a sound system. For direct radiators, the low-frequency response is influenced by the (1) baffle or enclosure, (2) diameter of the cone, (3) ability of the cone and voice coil to execute large amplitudes of vibration, and (4) strength of the magnetic field in the air gap. The high-frequency response is limited by the mass of the voice coil and diaphragm.

For horn loudspeakers, the low-frequency response is influenced principal y by the (1) basic horn formula employed, (2) flare, and (3) mouth dimensions. The high-frequency response is limited by the (1) mass of the voice coil and the diaphragm, (2) phase effects caused by differences in path lengths due to bends, and (3) impedance irregularities caused by sudden changes in cross-sectional areas at folds or joints in the horn. Vibrations of the horn walls must be sufficiently damped to avoid introducing irregularities into the response, as well as transient effects.

DIRECTIVITY.— The directivity of a loudspeaker is an important factor in determining the efficiency of the sound radiation over the listening area. All practical forms of sound radiators exhibit some directional effects. If a radiator is placed in free space where the results are not affected by interfering reflections, the sound pressure at a given distance is not the same in all directions. The directivity of a loudspeaker is a function of both frequency and the size of the horn mouth of the loudspeaker. Thus, a loudspeaker becomes more directional with increasing frequency because of the shorter wavelength, and a direct radiator or horn mouth of large size is more directional than one of smaller size. These factors of frequency and size are interrelated in that the size becomes a factor relative to the wavelength of the sound being transmitted. Thus, the directional pattern of a small loudspeaker transmitting a high-frequency signal (short wavelength) is similar to that of a large loudspeaker transmitting a low-frequency signal (long wavelength). In general, a horn loudspeaker of a given mouth diameter is more directional than a direct radiator of the same diameter, particularly at the low frequencies.

The directivity of a horn loudspeaker is also dependent upon the rate of flare; that is, the directivity increases as the flare is made more gradual (longer horn). If a rectangular horn having a long narrow mouth (in terms of wavelength) is mounted with the long dimension of the mouth vertical, the radiation in the horizontal plane corresponds to that of a small radiator with a broad distribution pattern. The radiation in the vertical plane acts as a large radiator with a relatively narrow beam. In other words, the horn is made relatively much less directional in the horizontal plane than in the vertical plane, It is obvious that the reverse is true if the horn is turned so that the long dimension of the mouth is horizontal. Thus, the sound energy is flattened out in a plane at right angles to the long dimension of the loudspeaker mouth. This principle is used to obtain the required directional characteristics for efficient high-intensity reproduction on the flight decks of aircraft carriers.

CAPACITY.— The load-carrying capacity of a loudspeaker is usually expressed in terms of the maximum electrical power that should be applied to it. This power is limited by heating, mechanical strength, and the production of nonlinear distortion that is caused by excessive diaphragm amplitudes or excessive acoustical pressures in the sound passages. Excessive power causes the diaphragm to strike portions of the magnet or supporting frame and may produce buzzing or rattling.

EFFICIENCY.— The loudness of the sound obtainable from a loudspeaker at any particular listening point is not a factor of load-carrying capacity alone. Other important factors are the efficiency and the amount that the sound is spread out. The definition of absolute efficiency of a loudspeaker is not subject to simple practical interpretation, However, for specification purposes and for checking the performance of naval loudspeakers, a specified voltage is applied to the input terminals and the output sound pressure is measured at a given distance from the loudspeaker on the loudspeaker axis using various test frequency signals. These measurements are combined with off-axis sound pressure measurements to evaluate the relative loudspeaker efficiency.

When satisfactory frequency in a loudspeaker is limited to a small angle about the axis, the absolute efficiency at high frequencies is considerably lower than at low frequencies. The use of diffusing arrangements with these loudspeakers to spread out the high frequencies usually results in spreading out the small amounts of available high-frequency energy to such an extent that the response is unsatisfactory at all locations.

IMPEDANCE.— The impedance of a loudspeaker is usually measured between the voice coil terminals at some average frequency, such as 1000 Hz, in the usable range. This impedance varies with the frequency, rising with increasing frequency. The usual value of voice coil impedance varies from 3 to 15 ohms.

In shipboard announcing and public-address systems, a matching transformer is built into each loudspeaker to transform the low voice-coil impedance to a higher value suitable for connection to loudspeaker distribution lines. Because loudspeakers in a system are connected and operated in parallel, the combined impedance of a large number of low-impedance voice coils without matching transformers would be so low compared with the resistance of the connecting cables that an appreciable portion of the amplifier output power would be dissipated in the cables. Thus, matching transformers are provided to reduce this loss. These transformers have several taps to vary the loudspeaker impedance. Changing the loudspeaker impedance changes the power absorbed by the loudspeaker from the lines, and thus provides a means of varying the loudness of the loudspeaker.

7.2.0 CENTRAL AMPLIFIER SYSTEM (ONE-WAY)

The one-way central amplifier amounting system provides a means of transmitting general orders, information and, in some cases, alarm signals to various locations simultaneously by microphones and loudspeakers connected through a central amplifier. Two examples of the one-way central amplifier announcing system are the general announcing system, circuit 1MC, and the intership announcing system, circuit 6MC.

One of the more common types of central amplifiers installed on board ship today for use with circuits 1MC and 6MC is the AN/SIA-114B amplifier-oscillator group. The AN/SIA-114B, with other equipment, comprises a shipboard announcing system capable of both circuit 1MC and circuit 6MC operation. The major components of the system are the control rack and the power rack. The AN/SIA-114B contains two distinct amplifier channels, A and B. Each channel is made up of a preamplifier located in the control rack and a 500-watt power amplifier located in the power rack. There are two identical oscillator groups, 1 and 2, located in the control rack for generating alarm signals. There is also additional sound equipment used with the system and facilities available for muting and attenuating the ship's entertainment system. Figure 7-9 is a simplified block diagram of the circuits 1MC and 6MC using the AN/SIA-114B.

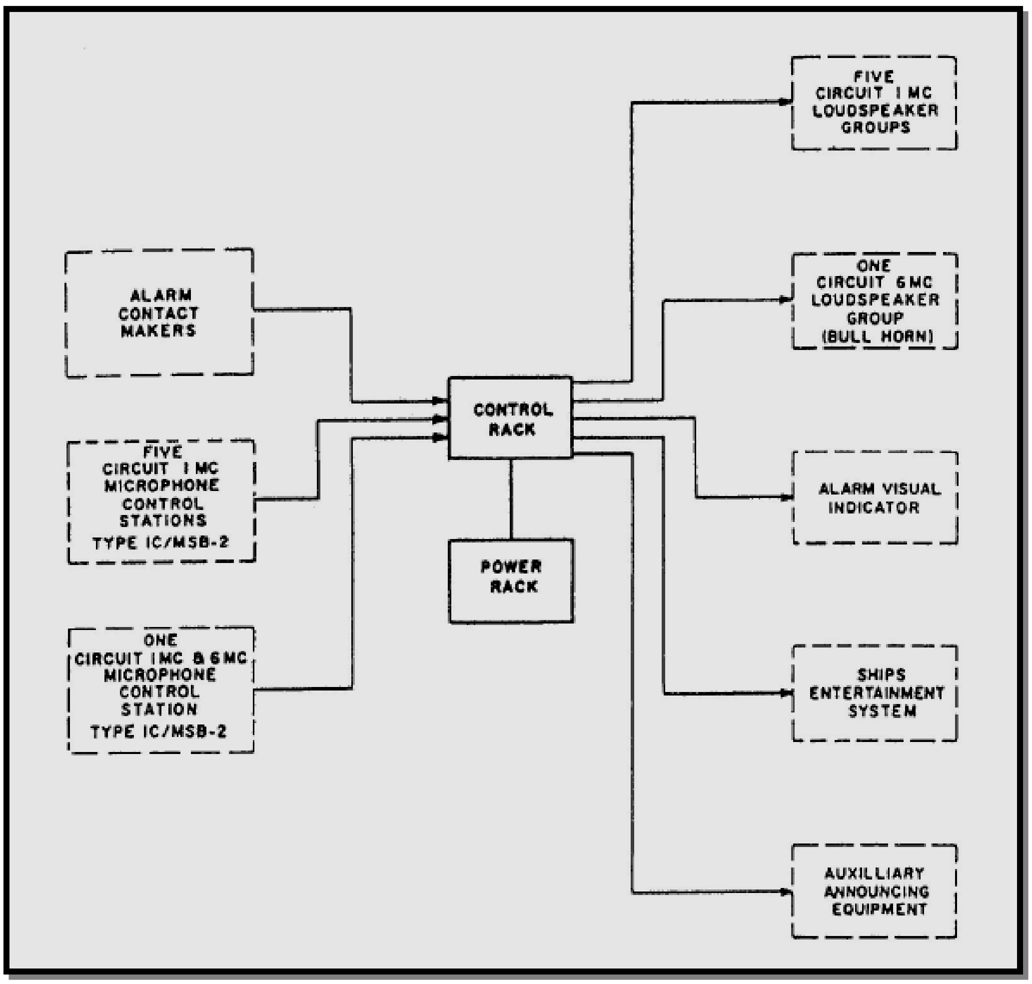


Figure 7-9.— Simplified block diagram of 1MC-6MC central amplifier announcing system.

7.2.1 Control Rack

The control rack (fig. 7-10) is a bulkhead-mounted enclosure containing the preamplifier modules, power supply modules, oscillator alarm modules, and the system switching and transferring controls and indicators. The rack also contains the control and power relays, the relay power supply, and the terminal boards for making connections to the ship's wiring.

The control rack preamplifier voice and alarm signals from the microphone control stations, routes them to the power rack for amplification, and then transmits them to the various loudspeaker groups.

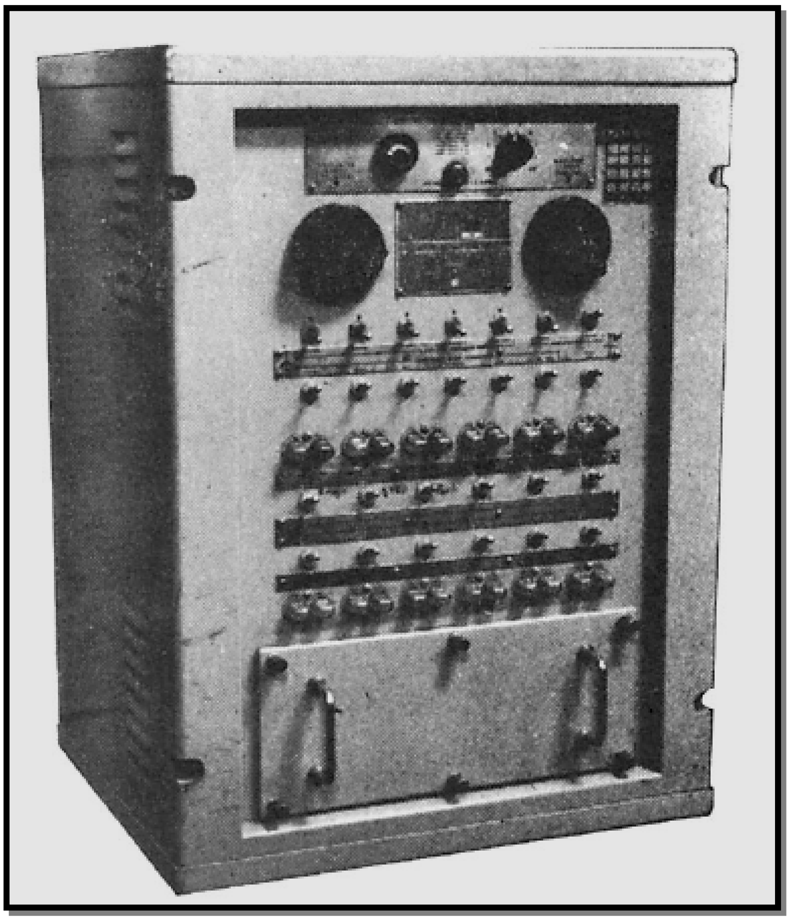


Figure 7-10.— Control rack.

Preamplifier Modules

Two preamplifier modules are located in the control rack one for each amplifier channel. Each preamplifier contains four transistor amplifier stages for increasing the low-level microphone and alarm signals to drive their associated power amplifier to full output. Figure 7-11 is a block diagram of a preamplifier.

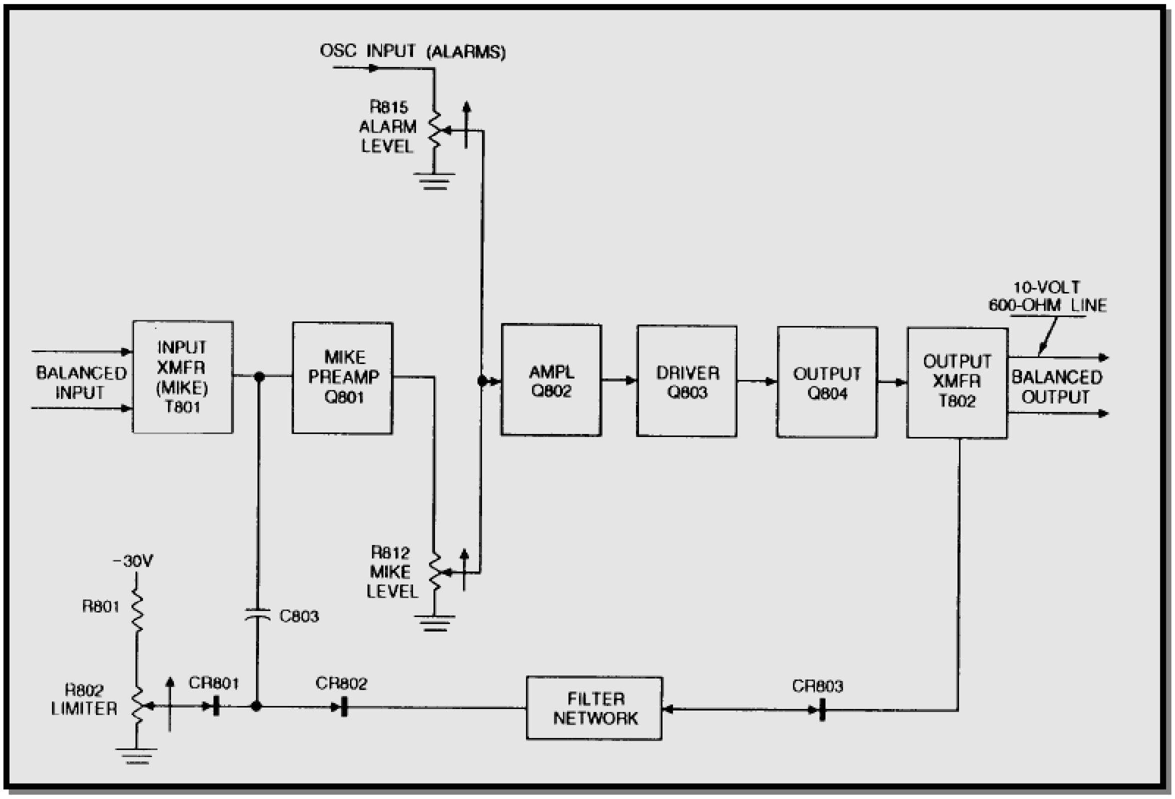


Figure 7-11.— Block diagram of a preamplifier.

Power Supply Modules

Two power supply modules are located in the control rack. Each power supply is a regulated transistor unit that supplies -10 volt dc and -30 volt dc operating voltages to the alarm modules and preamplifier modules.

Alarm Modules

Ten alarm modules are located in the control rack, five for each oscillator group. Each alarm module, when actuated by an alarm contact maker, is capable of generating an audio-frequency alarm. When an alarm signal is actuated, all microphone control stations are automatically disconnected by priority relays. The audio-frequency oscillator output (alarm signal) is then connected to the alarm input of the microphone and oscillator amplifier of the channel selected for use on circuit 1MC.

The output from the power rack is distributed to all circuit 1MC loudspeaker groups. Alarm signals are not transmitted over the circuit 6MC loudspeakers. The alarm modules in the order of their priority are (1) collision, (2) chemical, (3) general, (4) unassigned A, and (5) flight crash.

The order of priority is controlled automatically by relays in the control rack. Any alarm takes priority over voice announcements.

COLLISION ALARM.— The collision alarm is a transistorized oscillator circuit that generates a signal composed of three 1000-Hz bursts. Each burst is 60 milliseconds duration. The first and second burst is followed by an off time of 60 milliseconds. The third burst is followed by an off time of 420 milliseconds. This cycle repeatedly continues as long as power is applied to the circuit.

Figure 7-12 is a block diagram of a collision alarm module. Operation of the collision alarm contact maker will supply -10 volts dc to all stages in the circuit through relay K101. K101 will also apply control voltage to operate the visual signal circuit and the amplifier channel.

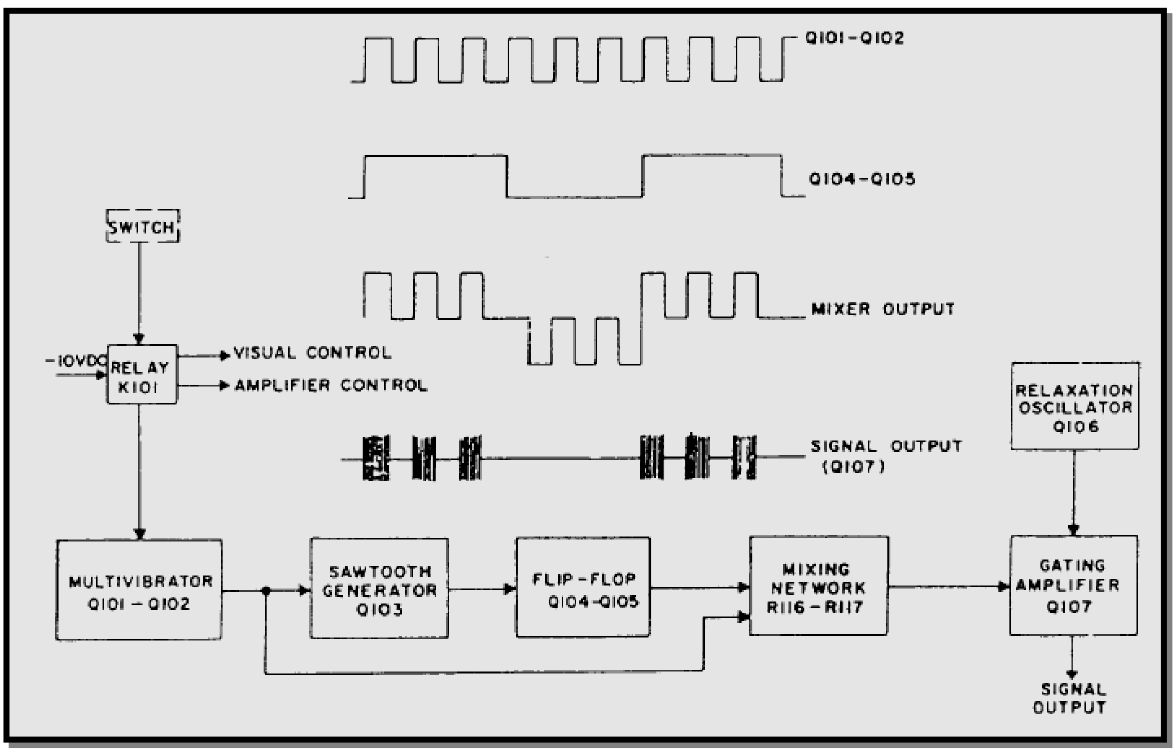


Figure 7-12.— Block diagram of the collision alarm module.

Resistor R107 (not shown) is a trimpot used in the circuit to adjust the number of pulses in a group. Clockwise rotation of the pot will decrease the number of pulses, while counterclockwise rotation will increase the number of pulses. Resistor R127 (not shown) is a trimpot used in the circuit to adjust the frequency to exactly 1000 Hz. Clockwise rotation of the pot will increase the frequency, while counterclockwise rotation will decrease the frequency.

CHEMICAL ALARM.— The chemical alarm is a transistorized oscillator circuit that generates a continuous 1000-Hz signal as long as power is applied to the circuit. This circuit consists of a square wave multi vibrator. Figure 7-13 is a block diagram of a chemical alarm module. Operation of the chemical alarm contact maker will supply -10 volts dc to the circuit through relay K201. Relay K201 will also apply control voltage to operate the visual signal circuit and the amplifier channel.

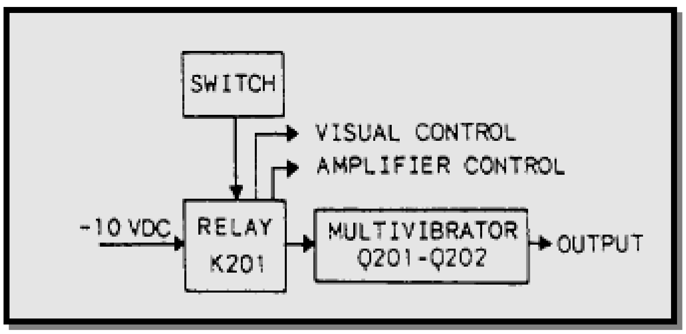


Figure 7-13.— Block diagram of the chemical alarm module.

Resistor R203 (not shown) is used in the circuit to adjust the frequency to precisely 1000 Hz. Clockwise rotation of the pot will increase the frequency, while counterclockwise rotation will decrease the frequency. There are also two other transistors in the chemical alarm circuit. These transistors are associated with the general alarm and will be discussed later.

GENERAL ALARM.— The general alarm consists of a 400-cycle per second rectangular wave oscillator coupled through a gated transformer. A striking multi vibrator supplies current to a diode across the gating winding of this transformer that produces the decaying characteristics of a gong. A timing multi vibrator and relay holds the operating relay in the operating position for a period of 10 to 15 seconds after the alarm contact maker is released. Figure 7-14 is a block diagram of a general alarm module.

Operation of the general alarm contact maker will energize relay K302, which will ground all stages fed with -10 volts dc. K302 also supplies -30 volts dc to transistor Q307 through relay K301, thus energizing K301, which holds K302 energized and supplies control voltage to the amplifier.

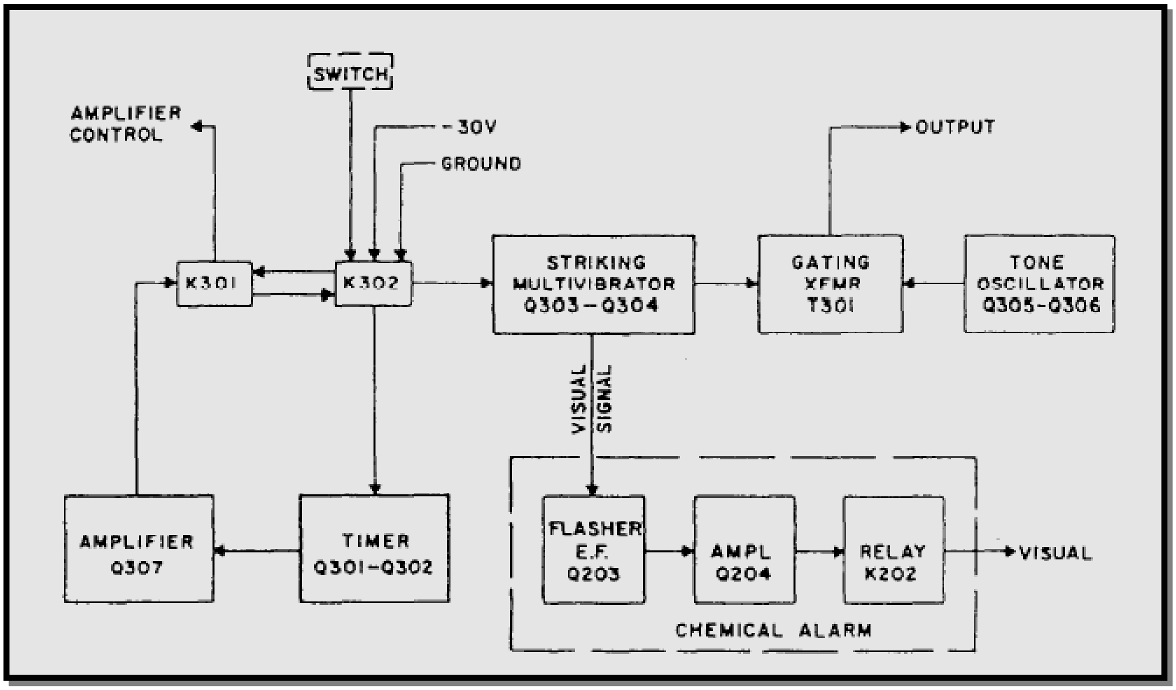


Figure 7-14.— Block diagram of the general alarm module.

The striking multi vibrator also supplies a signal to transistors Q203 and Q204 in the chemical alarm circuit, causing K202 in the chemical alarm circuit to operate every time the gong strikes at the rate of 100 times per minute, causing the visual signal to flash.

Resistor R311 (not shown) is a trimpot used in the circuit to adjust the rate at which the alarm strikes. Clockwise rotation speeds up striking, while counterclockwise rotation reduces it. Normal adjustment is for 100 strokes per minute. Resistor R302 (not shown) is a trimpot used in the circuit to adjust the amount of time the alarm will continue sounding after the alarm contact maker is released. Normal adjustment is for a 15-second hold.

UNASSIGNED A ALARM.— The unassigned A alarm contains transistorized oscillator and timer circuits that generate 500-Hz and 1500-Hz sine waves alternating at a rate of 1 1/2 Hz, producing a jump tone. Figure 7-15 is a block diagram of an unassigned A alarm module. Operation of the unassigned A alarm contact maker supplies -10 volts dc through relay K401 to all stages of the circuit.

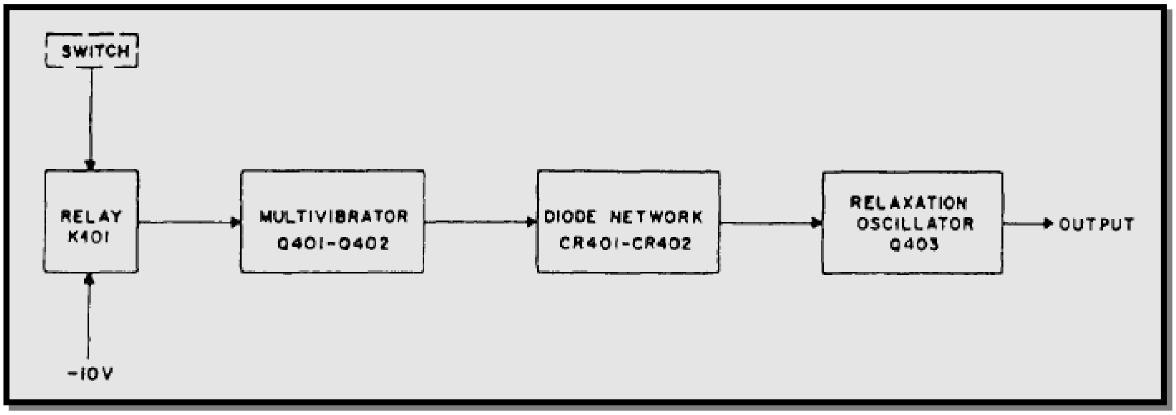


Figure 7-15.— Block diagram of the unassigned A alarm module.

Resistor R406 (not shown) is a trimpot used in the circuit to adjust the high-frequency tone. Resistor R408 (not shown) is a trimpot used in the circuit to adjust the low-frequency tone. If adjustment is required, you should always make the low-frequency adjustment first. The normal setting is 500 cycles per second for the low frequency and 1500 cycles per second for the high frequency. In either case, clockwise rotation of the pots will increase frequency and counterclockwise rotation will decrease frequency.

FLIGHT CRASH ALARM.— The flight crash alarm consists of a phase shift oscillator that controls the frequency of a relaxation oscillator through a varistor network and an amplifier stage producing a siren tone. Figure 7-16 is a block diagram of a flight crash alarm module. Operation of the flight crash alarm contact maker supplies -30 volts dc through relay K501 to all stages of the circuit.

Resistor R7 (not shown) is a trimpot used in the circuit to adjust the frequency limits of the siren tone. Clockwise rotation of the pot will raise the frequency of Q503, while counterclockwise rotation will decrease it. The normal setting produces a frequency varying between 750 cycles per second and 1750 cycles per second.

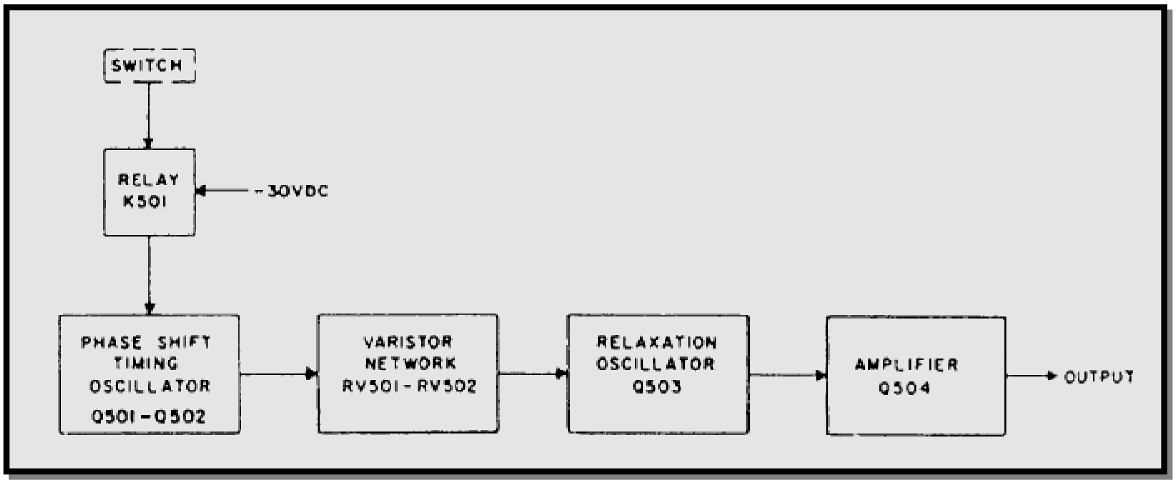


Figure 7-16.— Block diagram of the flight crash alarm module.

7.2.2 Switching and Transfer Controls and Indicators

The switching and transfer controls on the front of the control rack consist of the amplifier oscillator power switches, the amplifier channel selector switch, the oscillator group selector switch, the microphone control station disconnect switches, the loudspeaker group disconnect switches, visual disc switch, and various test switches. Indicators on the front of the control rack consist of a power available lamp, blown-fuse indicators, and a test meter.

AMPLIFIER OSCILLATOR POWER SWITCHES.— These switches provide power to the two power supplies and relay power supply located in the control rack and the power amplifiers and blowers located in the power rack. During normal operation, these switches are in the ON position.

AMPLIFIER CHANNEL SELECTOR SWITCH.— Three choices of channel operation are available in this system: (1) 1MC-A/6MC-B, (2) 1MC-A/6MC-A, and (3) 1MC-B/6MC-B. Selection is accomplished by operation of the AMPLIFIER CHANNEL SELECTOR switch. Channel A is normally used for circuit 1MC operation, and channel B is normally used for circuit 6MC operation. Should one channel fail during operation, the switch can be positioned to the operational channel, thus putting both circuit 1MC and circuit 6MC on the same charnel. Under this condition, however, circuit 1MC has priority over circuit 6MC. Figure 7-17 is a simplified system switching diagram showing the AMPLIFIER CHANNEL SELECTOR switch in the 1MC-A/6MC-B position.

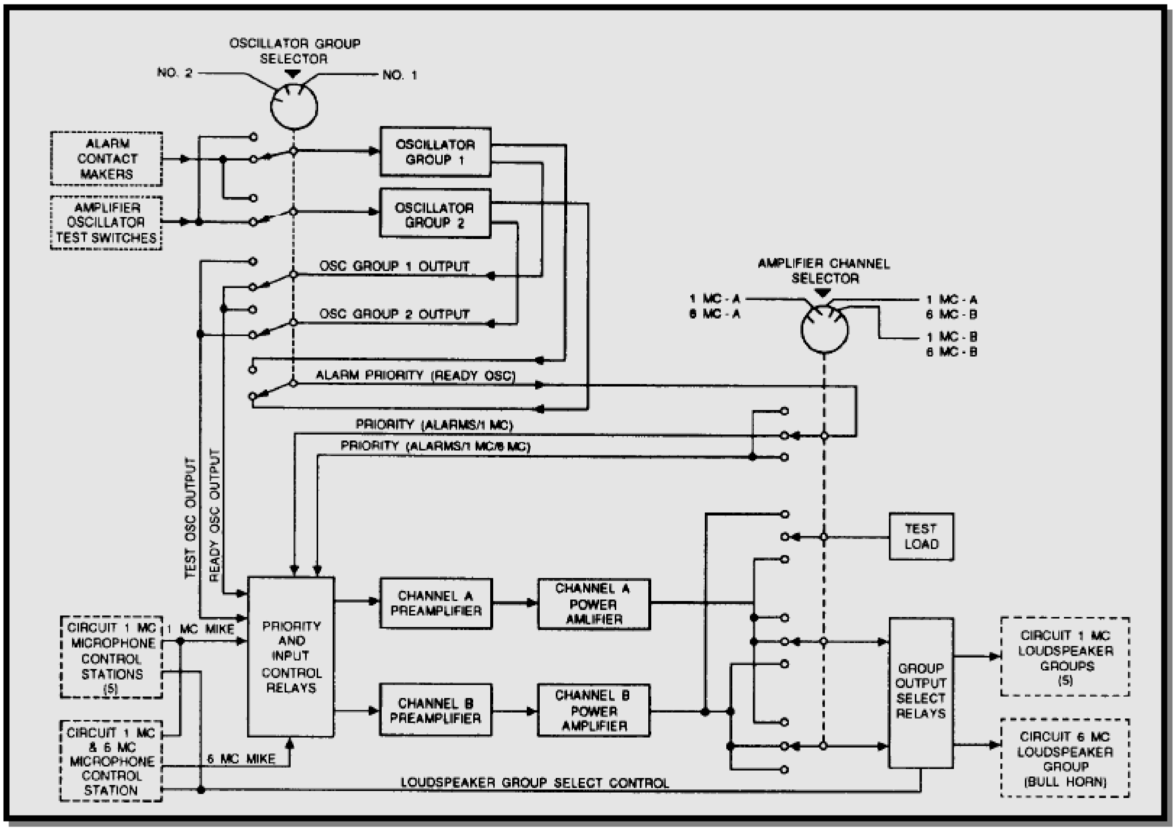


Figure 7-17.— Simplified system switching diagram.

OSCILLATOR GROUP SELECTOR SWITCH.— Selection of either group of alarms is accomplished by operation of the OSCILLATOR GROUP SELECTOR switch. Should any alarm module within either oscillator group fail during operation, the switch can be positioned to the operational group. During normal operation, this switch is in the NO. 1 position.

MICROPHONE CONTROL STATION DISCONNECT SWITCHES.— There are six microphone control station disconnect switches, one for each microphone control station. These switches control the relay power for each control station. They are also used to isolate the control stations during troubleshooting.

LOUDSPEAKER GROUP DISCONNECT SWITCHES.— There are six loudspeaker group disconnect switches, one for each loudspeaker group. These switches control system output power to each loudspeaker group. They are also used to isolate the loudspeaker groups during troubleshooting.

VISUAL DISC SWITCH.— This switch controls the output to the visual alarm indicators.

TEST SWITCHES.— The test switches consist of the amplifier test switches, the amplifier oscillator test switches, and a meter test switch. The amplifier test switches are used when making system level adjustments on the preamplifiers and the amplifiers. The amplifier oscillator test switches and the meter test switch are used to test the output of the power supplies and for silent and remote testing of the amplifier channels and oscillator groups.

POWER AVAILABLE LAMP.— This lamp, when lit, indicates that power is available to the control rack for operation of the system.

BLOWN-FUSE INDICATORS.— There are combination fuse holders and blown-fuse indicators for each amplifier oscillator power switch and for each microphone control station switch.

Primary power circuits are fused on both the high and low sides. The switch controlling power to the circuit, which a fuse protects, must be in the ON position for the blown-fuse indicator to give an indication of a fuse failure. For microphone control stations, the microphone press-to-talk switch at the station must be operated to give an indication of fuse failure.

TEST METER.— The test meter is used with the meter test switch for testing the output of the power supplies and for silent and remote testing of the amplifier channels and oscillator groups. Figure 7-18 is an illustration of the test meter.

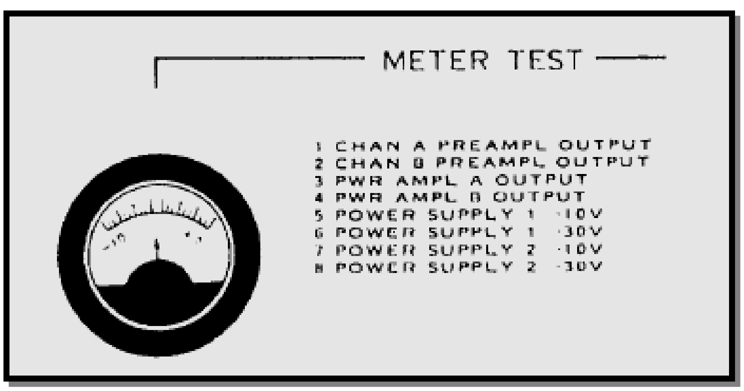


Figure 7-18.— Test meter.

AUDIO FREQUENCY AMPLIFIER GROUP.— Audio Frequency Amplifier Group AM-2316D/SIA, shown in figure 7-19, consists of a single cabinet containing two power supplies, two power amplifier assemblies, and a power control panel. All input and output signals are connected through two terminal boards (one for channel A and one for channel B). Input power is connected through two in-line filters.

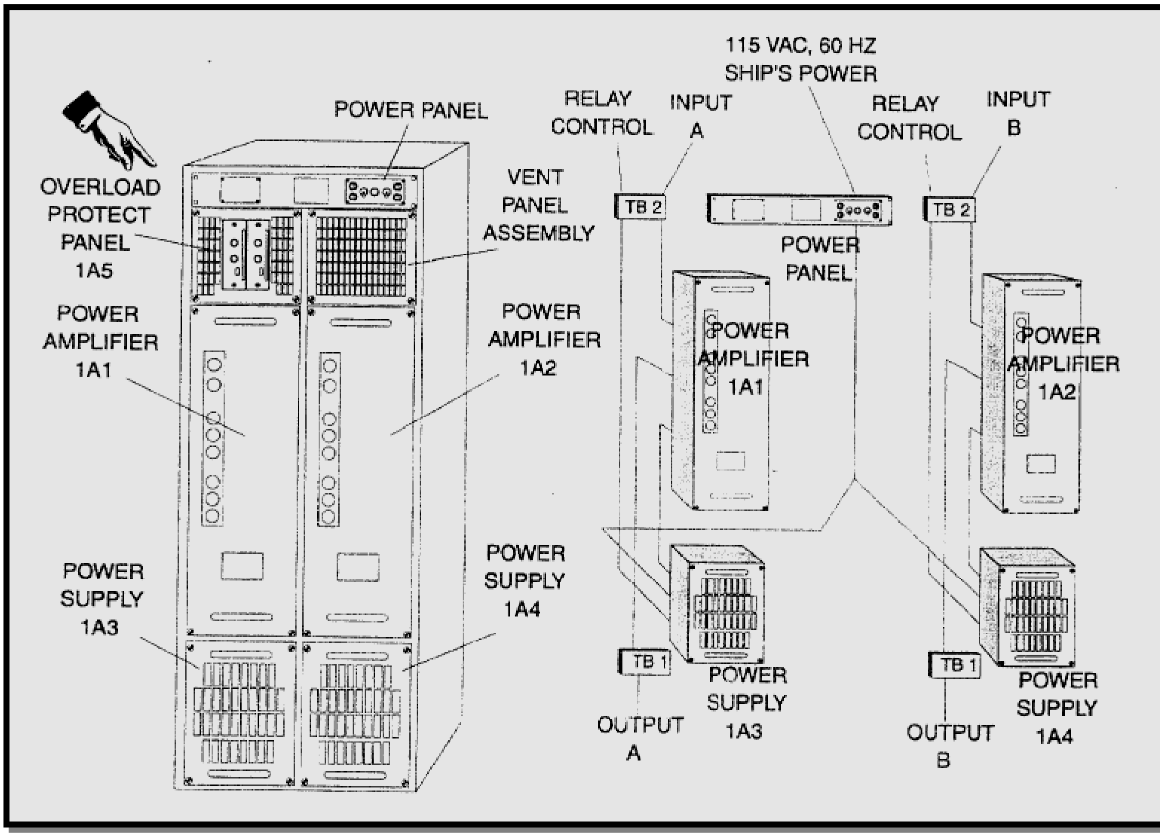


Figure 7-19.— Audio Frequency Amplifier Group AM-2316D/SIA, Relationship of Units.

The purpose of the AM-2316D/SIA Amplifier Group is to provide 1000 watts continuous audio power available through two 500 watt solid state amplifiers at 70 to 95 Volts. Preamplification and control is provided by an external amplifier-control group, such as AN/SIA-114, 117, and 118.

The unit requires a remote relay control input signal (-26 volts dc, +26 volts dc, or 115 volts ac) to turn on each amplifier channel. The unit has a built-in test meter to monitor internal voltages and audio signals.

The equipment is contained in a deck-mounted cabinet 59.81 inches in height, 22.62 inches in width, and 15.50 inches in depth. The mounted equipment weights 475 pounds. The equipment is cooled for heat dissipation by normal convection. The only controls are two power switches (one for each channel) located on the power panel at the top of the unit; a NORMAL—BYPASS switch located inside each AM6551/SIA Amplifier Chassis; two RESET switches located on each of the two modules on the Overload Protection Panel at the upper left front of the assembly; and two test meter switches, one located on each of the two power amplifier assemblies.

The power panel contains line switches and fuses for ships power 115 volts, 60 hertz single phase. The ac inputs to the amplifier dc power supplies are individually fused as well. A POWER AVAILABLE indicator, located on the power panel, lights when ships power is available. The power panel also contains a maintenance ac service outlet with its own power available indicator. The externally-generated 10-volt rms alarm or audio signals are amplified by the two power amplifier assemblies. The amplified 70-volt rms or 95-volt rms audio signals (500 watts per channel) are applied to externally-selected loudspeaker groups.

7.3.0 ADDITIONAL SOUND EQUIPMENT

Additional sound equipment used with the system includes (1) microphone control stations, (2) loudspeakers, (3) alarm contact makers, and (4) visual alarm indicators.

7.3.1 Microphone Control Stations

The system has provisions for the connection of six type IC/MSB-2 microphone control stations. The microphone control stations are installed at various locations aboard ship. The stations provide a means of transmitting voice announcements over the 1MC or 6MC circuits and select the loudspeaker groups over which the announcements will be broadcast. All stations are capable of transmitting over circuit 1MC. Only station 1 is capable of transmitting over both circuit 1MC and circuit 6MC. Station 1 is normally located in the pilothouse/bridge and has operational priority over the other five stations. The other stations are normally located at the quarterdecks.

Figure 7-20 is an illustration of an IC/MSB-2 microphone control station. Microphone control stations are self-contained, bulkhead-mounted units with a hinged cover guard. The stations consist of a detachable microphone with a press-to-talk switch, loudspeaker group control switches, busy indicator lights, and a volume indicator meter.

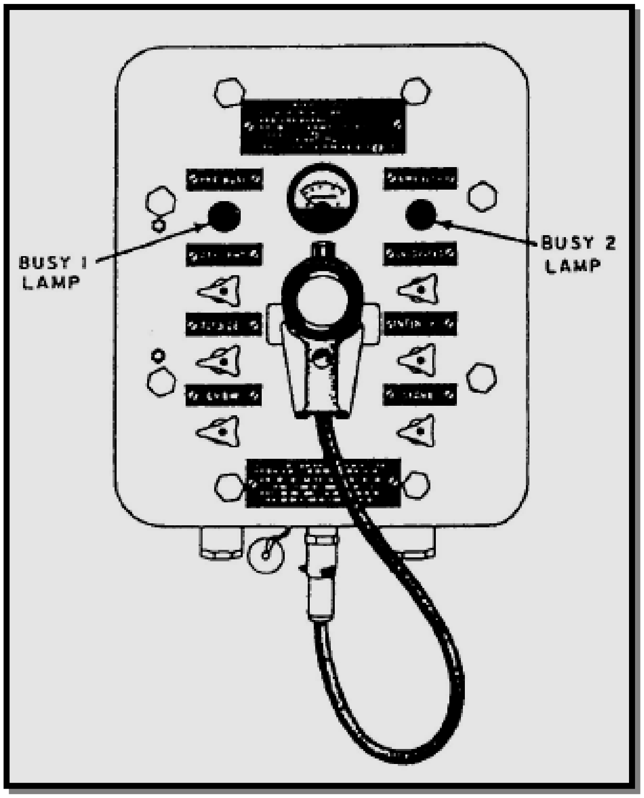


Figure 7-20.— IC/MSB-2 microphone control station.

MICROPHONE.— A magnetic type of microphone is used with the IC/MSB-2 microphone control station. This microphone is equipped with an 18-inch cable and a plug. The microphone plugs into a receptacle mounted in the bottom of the station. A tapered holder, mounted on the front panel of the station, holds the microphone. When using the microphone to transmit, you may remove it from its holder or leave it in the holder. To use the microphone, you must depress the press-to-talk switch located on the microphone to transmit. When talking into the microphone, you should hold the microphone one-half inch from your mouth and speak directly into it in a normal tone of voice.

LOUDSPEAKER GROUP CONTROL SWITCHES.— There are five circuit 1MC loudspeaker group control switches and one circuit 6MC loudspeaker group control switch mounted on the front of microphone control station 1. Stations 2 through 6 will contain circuit 1MC loudspeaker group control switches only. These switches are used to select which loudspeaker group(s) is/are to receive the announcement being transmitted from the microphone control station. When an announcement is made from any microphone control station, all loudspeakers selected at that station, except the loudspeaker in the immediate area of the station, will receive the announcement.

The loudspeakers associated with circuit 1MC are normally divided into four groups. These loudspeaker groups are designated (1) officers, (2) topside, (3) crew, and (4) engineering. There is only one circuit 6MC loudspeaker group, with only one or two loudspeakers installed.

After making an announcement over circuit 1MC, make sure you place the loudspeaker group control switches selected in the OFF position. If any loudspeaker group control switch at any 1MC microphone control station is left in the ON position, announcements made from any other control station will go out on those loudspeakers.

BUSY INDICATOR LIGHTS.— Two busy indicator lights are mounted on the front of the microphone control station, one for the 1MC (busy 1) and one for the 6MC (busy 2). These lights indicate if the associated circuit is in use, thereby avoiding the possibility of initiating a call through that circuit. Before making an announcement, make sure the busy light for the desired circuit is not lighted.

Except in an emergency, do not attempt to use circuit 1MC when the busy indicator light is lighted. If another microphone control station has already selected a circuit 1MC loudspeaker group(s) and is initiating an announcement, the transmission will go out to all loudspeakers selected at both microphone control stations.

When the circuit 6MC busy indicator light is lighted, it will have no effect on circuit 1MC operation.

When both busy indicator lights are lighted, three possible conditions exist: (1) both circuit 1MC and circuit 6MC are in use, (2) both circuit 1MC and circuit 6MC are using the same amplifier channel, or (3) an alarm signal is being transmitted.

When both circuits are using the same amplifier channel, circuit 1MC takes priority over circuit 6MC. Therefore, if circuit 6MC is in use and a circuit 1MC loudspeaker group is selected from another microphone control station and a transmission is initiated, circuit 6MC will be cut off. The announcement will then go out to the circuit 1MC loudspeakers only.

VOLUME INDICATOR METER.— A volume indicator meter (fig. 7-21) is mounted on the front of the microphone control station. This meter indicates that the system is ready for use. This meter also indicates the amount of output volume when a transmission is made. This meter is calibrated in decibels from -10 dB through 0 dB to +6 dB. When the press-to-talk switch on the microphone is depressed, the meter needle should deflect. When an announcement is being transmitted, the meter needle should deflect to 0 dB on peaks for normal volume.

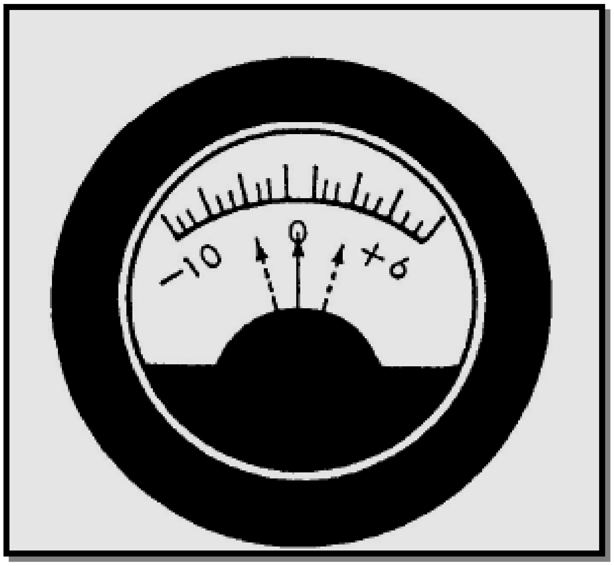


Figure 7-21.— Volume indicator meter.

7.3.2 Loudspeakers

Several different types of loudspeakers are used with circuit 1 MC to suit different needs. In areas with comparatively low noise levels, such as living spaces, low-power, radiator-type loudspeakers are used. On weather decks and in areas with high noise levels, such as engineering spaces, high-power, folded-horn loudspeakers are used.

Circuit 6MC requires the use of a multiunit straight-horn loudspeaker (fig. 7-22). This type of loudspeaker projects a narrow, powerful beam.

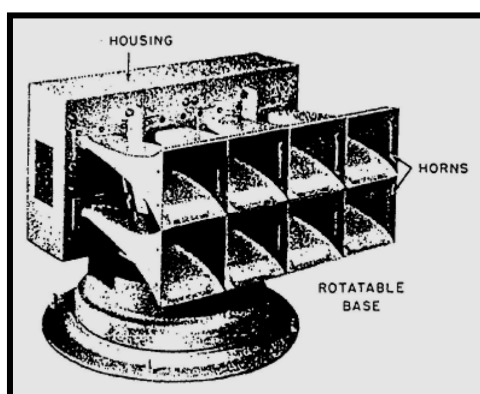


Figure 7-22.— Multiunit straight-horn loudspeaker.

Loudspeakers are usually provided with volume adjustments. The desired output level for each loudspeaker will depend on where it is located.

7.3.3 Alarm Contact Makers

Alarm contact makers are installed at various locations, such as the pilothouse/bridge and quarterdecks, where they are easily accessible to watch standers. The alarm contact makers are self-locking (in the OFF position), manual-release, lever-operated switches. Operation of any alarm contact maker will light both busy lights on all microphone control stations and transmit the alarm signal to all 1MC loudspeaker groups. Figure 7-23 is an illustration of a typical alarm contact maker arrangement. The alarm contact makers are color coded and prioritized according to their importance. The order of priority is controlled automatically by relays in the control rack. The alarm contact makers are color coded and prioritized as follows:

1. Collision (green)
2. Chemical attack (yellow)
3. General (red)
4. Unassigned A (gray)
5. Flight deck crash (red)

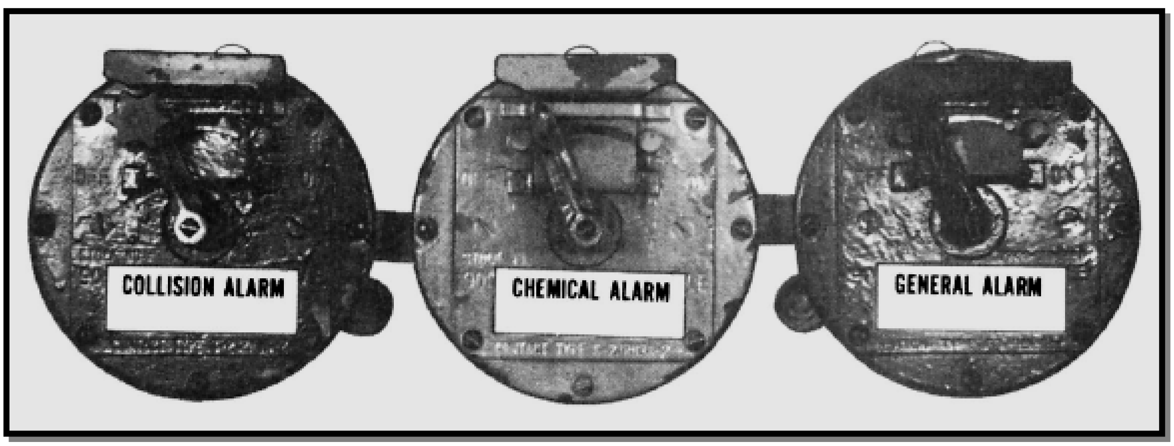


Figure 7-23.— Alarm contact maker arrangement.

If a low-priority alarm is being sounded and the contact maker for a higher priority alarm is operated, the lower priority alarm will be silenced and the higher priority alarm will be transmitted over the 1 MC loudspeakers. Conversely, the operation of a low-priority alarm contact maker has no effect on a high-priority alarm that is being transmitted.

The nature and number of 1MC alarms installed aboard ship is dependent on the type and mission of the ship. As a rule, however, all 1MC systems aboard surface ships are capable of generating and broadcasting collision alarms, chemical attack alarms, and general alarms.

7.3.4 Visual Alarm Indicators

In areas where the noise level is high, such as in engineering spaces and on hangar decks, visual alarm indicators are installed to alert personnel when an alarm is being sounded. The visual alarm indicators consist of lighting fixtures with red lamps installed in them. The red lamp lights steady when the collision or chemical attack alarm is sounded and flashes when the general alarm is sounded.

7.4.0 OPERATIONAL SYSTEM TESTING

There are two methods for testing the system for proper operation: (1) silent testing and (2) remote testing.

7.4.1 Silent Testing

Since the system can operate on either channel A or B and oscillator group 1 or 2, one channel and one oscillator group can be on the line for ship's use while the other channel and group are available for silent testing.

To test channel A and oscillator group 1, proceed as follows:

1. Place the LOAD DISC switch in the OFF position.

2. Place the AMPLIFIER CHANNEL SELECTOR switch to the 1MC-B/6MC-B position, and turn the OSCILLATOR GROUP SELECTOR switch to the NO. 2 position. This puts channel B and oscillator group 2 on the line, and leaves channel A and oscillator group 1 available for testing.

3. Turn the METER TEST switch to position 3 to test the power amplifier A output as the various alarm test switches are energized.

4. Hold the CHEMICAL test switch in the ON position. The meter reading should be 0æ2 dB. Release the switch.

5. Hold the COLLISION test switch in the ON position. The meter reading should fluctuate. Release the switch.

6. Operate the GENERAL test switch momentarily in the ON position. The meter reading should fluctuate for approximately 15 seconds. Release the switch.

7. Hold the UNASSIGNED test switch in the ON position. The meter reading should fluctuate. Release the switch.

8. Hold the FLIGHT CRASH test switch in the ON position. The meter reading should fluctuate. Release the switch.

This completes the testing of channel A and oscillator group 1. To test charnel B and oscillator group 2, turn the AMPLIFIER CHANNEL SELECTOR switch to the 1MC-A/6MC-A position and the OSCILLATOR GROUP SELECTOR switch to the NO. 1 position. Turn the METER TEST switch to position 4, and repeat steps 4 through 8.

7.4.2 Remote Testing

Remote testing consists of a test of the entire system. The test will include testing for proper operation of the system from the microphone control stations and the alarm contact makers. Figure 7-24 illustrates the proper switch positions on the control rack for remote testing.

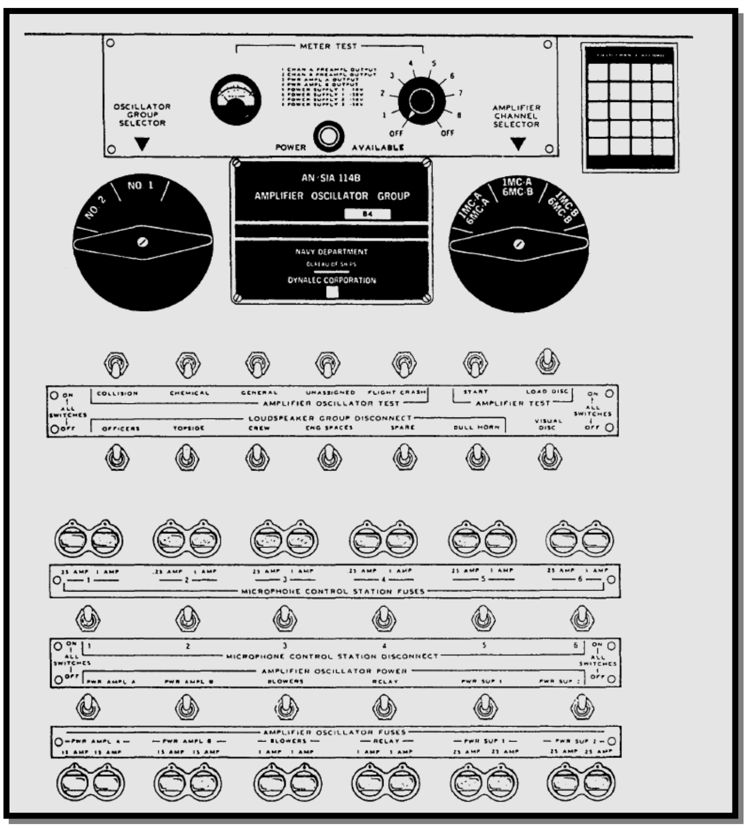


Figure 7-24.— Control rack with switches set for remote testing.

MICROPHONE CONTROL STATION TEST.— When conducting a test of a microphone control station, you must monitor all the other microphone stations and at least one loudspeaker in each loudspeaker group. Make several test announcements over circuit 1 MC, selecting a different loudspeaker group for each transmission. The volume indicators should fluctuate at all stations, and the circuit 1 MC busy signal light should illuminate when each test announcement is made. Each test should be heard on the loudspeaker of the loudspeaker group selected and not on loudspeakers of any other loudspeaker group. Check the priority feature of microphone station 1 by depressing the press-to-talk switch at station 1 while making an announcement from another station. This should cut off the other station.

Conduct a test announcement from station 1 over circuit 6MC. The circuit 6MC busy signal light should illuminate at all stations, and the announcement should be heard over the 6MC loudspeaker(s) only.

ALARM CONTACT MAKER TEST.— When conducting a test of the alarm contact makers, you must monitor all the microphone stations and at least one loudspeaker in each loudspeaker group and any visual alarm indicators. Test the alarm contact makers in order, beginning with the lowest priority alarm first. The following procedure is for testing the general, chemical, and collision alarm contact makers only:

1. Operate the general alarm contact maker momentarily to the ON position. The alarm should sound for approximately 15 seconds.

2. While the general alarm is sounding, operate the chemical alarm contact maker to the ON position and hold it there. The chemical alarm should override the general alarm.

3. While the chemical alarm is sounding, operate the collision alarm contact maker to the ON position. The collision alarm should override the chemical alarm.

4. Return the chemical and collision alarm contact makers to the OFF position.

Operation of any alarm should light up the busy signal lights and all visual alarm indicators of circuit 1MC and circuit 6MC. As each alarm contact maker is operated, the corresponding alarm should be heard over all the circuit 1MC loudspeaker groups.

7.4.3 Maintenance

Maintenance of the system consists of routine preventive maintenance and corrective maintenance.

Preventive Maintenance

Routine preventive maintenance of the system will be accomplished according to the maintenance requirement cards (MRCs) for the system, In most cases, this will consist of cleaning the interior and exterior of each rack, a visual inspection of equipment components and wiring, checking for loose connections, and testing the power amplifier tubes.

Corrective Maintenance

Corrective maintenance of the system consists of troubleshooting and actual replacement of defective parts. When performing corrective maintenance, you must observe all safety regulations and precautions at all times. There are no interlocks used on this equipment, and power to the control rack can be secured only by turning off the switch on the main IC switchboard. Operation of the system involves the use of high voltages, and you should not service or adjust this equipment alone. Under certain conditions, dangerous potentials may exist in circuits with the power amplifier in the OFF position, due to charges retained by capacitors and so on. Always use a safety shorting probe to discharge and ground circuits before touching them.

Localization of trouble in the system will be comparatively simple because of the test facilities included in the equipment. In most cases, a faulty assembly or even the faulty stage of an assembly can be localized by using the test meters and meter test switches included in the control and power racks. Also, the use of duplicate oscillator, preamplifier, and power amplifier assemblies permits the testing or repair of one assembly while the other assembly remains in active service, thereby avoiding the necessity for shutting down the system.

If the entire announcing system is inoperative, the trouble is probably in the ship’s power supply or wiring from the ship’s power supply. Check the power available indicator on the control rack. This indicator, unless it is defective, will be lighted when power is available to the rack. If power is not available, check the position of the supply switch on the main IC switchboard.

If power is available, check all fuses and switches associated with the system. If a fuse failure is indicated, replace the fuse. If the new fuse burns out immediately, do not replace it a second time until the cause has been corrected. A check of the switches on both the control rack and the microphone control stations may show that one or more are not in the proper position.

Tables 7-2, 7-3, and 7-4 are trouble charts for the system. These tables show some of the more common symptoms and probable defective assemblies or components.

SYMPTOM	PROBABLE DEFECTIVE COMPONENT						
	STA NO.1	STA NO.2	STA NO.3	STA NO.4	STA NO.5	STA NO.6	OTHER
Unable 10 select Officers loudspeaker Group	K901 CR907	K910	K914	K918	K922	K926	K945
Unable 10 select Topside loudspeaker Group	K901 CR908	K910	K914	K918	K922	K926	K946
Unable to select Crew Loudspeaker Group	K902 CR909	K911	K915	K919	K923	K927	K947
Unable to select Engineering Spaces Loudspeaker Group	K902 CR910	K911	K915	K919	K923	K927	K948
Unable to select Space Loudspeaker Group	K903 CR911	K912	K916	K920	K924	K928	K949
Unable to select Bull Horn	K903	-	-	-	-	-	K950
Busy lamps do not light and Amplifier channel does not switch to the Ready condition when a Microphone button is depressed for Circuit 1MC announcements	K906	CR912	CR913	CR914	CR915	CR916	K932
Busy lamps light but Amplifier Channel does not switch to the Ready condition	-	-	-	-	-	-	K941 K943
Busy 2 lamps do not light and Amplifier Channel does not switch to the Ready condition when the Circuit 6MC Microphone button is depressed.	-	-	-	-	-	-	K933
All stations except No. 1 inoperative	-	-	-	-	-	-	K953

Table 7-2.— Microphone Control Station Trouble Chart.

SYMPTOM	PROBABLE DEFECTIVE ASSEMBLY OR COMPONENT
No System output when Collision Alarm Contact Maker is operated.	Collision Alarm, K101, S913deck 1.
No System output when Chemical Alarm Contact Maker is operated.	Chemical Alarm, K201, S913 deck 2.
No System output when General Alarm Contact Maker is operated.	General Alarm, K302, S913 deck 3.
No System output when Unassigned “A” Alarm Contact Maker is operated.	Unassigned “A” Alarm, K401, S913 deck 4.
No System output when Flight Crash Alarm Contact Maker is operated.	Flight Crash Alarm, K501, S913 deck 5.
No System output when any Alarm Contact Maker is operated.	Relay power supply, Preamplifier, Power Supply, Power Amplifier, K930, S923 deck 4, K938 or K939, S913 deck 6 or 7, CR930 or CR931.

Table 7-3.— Alarm Circuit Trouble Chart.

SYMPTOM	PROBABLE DEFECTIVE ASSEMBLY OR COMPONENT
No System output when any 1MC mike circuit is energized.	Preamplifier, Power Supply, Power Amplifier, K932, S923 deck 5, K934, CR926, K940 or K942, K941 or K943.
No System output when any 6MC mike circuit is energized.	Preamplifier, Power Supply, Power Amplifier, K933, S923 deck 6, K935, CR927, K940 or K942, K941 or K943.
No System output when any 1MC or 6MC mike circuit is energized.	Relay power supply, K930.

Table 7-4.— Amplifier Circuit Trouble Chart.

DIODES.— If operation indicates that a diode is defective, disconnect one lead of the diode, being careful not to overheat the diode. Check the diode by measuring the front-to-back resistance ratio. The ratio should be at least 100 to 1.

RELAYS.— If operation indicates that a relay is defective, use the relay test facility located behind the front panel of the control rack to check the relay. The relay test facility (fig. 7-25) consists of two relay test sockets, two indicating lamps, and a test switch. Test suspected defective relays by plugging into the proper socket and operating the test switch. When a crystal can-type relay is tested, both lamps should illuminate in both test switch positions. When a power-type relay is tested, both lamps should illuminate only in test switch position 2.

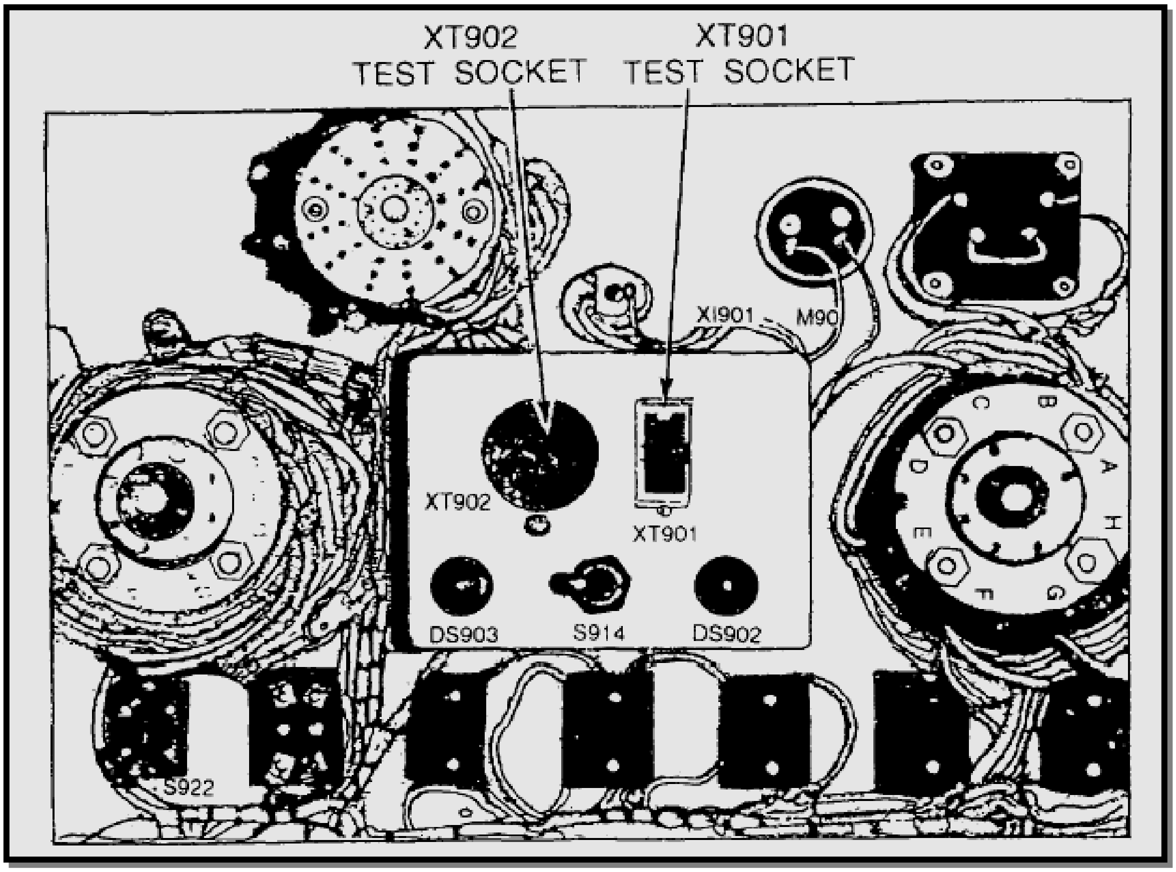


Figure 7-25.— Relay test facility.

RESISTORS.— You can use an ohmmeter to check the value of resistors in a circuit. Make sure the power is turned off and the circuit discharged before putting the meter across the resistor. If other components are in parallel with the resistor, one end of the resistor will have to be disconnected to get a correct reading.

Overloaded resistors will be discolored and give off a burnt odor and are often caused by shorted capacitors in the circuit. If you find an overloaded resistor in a circuit, check all the capacitors in the circuit as well.

CAPACITORS.— A shorted or leaking coupling capacitor or an open cathode bypass capacitor will cause an amplifier to hum and reduce amplification. An open coupling capacitor will block amplification and no sound will be produced by the amplifier.

You can use an ohmmeter to check for short-circuited or leaky capacitors with the power off. A good capacitor will give you an ohmmeter reading of very high resistance or infinity. However, the same is true for an open capacitor. Therefore, if you get a good reading and still suspect the capacitor of being faulty, shunt a new capacitor across it and note the effect.

TRANSFORMERS AND CHOKES.— In most cases, a shorted transformer or choke will cause the fuses in the supply circuit to blow. An ohmmeter can be used to check the dc resistance of transformers and chokes. A voltmeter can be used to check power transformers and chokes. To check a suspected transformer with a voltmeter, apply primary power to the input terminals; then use the voltmeter to read the output of the secondary windings. If one or more of the secondary windings show no voltage output, the transformer is defective.

To check a power-supply choke, use the voltmeter to read the output voltage of the choke. If the reading is excessively high, the choke has an internal short within the choke. If there is no output voltage, the choke has an open winding or a winding shorted to the case or core.

TRANSISTORS.— To check a suspected transistor, use an in or out of circuit transistor test set, or substitute the suspected transistor with a known good transistor.

SWITCHES.— An ohmmeter can be used to make continuity checks between switch terminals, or a voltmeter can be used to measure the voltages at the switch terminals.

INDICATOR LAMPS.— To check a suspected indicator lamp, you must replace it with a new lamp or one known to be good.

7.4.4 2kVA Uninterruptable Power System Single Phase (2kVA UPS)

The M120BA-1A is a high quality, rugged, 2KVA, 19² rack-mounted Uninterruptible Power Source (UPS). In addition to full compliance with all the requirements of MIL-STD-1399 (Section 300), the M120BA-1A is specifically designed to meet the harsh military shipboard environment. The high reliability and ruggedness of the M120BA-1A make it an excellent choice not only for military shipboard applications, but for critical shore-based applications as well.

The M120BA-1A consists of two main sections: Power Conditioner and UPS (see Figure 7-26).

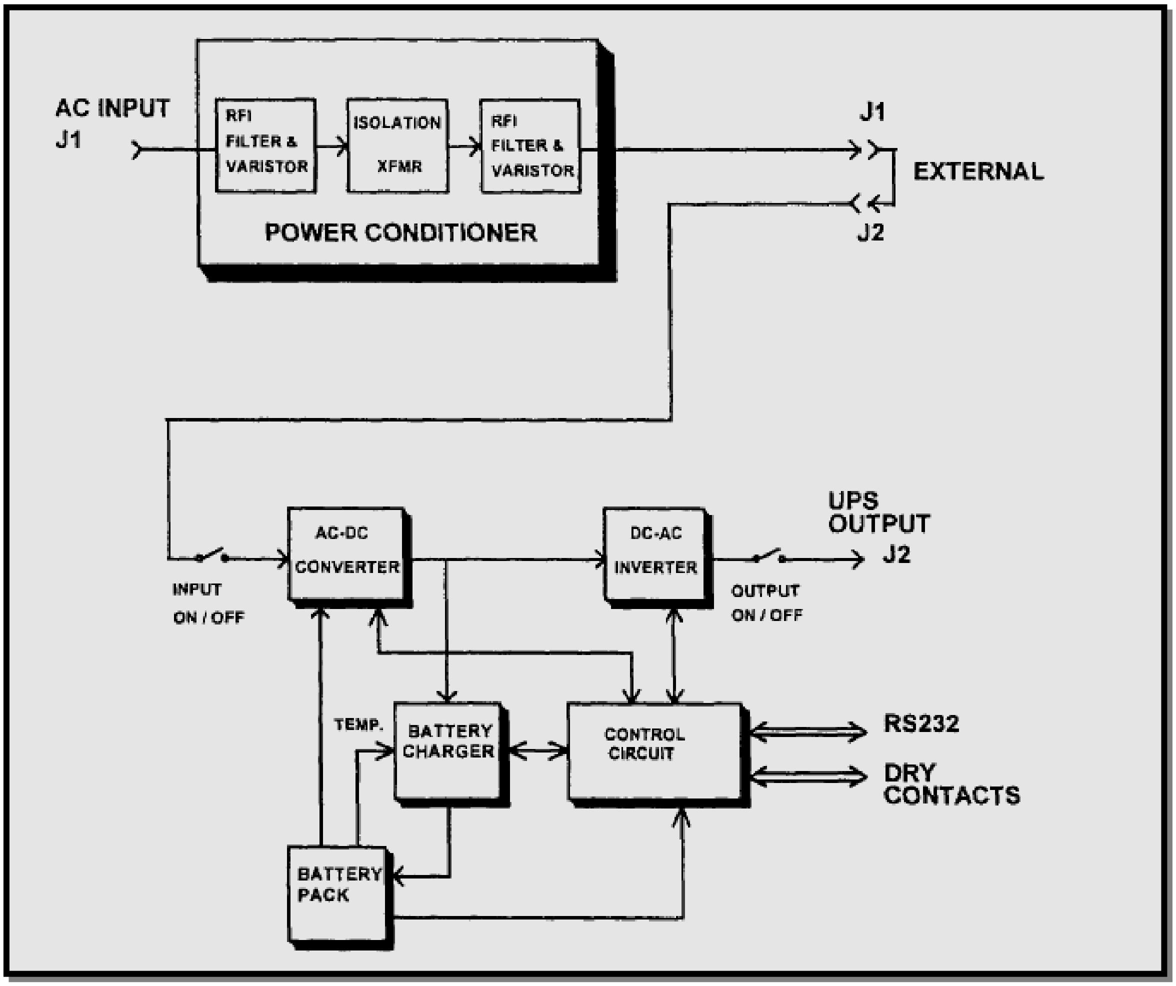


Figure 7-26.— M120BA-1A Block Diagram.

The Power Conditioner is an isolation transformer (with RFI filters and spike absorbers). Both the input and output of the Power Conditioner are available to the user via the external connectors of the unit. This configuration allows the user to externally bypass the UPS section of the UPS section of the M120BA-1A without loosing the surge protection and noise filtering provided by the Power Conditioner. This capability is extremely important in shipboard applications since most standard commercial equipment is designed to operate safely from grounded AC lines, whereas in standard shipboard electrical systems both lines are HOT and none may be grounded. The power conditioner allows the safe connection of commercial equipment to standard shipboard electrical systems without creating a safety hazard.

The UPS is composed of a high power factor AC-DC Input Section Converter, Removable Battery Pack, a Battery Charger, a DC-AC Inverter and a microcontroller-based Control Circuit.

The AC-DC Input Section Converter is a high frequency switching converter that provides 320VDC to the DC-AC inverter. The AC-DC converter draws clean sine input current waveform and does not induce electrical noise into the input lines.

The Removable Battery Pack contains the energy source used by the UPS to provide power during AC input failures. The Battery Pack includes a dozen 12V/7AH lead-acid, sealed, maintenance-free type cells. It provides 15 minutes of full rate output power. The Battery Pack is not a serviceable item. It cannot be disassembled, and can only be replaced as a single unit.

The Battery Charger is a high frequency, voltage-regulated and current-limited DC to DC converter. It is powered from the 320VDC output of the AC-DC Input Converter and provides temperature-compensated float charge to the Battery Pack.

The DC-AC Inverter is high frequency inverter that generates clean sine-shape 115VAC voltage from the 320VDC output of the AC to DC Input Section. The DC-AC Inverter is current-limited and has an overload protection circuit that turns it off (latched) after a delay from the time the load exceeds 120%. The delay depends upon the overload level.

The Control Circuit is a microcontroller-based circuit that provides monitoring of the unit's status (battery charge, load level, input and output levels, etc.) and supports communications and front panel status indicators.

Note than when the UPS is bypassed, an external circuit breaker (or fuse) must be used in order to protect the Power Conditioner from overload. The circuit breaker may be on the input or output side of the Power Conditioner. The Power Conditioner contains internal fuses on its input. These internal fuses are intended only as a safety feature in case of an internal failure and should not be used as overload protection devices.

Setting the Input Voltage Range

NOTE:
The input voltage range is set (prior to shipping) to 115VAC.

To change the input voltage range:

a) Turn off both Input and output ON/OFF switches.

b) Disconnect connectors J1 and J2 from the rear panel.

c) Open the Input Voltage Setting access cover (2 screws).

d) Pull out the exposed connector handle upward.

e) Reconnect the connector in the desired location (the window should line up with the desired voltage marking).

f) Close the access cover (tighten the two screws).

g) Verify that the desired AC input voltage matches the voltage seen through the window.

Figure 7-27.— 2kVA 1MC UPS.

7.5.0 ANNOUNCING SYSTEM AN/SIA-127F

Technology and US Navy announcing systems are changing very quickly. It is imperative to realize that every system cannot be discussed in its entirety; however, most systems in use today have at least some commonality. Table 7-5 shows the numerous possible designations in use throughout the Fleet today. Also, Table 7-5 does not show installations on ship classes with announcing systems that have been previously discussed in this chapter.

Designation	Old Designation	Installed On	Installs Planned	APL
AN/SIA-127	AM1-008	LPD-7, 8, 9, 13, 15		00046807CL
AN/SIA-127A	AM1-009	LHD-8		00046276
AN/SIA-127B	AM2-009	LHD-8		00046277
AN/SIA-127C	AM5-009	LHD-8		00046278
AN/SIA-127D	AM6-009	LHD-8		00046279
AN/SIA-127E	AM1-011	CVN-68, 76	CVN-77	000A0018CL
AN/SIA-127F	N/A	CVN-69, 75, 73	CVN-68, 70, 72	000A1203CL
AN/SIA-127G	AM5-004	LHA-4		00045036
AN/SIA-127H (Fiber control MCS)	N/A		LHA-6, CVN-71, 74	000A5119CL 000A5120
AN/SIA-128	DIAS (Old)	LCC-20		00043264
AN/SIA-129	DIAS (New)	DDG-102 Class, LCS-1 Class, CG-52	DDG-102 Class, LCS-1 Class	000A4641
AN/SIA-130	AM1-002 (1/3/6MC)	LHA-2		000A1391
AN/SIA-131	AM5-001 (5MC)	LHD-5, 6, 7		000A1393
AN/SIA-132	AM1-004 (1/3/6MC)	LHA-4		00045035
AN/SIA-133	AM1-001 (1MC)	LHD-6, 7		000A1184
AN/SIA-134(V)1 AN/SIA-134(V)2 AN/SIA-124(V)3	90-313 90-313-1	LPD-17, 18	LPD-19-25	27A0018 27A0019
UM-ICSC-1338	N/A	PC-1 Class		00040190

Table 7-5.— Announcing Systems Designations.

Since it is impossible to discuss each system entirely, individual components that may be installed within the systems will be discussed briefly (after the AN/SIA-127F) to familiarize the IC technician with the many possible combinations of Commercial Off-The-Shelf (COTS) equipment that may be encountered.

The equipment configuration described by this technical manual utilizes Commercial-Off-The-Shelf (COTS) components to provide up to 8,000 watts of audio output to drive the announcing system loudspeakers. The AN/SIA-127F rack design is centered around three Crown I-Tech series amplifiers controlled by a Crestron control computer. A touchpanel displays component status and signal inputs/outputs, and allows for an intuitive graphic-assisted user control interface. Through the touchpanel interface, the operator can test amplifier operation, monitor all incoming and outgoing control signals, view the current audio matrix configuration, set microphone control station priority, enable/disable mic stations, operate a virtual mic station, identify system faults, test alarm generators, and configure advanced system features. The AN/SIA-127F incorporates an internally-mounted uninterruptible battery power supply to protect and maintain operation of most electronics for approximately 20-30 minutes, depending on system activity. Operation of the audio amplifiers is not maintained during battery operation and thus, announcements or alarms are not possible on any supported circuit until external power is restored. The AN/SIA-127F actively monitors the operation of all key components and provides audible, visual, and control-closure outputs to indicate a component or system fault. A monitor panel allows the user to visually and audibly monitor all active announcements and alarms.

Physical Characteristics

The components of the AN/SIA-127F are housed in a 22-inch wide, 33-1/2-inch deep, and 63-inch tall cabinet. The cabinet provides Electromagnetic Interference (EMI) shielding to protect the enclosed components from external EMI and to attenuate internal EMI that may interfere with the operation of nearby equipment.

To maintain the EMI boundary, the front door panel must be properly secured when the rack is not being serviced.

All controls for operating and testing the AN/SIA-127F system are located on the front side of the cabinet (behind the EMI door). All rack circuits are grouped into removable, repairable, connectorized assemblies that can be serviced through front access. Most components are mounted on slide rails to facilitate servicing and maintenance. Refer to Figure 7-28 (Announcing System Equipment Rack, AN/SIA-127F) for the location of each major component or assembly.

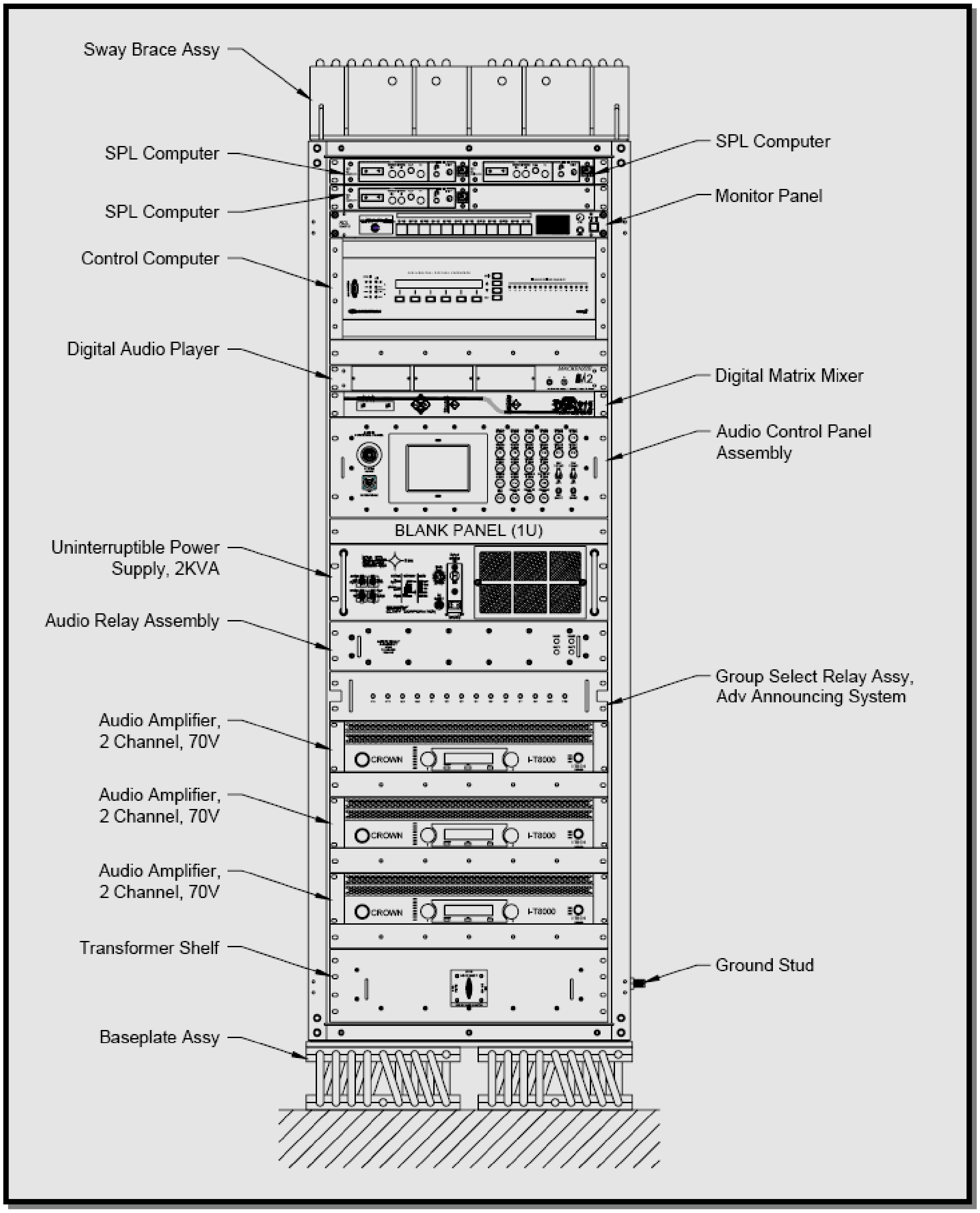


Figure 7-28.— AN/SIA-127F Front View.

The AN/SIA-127F rack is designed to meet MIL-901D Grade A requirements when mounted on the supplied resilient mounts. Total weight for the AN/SIA-127F is approximately 980 pounds.

Functional Description

The AN/SIA-127F rack controls the priority of inputs, generates alarm signals as required, and preamplifies audio signals from 1MC/3MC, 3MC, 5MC, 6MC, and Emergency 3MC microphone control stations. The equipment rack contains four active and two redundant amplifier channels with sufficient power to deliver intelligible audio to all associated speaker groups. Various interfaces are provided to external circuits, such as the telephone system. A touchpanel display allows monitoring of system inputs, control or amplifier transfer and system testing functions. The AN/SIA-127F receives audio, Press-To- Talk (PTT) and group selection switch closures from eighteen microphone control stations (twelve 1MC stations and six 3MC stations). Four switch closures from alarm contactors are received to initiate the associated alarm signal. Alarms and announcements are amplified and broadcast over one of six dedicated output groups. Various dry contact relay closures are available to interface to external circuits.

There are two digital message repeaters capable of generating all required alarm signals. Through touchpanel control, one generator is assigned primary duty and the other is redundant. When the control computer receives an external alarm contact closure, the respective alarm signal in both message repeaters are activated and the outputs applied to a computer-controlled selection relay in the Audio Control Panel (ACP). The output of this relay is sent to an input on the audio matrix mixer.

When no alarm signals are active, microphone control station PTT and group select contact closures are received by the control computer. Mic station audio is routed to one of eighteen dedicated preamplifiers in the ACP. The amplified audio output is sent to one of six inputs on the audio matrix mixer.

Announcements may also be generated from a touchpanel-based “virtual” microphone control station. Microphone audio and PTT is input through the test microphone jack on the front of the ACP. PTT from the microphone and group selection controls from the touchpanel are processed by the control computer. The audio signal is preamplified and sent to an input on the audio matrix mixer.

The AN/SIA-127F provides two analog telephone interfaces. Each analog telephone interface is customizable for a *Quick Access* or a *Menu Access.* One line is designated *Quick Access* and the second is *Menu Access*. When the *Quick Access* line is dialed, a phone line audio patch is immediately established based on touchpanel-customized group selections. When the *Menu Access* line is dialed, the system provides a voice-assisted Dual-Tone Multi-Frequency (DTMF)- controlled menu that allows the user to select individual speaker groups prior to establishing the audio patch. The telephone audio signals are sent to inputs on the audio matrix mixer.

The audio matrix mixer gathers all audio input signals, and, based on computer-controlled priorities and amplifier online status, routes the active audio to the input of the associated power amplifier channels. The amplifier uses signal processing to modify the audio waveform to improve speech intelligibility and normalize volume levels. The processed audio is amplified to 70 VAC, and sent to a dedicated set of high-current relays in the Audio Relay Assembly (ARA). Based on computer control, the ARA relays route the speaker-level audio to an audio isolation transformer. The transformer outputs are sent to a series of high-current relays in the D-3475 Group Select Relay (GSR) assembly. These relays distribute the audio to the active speaker groups based on control computer instructions.

Operation of Alarm Contactors

Shipboard alarms are initiated from alarm contactors located at various positions throughout the ship. Alarms may also be activated from the *Test Microphone Station* touchpanel page. Operation of any 1MC alarm contact maker will cause the selected signal to be reproduced over all 1MC and 3MC loudspeaker groups. The Collision alarm will be reproduced over all 5MC and 6MC speakers [AN/SIA-127F(5MC) only]. The alarm signal will override existing 1MC, 3MC, 5MC and 6MC voice announcements according to priorities established. When an alarm signal has ceased, the system returns to normal operation without need for a manual priority reset.

(1) Operate the alarm contactor to the closed position. The associated alarm will sound for as long as the contactor is held closed. The 1MC General alarm will sound for a minimum of 15 seconds or for the duration of the switch closure, whichever is longer.

(2) Return the contactor to the open position to cease the alarm. To cancel the 1MC General alarm prior to its 15-second duration, briefly activate either the 1MC Chemical or 1MC Collision alarm contactor. These alarms have priority and will cancel the General alarm.

WARNING:

The AN/SIA-127F supports 24 VDC busy lamp indicators. Standard IC/MSB-2 microphone control stations are preconfigured with 115 VAC busy lamp circuits. Each microphone control station must be modified before connecting into the AN/SIA-127F rack.

Operation of the Telephone Interfaces

The AN/SIA-127F provides two analog telephone interfaces (Line no. 1 and Line no. 2) for dial-up access to the 1MC/3MC and 5MC/6MC circuits. Line no. 1 is designated *Quick Access* and Line no. 2 is *Menu Access*. When the *Quick Access* line is dialed, a phone line audio patch is immediately established based on touchpanel-customized group selections. When the *Menu Access* line is dialed, the system provides a voice-assisted Dual-Tone Multi-Frequency (DTMF)-controlled menu that allows the user to select individual speaker groups prior to establishing the audio patch. The phone interconnection is given lowest priority in the system. Any voice or alarm announcement will have priority over the call in progress, and the control computer will immediately terminate the call in progress and hang up the phone. The system will present an off-hook (busy signal) to the phone system if the AN/SIA-127F is actively processing a voice or alarm announcement. The user should wait until the system is idle before dialing either telephone access number.

Tag-Out Procedure for Alarm Contactors

The alarm contactors are passive devices that rely on external control voltages for operation. The AN/SIA-127F supplies 24 VDC for switch control. Use the proper procedure from the tech manual to secure operation and voltages supplied to these switches.

TOUCHPANEL CONTROLS

The following paragraphs depict the operation and manipulation of the AN/SIA-127F using software-driven controls that are displayed and accessed through the touchpanel integrated into the ACP, as shown in Figure 7-28. The controls are activated by touching the screen on the area graphically represented as a pushbutton.

Controls are generally indicated by 3-dimensional shadowing and indicators are given a 2-dimensional look. Buttons that are used for page navigation have a blue face with white letters. Buttons that perform an action or change a setting are gray background with black letters. Unless otherwise noted, alternate-action pushbuttons are in the ENABLED (selected) position when they have a blue legend and have a recessed appearance.

Unless otherwise noted, indicators have a black background with gray legend when inactive (unlit), and a green background with white legend when active (lit). Differences between the AN/SIA-127F(1MC), AN/SIA-127F(3MC), and AN/SIA-127F(5MC) indicators and controls are noted where applicable.

Touchpanel Navigation

There are twenty pages that make up the touchpanel interface for the AN/SIA-127F. Each page allows control and/or diagnostics of a particular area of system operation.

VIRTUAL TOUCHPANEL CONTROLS

The AN/SIA-127F provides access to a virtual touchpanel through the external Ethernet interface via connector J20. All touchpanel pages and controls are available in Webpage format accessible by a PC running a Java enabled Web browser. In lieu of activating controls via touch-sensitive areas on the ACP touchpanel, the virtual touchpanel controls are activated by using a PC-connected mouse and screen cursor to highlight and left-click on control buttons.

7.5.1 General Announcing 1MC

The 1MC circuit of the AN/SIA-127F allows announcements and alarms to be broadcast to all general areas on the ship. The system accepts microphone-level (approximately 8.7 mV) audio and Press-To-Talk (PTT) inputs from up to twelve 1MC/3MC microphone control stations. The system provides volume meter and busy lamp indication to each microphone control station.

The microphone-level (approximately 8.7 mV) audio is first routed to the Audio Control Panel (ACP) where a dedicated switched preamplifier increases the signal to line-level (approximately 0.775 VAC). Each preamplifier is normally muted and requires a key control signal to turn on. The twelve preamplifier outputs are summed in groups of three to produce four line-level signals at the output of the ACP which are sent to input nos. 1 and 2 on the digital matrix mixer.

Based on commands sent from the control computer, the mixer will make the audio signal available at the input of amplifier A, channel nos.1 and 2 (or amplifier C, channel nos.1 and 2, if amplifier A is presently offline). Each amplifier channel accepts the audio input found in the rear of each amplifier. The audio passes through the internal amplifier circuitry to increase the level to 70 Vrms (speaker level) at the output. These amplified audio signals are sent to load transfer relays in the Audio Relay Assembly (ARA).

The control computer determines whether each audio signal is normal or test audio and commands the relays to route it to the external loudspeaker load (if normal), or the internal test load resistor (if test). The loudspeaker audio is sent to ground isolation transformer nos.1 and 2. Each transformer accepts 70 VAC input on the primary winding and provides taps for 70 VAC and 95 VAC outputs on the secondary windings, but only the 70 VAC output tap is used for 1MC.

The transformer output audio is sent to a set of group select relays in the D-3475 GSR. Based on group selection inputs from the microphone control station, alarm status, and touchpanel control override settings, the control computer determines which of the four speaker groups (Officer, Topside, Crew and Engineers) are active and commands the relays to pass the audio to the output connectors for distribution to the shipboard loudspeakers.

Any alarms generated from the AN/SIA-127F(1MC) rack are passed on to the AN/SIA-127F(3MC) rack. For the AN/SIA-127F(5MC) rack, only the Collision alarm is passed. Speech audio from the selected Hangar and/or Flight Deck Walkways are transferred to the Emergency 3MC rack.

The ACP provides a fused 24 VDC signal to each remote microphone control station to be returned via PTT and group selection switch closures. The returned PTT voltage directly drives the coil of an associated relay [relays K1 through K6 on PCB-001 Relay Board nos. 1 and 2] in the ACP.

One contact of the activated relay is used to signal the control computer of the PTT input by providing a switched ground path to a dedicated digital input on the CNPI-48I interface board in the ACP. The second relay contact connects a control computer-driven key control signal to the associated preamplifier. To activate the key control, the control computer turns on a dedicated output on the CNPI-48I interface board in the ACP.

This output provides a ground path current sink for the key control input on the preamplifier. The control computer is able to deny the preamplifier key control signal to temporarily override or disable the particular microphone station input. During control computer failure, or when COMPUTER BYPASS is selected on the touchpanel, the PTT-controlled relay directly activates the preamplifier key control.

Each group selection switch closure is first routed to the ACP where diode boards combine the like group switch closures into a single output. The control voltage output of the diode boards directly drives the coil of an associated relay [PCB-001 Relay Board no. 5, relays K1 through K6] in the ACP. One contact of the activated relay is used to signal the control computer of the group selection switch input.

NOTE:
The 24 VDC source voltage from the AN/SIA-127F rack is first fed through the microphone PTT switch closures (i.e., TALK1 and TALK2) before being made available to the group selection switches. In this way, the microphone PTT switch must be depressed before group selection switches are energized and the control system reads the associated switch closures.

7.5.2 Flight Deck and Hangar Announcing 3MC

The 3MC circuit of the AN/SIA-127F allows announcements and alarms to be broadcast to flight deck and hangar areas on the ship. The system accepts microphone-level (approximately 8.7 mV) audio and PTT inputs from up to eighteen 1MC/3MC and 3MC microphone control stations. The system provides volume meter and busy lamp indication to each microphone control station.

The microphone-level (approximately 8.7 mV) audio is first routed to the ACP where a dedicated switched preamplifier increases the signal to line-level (approximately 0.775 VAC). Each preamplifier is normally muted and requires a key control signal to turn on. The eighteen preamplifier outputs are summed in groups of three to produce six line-level signals at the output of the ACP, which are sent to input nos. 3 and 4 on the digital matrix mixer.

Based on commands sent from the control computer, the mixer will make the audio signal available at the input of amplifier B, channel nos.1 and 2 (or amplifier C, channel nos.1 and 2, if amplifier B is presently offline). Each amplifier channel accepts the audio input found in the rear of each amplifier. The audio passes through the internal amplifier circuitry to increase the level to 70 Vrms (speaker level) at the output. These amplified audio signals are sent to load transfer relays in the ARA. The control computer determines whether each audio signal is normal or test audio and commands the relays to route it to the external loudspeaker load (if normal), or the internal test load resistor (if test). The loudspeaker audio is sent to ground isolation transformer nos. 3 and 4. Each transformer accepts 70 VAC input on the primary winding and provides taps for 70 VAC and 95 VAC outputs on the secondary windings, but only the 70 VAC output tap is used for 3MC.

The transformer output audio is sent to a set of group select relays in the D-3475 GSR. Based on group selection inputs from the microphone control station, alarm status, and touchpanel control override settings, the control computer determines which of the two speaker groups (Hangar and Flight Deck Walkways) are active and commands the relays to pass the audio to the output connectors for distribution to the shipboard loudspeakers.

Any alarms generated from the AN/SIA-127F(1MC) rack are passed on to the AN/SIA-127F(3MC) rack. For the AN/SIA-127F(5MC) rack, only the Collision alarm is passed. Speech audio from the selected Hangar and/or Flight Deck Walkways are transferred to the Emergency 3MC rack.

The ACP provides a fused 24 VDC signal to each remote microphone control station to be returned via PTT and group selection switch closures. The returned PTT voltage directly drives the coil of an associated relay [relays K1 through K6 on PCB-001 Relay Board nos. 1, 2, and 3] in the ACP. One contact of the activated relay is used to signal the control computer of the PTT input by providing a switched ground path to a dedicated digital input on the CNPI-48I interface board in the ACP. The second relay contact connects a control computer-driven key control signal to the associated preamplifier. To activate the key control, the control computer turns on a dedicated output on the CNPI-48I interface board in the ACP. This output provides a ground path current sink for the key control input on the preamplifier. The control computer is able to deny the preamplifier key control signal to temporarily override or disable the particular microphone station input. During control computer failure, or when COMPUTER BYPASS is selected on the touchpanel, the PTT-controlled relay directly activates the preamplifier key control.

Each group selection switch closure is first routed to the ACP where diode boards [PCB-002 Diode Board nos. 1, 2, and 3] combine the like group switch closures into a single output. The control voltage output of the diode boards directly drives the coil of an associated relay [PCB-001 Relay Board no. 5, relays K1 through K6] in the ACP. One contact of the activated relay is used to signal the control computer of the group selection switch input.

7.5.3 Flight Deck Announcing 5MC

The 5MC circuit of the AN/SIA-127F(5MC) allows announcements and alarms to be broadcast to the flight deck and designated aviation areas on the ship. The system accepts microphone audio and PTT switch closure inputs from up to twelve 5MC microphone control stations. The system provides volume meter and busy lamp indication to each microphone control station.

The microphone-level (approximately 8.7 mV) audio is first routed to the ACP where a dedicated switched preamplifier increases the signal to line-level (approximately 0.775 VAC). Each preamplifier is normally muted and requires a key control signal to turn on. The twelve preamplifier outputs are summed in groups of three to produce four line-level signals at the output of the ACP, which are sent to inputs of the digital matrix mixer. The mixer amplifies the mic station audio signal from line level to 1.4 VAC, and distributes it to amplifiers. The amplifier amplifies the 1.4 VAC input to a 70 VAC output which go through group select relays to a selected group of speakers. For the AN/SIA-127F(5MC) rack, only the Collision alarm is passed.

The ACP provides a fused 24 VDC signal to each remote microphone control station to be returned via PTT switch closure. The returned PTT voltage directly drives the coil of an associated relay in the ACP. One contact of the activated relay is used to signal the control computer of the PTT input by providing a switched ground path to a dedicated digital input on the CNPI-48 interface board in the ACP. The second relay contact connects a control computer-driven key control signal to the associated preamplifier. To activate the key control, the control computer turns on a dedicated output on the CNPI-48 interface board in the ACP. This output provides a ground-path current sink for the key control input on the preamplifier. The control computer is able to deny the preamplifier key control signal to temporarily override or disable the particular microphone station input. During control computer failure or when COMPUTER BYPASS is selected on the touchpanel, the PTT-controlled relay directly activates the preamplifier key control.

Based on microphone control station activity, alarm status, and touchpanel control override settings, the control computer activates the appropriate key control outputs of the amplifier channel interface. To activate the key control output, the control computer turns on a dedicated output on the CNPI-48 interface board in the ACP.

7.5.4 Ship-to-Ship Announcing 6MC

The 6MC circuit of the AN/SIA-127F(5MC) allows announcements to be broadcast away from the ship to other nearby vessels or shore stations. The system accepts microphone audio and PTT switch closure inputs from up to six 6MC microphone control stations. The system provides volume meter and busy lamp indication to each microphone control station.

The microphone-level (approximately 8.7 mV) audio is first routed to the ACP where a dedicated switched preamplifier increases the signal to line-level (approximately 0.775 VAC). Each preamplifier is normally muted and requires a key control signal to turn on. The six preamplifier outputs are summed in groups of three to produce two line-level signals at the output of the ACP, which are sent to the input of the digital matrix mixer. The mixer amplifies the mic station audio signal from line level to 1.4 VAC, and distributes the output to the associated amplifiers. The amplifiers accept the 1.4 VAC audio inputs and amplifies them to 70 VAC and makes them available as audio outputs that are isolated. For the AN/SIA-127F(5MC) rack, only the Collision alarm is passed.

The ACP provides a fused 24 VDC signal to each remote microphone control station to be returned via PTT switch closure. The returned PTT voltage directly drives the coil of an associated relay in the ACP. One contact of the activated relay is used to signal the control computer of the PTT input by providing a switched ground path to a dedicated digital input on the CNPI-48 interface board in the ACP. The second relay contact connects a control computer-driven key control signal to the associated preamplifier. To activate the key control, the control computer turns on a dedicated output on the CNPI-48 interface board in the ACP. This output provides a ground-path current sink for the key control input on the preamplifier. The control computer is able to deny the preamplifier key control signal to temporarily override or disable the particular microphone station input. During control computer failure or when COMPUTER BYPASS is selected on the touchpanel, the PTT-controlled relay directly activates the preamplifier key control.

7.5.5 Alarms

The AN/SIA-127F accepts alarm contact closures for the Collision, Chemical, General, Unassigned, and Fire Announcing alarms. The contact closures are read by the control computer and processed according to system priority. If a lower priority signal is being processed by the system, the control computer interrupts signal flow and sets up for alarm operation.

Each digital repeater card in the Mackenzie A1236 digital audio player stores the audio files for each of the six alarms.

The ACP provides a fused 24 VDC signal to the remote alarm contactors to be returned via switch closures. The returned alarm control voltage directly drives the coil of an associated relay [relays K1 through K4 on PCB-001 Relay Board no. 4] in the ACP. One contact of the activated relay is used to signal the control computer of the alarm input by providing a switched ground path to a dedicated digital input on the CNPI-48 interface board in the ACP.

The contact closures are read by the control computer and processed according to alarm priority. If a lower priority alarm is being processed by the system, the control computer interrupts the current alarm and plays the new alarm. The control computer uses two dedicated RS232 serial ports to issue commands to the digital repeater cards in the Mackenzie A1236 digital audio player where alarm tones are stored and processed.

When the control system receives an alarm request from an external contactor, it simultaneously issues a command to both digital repeater cards to play the required alarm tone. The line-level output of each repeater card is sent to a computer-controlled relay in the ACP, which selects one of the two audio signals to be routed to input no. 8 on the digital matrix mixer. Based on commands sent from the control computer, the mixer will make the audio signal available at the input of all online amplifier channels.

The 70 VAC amplified audio signal is sent through the load transfer relays in the ARA, then through the D-3475 GSR and the ground isolation transformers. Based on the touchpanel control override settings, the control computer commands the relays to pass the alarm audio to the output connectors for distribution to the shipboard loudspeakers.

7.5.6 Prioritization

For a given circuit, alarms have priority over announcements. An announcement in progress will be muted during an announcement or alarm of higher priority. The lower priority signal will be allowed to retransmit following completion of higher priority signals. Using touchpanel controls, microphone controls stations can be individually assigned one of three levels of priority: *HIGH*, *MEDIUM*, or *LOW*. A station with priority set to *HIGH* will preempt active announcements from stations on the same circuit that have their priority set to *MEDIUM* or *LOW*. Stations with equal priority on the same circuit will have first-come first-served access to the circuit.

7.5.7 Local Loudspeaker Cutout

Loudspeakers in the general vicinity of an active microphone control station or jackbox must be muted to eliminate the potential for audio feedback. Eighteen relays (CNXRY-16 cards in slot nos. 9 through 11) in the control computer provide cutout switching for the isolation of local speaker audio. Through touchpanel controls, the local cutout speaker associated with each of the eighteen 1MC/3MC and 3MC microphone control stations can be programmed to respond to a specific 1MC or 3MC speaker group. Local cutout speakers receive all system announcements, except when the announcement is generated from the associated microphone control station.

7.5.8 Busy Circuits

Two busy circuits are provided based on system activity sensed by the control computer. The BUSY1 circuit is triggered during an active 1MC group 1, 2, 3 or 4 announcement or any 1MC alarm. The BUSY2 circuit is triggered during an active 3MC group 5 or 6 announcement or any 1MC alarm. The control computer operates relays K1 and K2 on PCB-003 Relay Board in the ACP which supply a grounded return path to the fuse-protected 24 VDC supplied to each station to drive busy lamp indication. The control computer also operates various relays during busy conditions for interfacing to external circuits.

NOTE:

Typical IC/MSB-2 microphone control stations are equipped with 115 VAC busy lamps circuits. The AN/SIA-127F supports 24 VDC busy lamps. Each microphone control station must be modified for compatible operation with the AN/SIA-127F.

7.5.9 Volume Indicator Meter Circuit
The AN/SIA-127F supports volume meter indicators found in IC/MSB-2 microphone control stations. These meters provide the user with visual feedback of system volume level. 70 VAC audio for each of the circuits (1MC and 3MC) is taken from the ARA output and provided to the input of the PCB-004 VU Meter Board mounted to the inside of the AN/SIA-127F rack. Four potentiometer circuits attenuate the 70 VAC signal to a calibrated level required by the control station's VU meter.

Monitor Panel
The AN/SIA-127F is equipped with a monitor panel that allows the user to actively monitor various audio signals as they pass through the equipment rack. Using this panel, the user may observe operation, volume and intelligibility of the audio that is being broadcast to the shipboard speakers.

Crestron TPS-2000L Touchpanel
This unit is installed in the ACP assembly and provides the user controls and indicators for the AN/SIA-127F. The graphics file stored in on-board non-volatile memory works in conjunction with the control system program stored in the RACK2 control computer. A factory replacement touchpanel must be modified before use in the AN/SIA-127F.

Figure 7-29.— TPS-2000L Touchpanel.

Ethernet Interface
The AN/SIA-127F is equipped with an internal Ethernet switch that allows communication between the various IP enabled components. There is also an RJ45 connector on the AN/SIA-127F for connection to an external network. Each component within the AN/SIA-127F subnet is assigned a default IP address at the factory. An external PC can be connected to the AN/SIA-127F for setup and diagnostics of components and access to the virtual touchpanel.

ClearOne PSR1212 Digital Matrix Mixer
The PSR1212 allows independent routing of any of 12 line-level inputs to any of 12 line-level outputs. Each output may have a unique mix of the twelve available inputs based on RS232 commands issued by the control computer. Input / output crosspoint settings are displayed on the *Audio Matrix Mixer* page of the touchpanel. The front panel controls are locked out and not normally accessible by the user. Refer to the PSR1212 operation manual in Section 10 for instructions on unlocking the front panel. The AN/SIA-127F configuration requires that the Device ID of the PSR1212 be set for proper operation. Refer to the PSR1212 operation manual in Section 10 for instructions on checking and setting the Device ID. The PSR1212 has many adjustable software parameters that affect the operation of the unit and the processing of the audio signals that pass through the matrix. The AN/SIA-127F requires these parameters to be set to a default set of values for proper operation of the system. Use the INITIALIZE MIXER control on the *System Controls* page to load the default parameter set into the mixer's non-volatile memory. The PSR1212 requires externally applied 115 VAC single-phase 60 Hz power for operation.

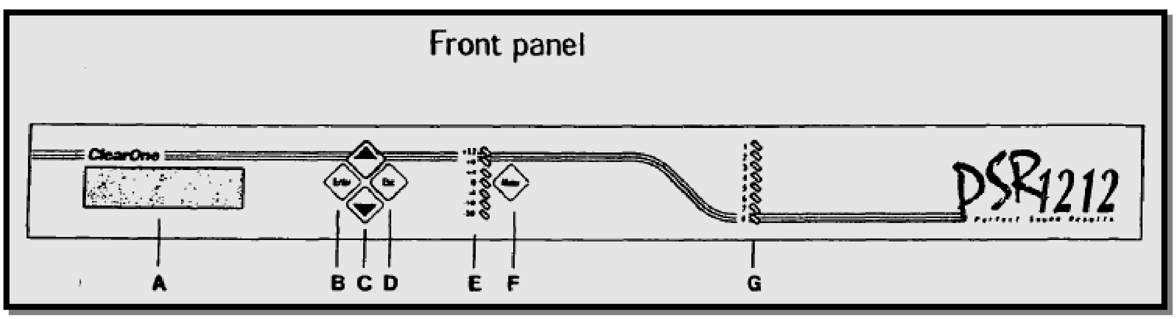


Figure 7-30.— PSR1212 Front Panel Controls.

A. **LCD.** This display is for PSR1212 setup in conjunction with the four associated front-panel buttons [B, C, and D]. Baud rate and flow control must be configured from the front panel; see the LCD Menu Tree for the location of these in the menu system. Other functions accessed via the front panel include system options: RS-232 configuration, troubleshooting, and level readings.

B. **Enter.** This button is used when programming the PSR1212 via the LCD window. To move deeper in the menu or execute a selected parameter, press the Enter button.

C. **Up/Down Buttons.** These buttons scroll up and down through vertical programming options within a specific PSR1212 programming parameter or increases/decreases a numeric value.

D. **Esc.** This button steps you out of a selected parameter or moves you up one level in the menu. When a parameter has been displayed with the arrow buttons [C], you can select it with the Enter button [B] to modify it. Then, you can step out of the menu with the Esc button.

E. **LED meter.** This assignable, peak-level LED bar meter is used to display the audio level of an input, output, or processing channel of the PSR1212.

F. **Meter.** Takes you directly to the Meter branch of the PSR1212's LCD menu tree.

G. **LED** 1-8. These LEDs indicate Inputs 1-8 gate status.

Crown I-T8000 Amplifier

The amplifier is capable of supplying 2500 watts (into a 2-ohm load) of audio output power to each of two channels. Advanced protection circuitry and a thermal management controller detect and compensate for overheating and overload conditions; monitor and correct signal distortion; monitor output current and allow the amplifier to continue operation under excessive load conditions. The amplifier is controlled and monitored by the control computer through an Ethernet built in each amplifier. The Crown IT8000 requires externally applied 115 VAC single-phase 60 Hz power for operation. Through an integrated Ethernet port, the Crown I-T8000 allows the control computer or externally connected PC to monitor and control amplifier operation. The Crown I-T8000 executes commands issued by the control computer and reports back the status of the amplifier. The AN/SIA-127F requires these parameters to be set to a default set of values for proper operation of the system. Use the INITIALIZE AMPLIFIERS control on the *System Controls* page to load the default parameter set into the non-volatile memory of each amplifier.

Figure 7-31.— Crown Amplifier.

Audio Relay Assembly

The ARA assembly provides high-current, load-switching for up to eight online amplifier channels, eight load circuits, two offline backup amplifier channels, and one test load. Using feedback from the touchpanel and amplifier failure indicators, the control computer can use the relays of the ARA to switch an amplifier offline, connect the output of the offline amplifier to a test load, and connect the speaker load of the offline amplifier to the backup amplifier. Eighteen DPDT relays (K1 through K18) provide these load switching functions. Four DPDT relays (K19 through K22) with normally open and common normally closed contacts are provided for configurable high-current switching applications. One DPDT relay (K23) is provided as an unwired on-board spare. Two installed interface boards (Crestron CNPI-16B) allow the control computer to individually control each relay. Each interface board is addressable and must be assigned a unique CRESNET network ID.

Each interface board has two indicators on the ARA front panel that communicate the status of the CRESNET power and data pairs for each board. The PWR1 and PWR2 indicators are lit when 24 VDC power is available to the associated board. The NET1 and NET2 indicators are lit when the associated board has established stable communications with the control computer. Connection of the ARA to other circuits within the AN/SIA-127F is made through rear-mounted connectors. Connectors J1 through J4 carry audio signals in and out of the ARA.

Connector J5 supplies audio output samples to an external circuit. Connectors J6 and J7 are paralleled power and CRESNET connection points that may serve as a pass-through connection to other devices. The ARA requires externally applied 24 VDC power for operation.

D-3475 Group Select Relay Assembly

The D-3475 GSR assembly provides high-current switching for ten speaker groups. A pair of jacks on the front panel is provided for each speaker group relay. When a group relay is active, the jacks are connected through normally open contacts to the speaker load. A speaker load analyzer can be used to measure the connected speaker load through these jacks. Based on system activity, the control computer will release (de-activate) the group relay to allow amplifier output audio to be delivered through normally closed contacts to the speaker load. Ten DPDT relays (K1 through K10) provide these group select switching functions. Two DPDT relays (K11 and K12) with normally open and normally closed contacts are provided for configurable high-current switching applications. Four DPDT relays (K13 through K16) with normally open and common normally closed contacts are provided for configurable high-current switching applications. Two DPDT relays (K17 and K18) are provided as unwired on-board spares. An interface board (Crestron CNPI-16B) allows the control computer to individually control each relay. The interface board is addressable and must be assigned a unique CRESNET network ID.

The interface board has two indicators on the D-3475 GSR front panel that communicate the status of the CRESNET power and data pairs. The PWR indicator is lit when 24 VDC power is available to the board. The NET indicator is lit when the board has established stable communications with the control computer. Connection of the D-3475 GSR to other circuits within the AN/SIA-127F is made through rear-mounted connectors. Connectors J1 through J4 carry audio signals in and out of the D-3475 GSR. Connector J5 supplies audio output samples to an external circuit. Connectors J6 and J7 are paralleled power and CRESNET connection points that may serve as a pass-through connection to other devices. The D-3475 GSR requires externally applied 24 VDC power for operation.

Isolation Transformers

The AN/SIA-127F is equipped with four high-power isolation transformers. The transformers increase the safety of distributing a 70 V or 95 VAC signal throughout a metal-hull ship by completely isolating the two signal conductors of each amplifier output channel from ground. This balanced signal allows accidental contact with one of the signal conductors without creating a personnel or equipment hazard. For a given 70 VAC (at 1 kHz) in signal, the transformer is designed to provide 70 VAC (35 amps max) and 95 VAC (30 amps max) outputs. The combined load on the secondary side of the transformer is limited to 2500 watts. The transformer terminations are assigned as shown in Table 7-6.

WIRE NO.	DESIGNATION
1	Primary 70V
2	Primary COM
3	Secondary COM
4	Secondary 70V
5	Secondary 95V

Table 7-6.— Transformer Taps.

RDL RM-MP12 Monitor Panel

The monitor panel provides visible and audible monitoring of audio signals generated within the AN/SIA-127F. The RM-MP12 provides 12 individually selectable audio inputs configurable for various standard input signal levels. A jumper for each input sets the expected signal level (line, 25 V, 70 V, or 100 V). Audible monitoring is via a volume-controlled front panel speaker. Visual monitoring is via a 15-segment Light Emitting Diode (LED) display. Each audio input has a gain pot to calibrate the LED and speaker output levels. The RM-MP12 requires externally applied 24 VDC power for operation.

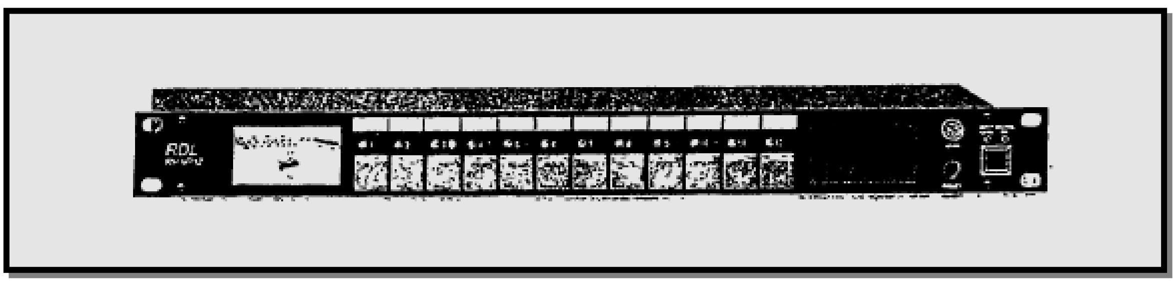


Figure 7-32.— Rack Mount 12-Channel Audio Monitor Panel (RM-MP12).

Clary Corporation UPS1-2K-1G-SRNDTI-J2 Uninterruptible Power Supply

The UPS provides approximately 5 minutes of runtime for a full (2000VA) load and 18 minutes at half load. The fully-isolated input is configured specifically for shipboard delta-power installations. Output is provided at two rear-mounted connectors. Indicators and control outputs 0communicate UPS operation and health to the user and control computer. The AN/SIA-127F utilizes the UPS to protect all components except the audio power amplifiers (Crown I-T8000). This allows the sensitive on-board processors and non-volatile memory to be shielded from the frequent brownouts and blackouts associated with typical shipboard power. The AN/SIA-127F incorporates an UPS bypass switch to power the UPS load directly from available utility power. The UPS requires externally applied 115 VAC single-phase 60 Hz power for operation.

Figure 7-33.— Clary UPS.

Mackenzie A1236 Digital Audio Player

The A1236 is a computer controlled audio reproduction device that plays stored audio messages when commanded. The A1236 incorporates two sets of independently controlled dual-channel audio processors that each store a copy of the complete message files on non-volatile PCMCIA memory cards. Each audio processor board is serviced by a dedicated 24 VDC power supply and utility fuse. Each audio processor board accepts either direct contact closures or RS-232 commands to control message playback. A dry-contact relay closure provides indication of playback status. The A1236 requires externally applied 115 VAC single-phase 60 Hz power for operation.

Figure 7-34.— High Fidelity Multi-channel Digital Audio Player.

Moxa EDS-308 EtherDevice Switch

The EDS-308 is an eight port Ethernet Switch that supports 10/100BaseT(X) full/half-duplex network communications with automatic speed negotiation and MDI/MDI-X connection. Indicators denote the power, ACT, LNK, and 10/100 status for each port. A DIP8 switch provides configuration for the port break alarm relay. The EDS-308 requires externally applied 12 to 48 VDC power with provisions for redundant inputs.

Figure 7-35.— Moxa EtherDevice Switch.

The EDS-308 Ethernet switch is used by the AN/SIA-127F to form a subnet between the control computer and amplifiers, as well as provide an access point for an externally connected network. A factory replacement Ethernet switch must be modified before use in the AN/SIA-127F.

Crestron RACK2 Control Computer

The RACK2 is a configurable computer control system with sixteen expansion card slots. A front panel digital display and pushbuttons allow various diagnostic and control functions. The RACK2 requires externally applied 24 VDC power for operation. The AN/SIA-127F requires the installation of the control cards in specific assigned slots into the RACK2 card cage.

<u>Symetrix 371 SPL Computer</u>

The Symetrix 371 SPL Computer automatically raises and lowers sound system levels in response to changes in ambient noise conditions. Externally-mounted sensing microphones on the 371 ensure that announcements are always clearly audible and distinct. The 371 tracks environmental noise levels, internal signal levels and all the control settings in operating conditions. It makes appropriate gain changes whenever it finds measured noise levels that deviate from the stored performance characteristics. All front panel controls are set during initial calibration and should not be changed. A multi-segment LED bar graph indicates the internal gain of the 371 during operation. For this application, the 371 provides ambient noise sensing and level adjustment for the circuit 3MC Hangar Bay speakers. The 371 operates from 115 VAC applied through a rear-mounted cord assembly.

Figure 7-36.— Symetrix 371 SPL Computer.

<u>Pressure Zone Microphone (PZM)</u>

The PZM, external to the ANSIA/127F, utilizes a condenser microphone mounted very close to a sound reflecting plate. The capsule is mounted in the "pressure zone" where sound coming directly from the sound source combine in-phase with sound reflected off the boundary. The output is a balanced, low impedance signal. The PZMs are the inputs to the Symetrix 371 SPL Computers. The PZMs serve the 3MC system and are mounted in the Hangar Bay.

<u>Presentation Control Station (PCS)</u>

This station allows for the remote input and control of local microphone and line signal inputs to the announcing system rack from the Hangar Bay. The PCS operates on a 24 VDC and Cresnet control.

7.5.10 AN/SIA-127F Troubleshooting

This section presents the technical data and procedures required to locate and identify faulty components within the AN/SIA-127F rack or other equipment, which together comprise the 1MC and 3MC shipboard announcing systems.

Fault Recognition

Equipment fault recognition will usually occur as a result of normal system operations. Performance of the routine preventive maintenance performance tests will occasionally disclose some fault conditions normally evident during equipment operation. Conducting these tests will more precisely define the extent of the malfunction and assist in localizing the fault.

Fault Isolation

This equipment maintains redundancy for key components, though as in most systems, there still exists, single points of failure that can inhibit individual features, or temporarily disrupt operation of the entire system. For failures of redundant circuits, the AN/SIA-127F will automatically switch to the backup unit and maintain full operation while notifying the operator of the fault. Other common components have unwired on-board spares available to be manually substituted for the failed component. In most cases, the technician should be able to identify the fault, isolate the faulty component, and return the equipment to limited operation until the faulty component can be replaced.

7.5.11 Test Equipment

Recommended equipment and minimum operating specifications are detailed below:

Tone Generator

A tone generator is required to establish reference level audio input signals used to calibrate the gain structure of the components in the AN/SIA-127F. To simulate a microphone control station audio input, the tone generator shall be capable of producing a sine wave with a frequency of 1 kHz and amplitude of 8.7 mVrms. To simulate a line-level audio input, the tone generator shall be capable of producing a sine wave with a frequency of 1 kHz and amplitude of 0.775 Vrms.

Voltmeter

A true-rms voltmeter is required to measure the various signal levels found within the AN/SIA-127F. The meter should have a minimum AC and DC resolution of 0.001 V (1 mV) to 250 V. During troubleshooting or maintenance of the AN/SIA-127F, the technician may encounter the signal types and levels shown in Table 7-7.

SIGNAL TYPE	LEVEL
Microphone Level Audio	8.7 mVAC (@ 1 kHz)
Line Level Audio	0.775 VAC (@1 kHz)
VU Meter Audio	2 VAC (@1 kHz)
Speaker Level Audio	70 VAC (@ 1 kHz)
Utility Power	115 VAC (@ 60 Hz)
Logic High	5 VDC
Main Power Supplies	24 VDC

Table 7-7.— Signal Levels.

Computer

A computer running the Windows operating system (version 9x or later) which shall be equipped with a CD-ROM drive, floppy drive, one available COM port, and a 100BaseT network interface port. A serial cable (DB9-male to DB9-female, wired straight through) is required to connect the computer to various components within the AN/SIA-127F. A CAT-5 Ethernet cable (RJ45-male to RJ45-male, wired straight through) is required to connect the computer to the AN/SIA-127F subnet. Specific system requirements are located in the technical documentation for each vendor software package.

Software

Various software packages are required to set up individual components within the AN/SIA-127F. The technician should always check, when possible, for newer versions on the vendor Website prior to installing the enclosed software packages.

7.6.0 CROWN MACRO-TECH AMPLIFIERS

There are many reasons to use amplifiers with an extremely high power density. As more loudspeakers are driven with fewer amplifiers, audio systems become more compact and efficient.

7.6.1 Crown Power Amplifier MA-5000VZ

The Macro-Tech 5000VZ uses the very latest technology and miniaturized design to provide the highest power and value for its size, weight and price. Its patented grounded bridge circuitry offers many advantages over conventional designs. In Stereo mode, the amplifier's separate high-voltage supplies and ultra-low crosstalk make it possible to treat each channel as an independent amplifier.

A. Dust Filters

The dust filters remove large particles from air drawn in by the cooling fans. Check the filters regularly to prevent clogging.

B. Level Controls
The output level for each channel is set with these convenient front panel level controls. Each control has 31 detents for precise adjustment. A security option is also available to prevent tampering.

C. Load/Limit Indicators
The flow of current to the loudspeakers (“load current”) and the maximum current limit of the amplifier (“limit current”) are monitored by these two-color front panel indicators. Normally, the Load/Limit indicators glow green to show that load current is flowing. They turn off when there is no significant load current. This happens when there is no input signal, the input signal is at an extremely low level, or there are no loads connected to the amplifier’s outputs. They turn red if the amplifier has reached its maximum output current capacity. The Load/Limit indicators are very useful when loading the amplifier for maximum output. Just continue to connect additional loudspeakers in parallel with each output until the Load/Limit indicator turns red under normal operating conditions. The optimum load is achieved just before the indicator turns red.

D. Signal/IOC Indicators
These green multifunction indicators show both signal presence and distortion for each channel. As signal presence indicators, they flash synchronously with the amplifier’s audio output. As IOC (Input/Output Comparator indicators, they flash brightly with a 0.1 second hold delay if there is a difference of 0.05% or more between the input and output audio waveforms. IOC “errors” occur most commonly when a large input signal causes an input overload or output clipping. The IOC function is also provided as proof of distortion-free performance.

E. ODEP Indicators
During normal operation of the ODEP (Output Device Emulation Protection) circuitry, these amber indicators glow brightly to show the presence of reserve thermal-dynamic energy. They dim proportionally as energy reserves decrease. In the rare event that energy reserves are depleted, the indicators turn off and ODEP proportionally limits output drive so the amplifier can safely continue operating even under severe conditions. These indicators also help to identify more unusual operating conditions.

F. Enable Indicator
This indicator lights when the amplifier has been turned on (enabled) and has AC power.

G. Enable Switch
This push button is used to turn the amplifier on and off. When turned on, the output is muted for about four seconds to protect your system from start-up transients. This is why a power sequencer is rarely needed for multiple units. (The length of the turn-on delay can be changed.

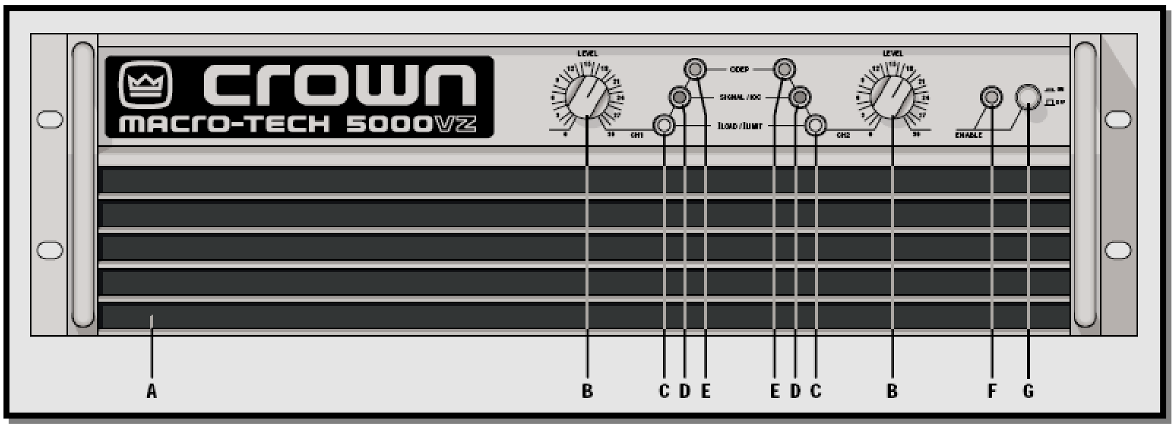


Figure 7-37.— MA-5000VZ.

7.6.2 Crown Power Amplifier MA-3600VZ
The Macro-Tech 3600VZ amplifier uses the latest technology and miniaturized design to deliver the highest power and value for its size, weight and price. Crown's Grounded Bridge output and patented ODEP protection circuitry combine to provide performance and reliability that surpass all conventional amplifier designs. Macro-Tech amplifiers also have an independent high voltage power supply for each channel. This design provides ultra-low crosstalk specifications and makes it possible to treat each channel as a separate amplifier.

A. Dust Filter
The dust filters remove large particles from the air at the air intake. Check filters regularly to be sure they do not become clogged. The filter elements can be easily removed for cleaning by gently pulling them away from the front panel.

B. Level Controls
The level for each channel is set with these convenient controls mounted on the front panel. Each level control has 31 detents for precise adjustment. A security option is available to prevent tampering.

C. Signal / IOC Indicators

The presence of an audio signal and the distortion level of each channel is represented by these green multifunction indicators. As signal presence indicators, they flash with normal intensity in sync with the output audio signal to indicate its presence. As IOC (Input/Output Comparator) indicators, they compare the waveform of the input signal to that of the output. They flash brightly with a 0.1 second hold delay if there is a difference (or distortion) of 0.05% or more. Another IOC function is to indicate input overload. If the input signal is too large the indicators will flash brightly (with a 0.5 second hold delay) to indicate input clipping distortion. Note: The Channel 2 IOC indicator will stay on in Parallel-Mono mode.

D. ODEP Indicators

During normal operation of the Output Device Emulation Protection circuitry, these indicators glow brightly to show the presence of reserve thermodynamic energy.

They dim proportionally as energy reserves decrease. In the event that energy reserves are depleted, the indicators turn off and ODEP proportionally limits output drive so the amplifier can safely continue to operate even under severe conditions. These indicators can also help to identify more unusual operating problems.

E. Enable Indicator

This indicator lights when the amplifier has been “enabled” or turned on, and AC power is available.

F. Enable Switch

Depress this push-button to turn the amplifier on or off. When turned on, the output is muted for approximately four seconds to protect your system from start-up transients.

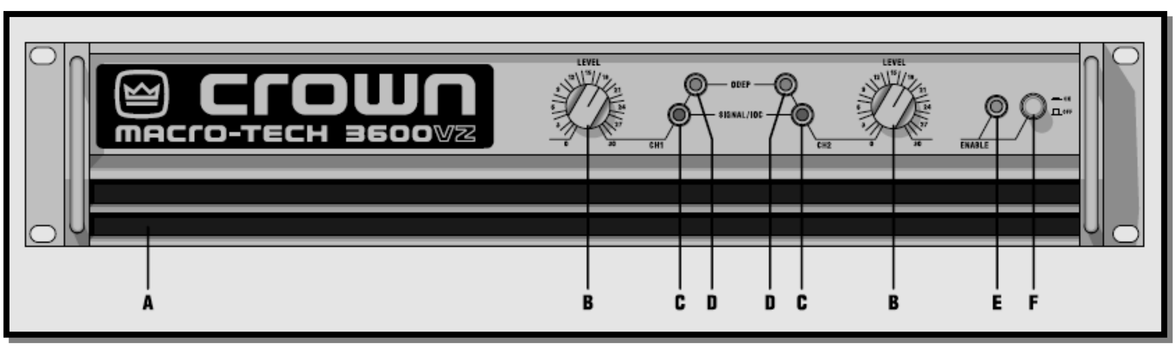


Figure 7-38.— MA-3600VZ.

7.6.3 Crown Power Amplifier MA-2402

Macro-Tech amplifiers use cutting edge technology to deliver the ultimate in power and value for their size, weight and price. They offer numerous advantages over conventional designs and provide benefits you can't get in amplifiers from any other manufacturer.

A. Dust Filters

The dust filters remove large particles from the air drawn in by the cooling fan. Check the filters regularly to prevent clogging. The filter elements can be easily removed for cleaning by gently pulling them away from the front panel.

B. Level Controls

The output level for each channel is set with these convenient level controls mounted on the front panel. Each level control has 31 detents for precise adjustment. A security option is available to prevent tampering.

C. Signal/IOC Indicators

These green multifunction indicators show signal presence and distortion for each channel. As signal presence indicators, they flash synchronously with the output audio signals to show their presence. As IOC (Input/Output Comparator) indicators, they flash brightly with a 0.1 second hold delay if there is a difference of 0.05% or more between the input and output signal waveforms. This provides proof of distortion-free performance. Note: The Channel 2 IOC indicator stays on in Parallel-Mono mode.

D. ODEP Indicators

During normal operation of the ODEP (Output Device Emulation Protection) circuitry, these amber indicators glow brightly to show the presence of reserve thermal-dynamic energy. They dim proportionally as energy reserves decrease. In the rare event that energy reserves are depleted, the indicators turn off and ODEP proportionally limits output drive so the amplifier can safely continue operating even under severe conditions. These indicators can also help identify more unusual operating conditions.

E. Enable Indicator

This indicator lights when the amplifier has been "enabled" or turned on, and AC power is available.

F. Enable Switch

This push button is used to turn the amplifier on and off. When turned on, the output is muted for approximately four seconds to protect your system from start-up transients.

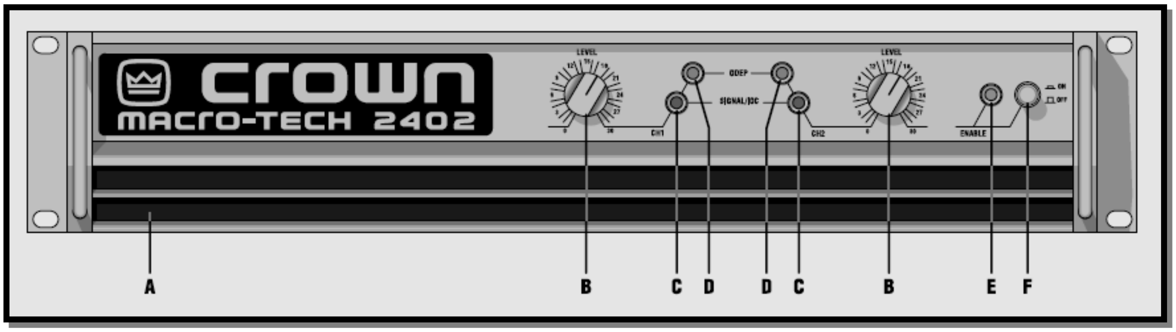


Figure 7-39.— MA-2402.

7.7.0 CROWN PROGRAMMABLE INPUT PROCESSOR (IQ-PIP-SMT)

The IQ–P.I.P.–SMT is a PIP2 input module for Crown P.I.P. (programmable input processor) and PIP2-compatible amplifiers. Because it is also an IQ2-series component, it supports Crown's UCODE protocol and requires an IQ System with an IQ2-compatible IQ interface. UCODE (universal code) enables users and third parties to develop custom software objects to control and monitor IQ2-compatible components like the IQ–P.I.P.–SMT. The IQ–P.I.P.–SMT connects the amplifier to the Crown Bus of an IQ System so the amplifier can be controlled and monitored. With its SmartAmp features, it offers several automation functions such as the ability to automatically turn on an amplifier channel (high voltage supply) when it is needed and then turn it back off when it is no longer needed. This conserves power and saves money.

Figure 7-40.— IQ-PIP-SMT.

A. Mounting Screws

The IQ–P.I.P.–SMT is secured to the back panel of the amplifier with two phillips-head screws and star-tooth lock washers. The lock washers are required for proper ground connection.

B. Balanced Audio Inputs
A 3-pin female XLR connector is provided for balanced audio input to each channel of the amplifier. Pin 1 is chassis (gnd); pin 2 is not inverted (+); and pin 3 is inverted (–). Do not use the Ch.2 input if the amplifier is configured in either Bridge or Parallel-Mono mode.

C. Reset Switch
A multifunction reset switch is provided to restore the IQ–P.I.P.–SMT to a prior state. It can be depressed with a straightened paper clip through the small hole in the P.I.P. panel. Press the reset switch for less than 2 seconds and all settings, except the amplifier model scale factors, will be reset with "user default" parameters and the DSPI will flash once. (If no "user default" settings have been stored, the unit will be reset to the "factory default" settings described next.) Press the reset switch for more than 2 seconds and the same settings will be reset with "factory default" parameters and the DSPI will flash twice. After the unit has been reset to the factory default settings, it will behave like a standard P.I.P.-FX until it is reprogrammed by an IQ System or it is toggled to the "user default" settings.

D. AUX Connector
A 3-pin male mini XLR connector is provided to control auxiliary equipment.
When the AUX feature is turned on, +15 VDC is provided across pin 1 (gnd) and pin 3 (+). A nominal current of 10 mA is available. The AUX connector also includes a high-impedance input that can sense logic signals.

E. DSPI
The DSPI is a Data Signal Presence Indicator which flashes whenever a valid IQ command has been received. The indicator can also be forced to stay on to aid rapid troubleshooting of the Crown Bus wiring.

F. Crown Bus Input Connector
A lockable 5-pin female DIN connector is provided for input connection to the Crown Bus. Pin 1 is negative (–), pin 2 is positive (+), and pin 3 is ground (gnd). Pins 4 and 5 are not used.

G. Crown Bus Output Connector
A lockable 4-pin female DIN connector is used for output connection to the Crown Bus. Pin 1 is negative (–) and pin 2 is positive (+). Pins 3 and 4 are not used.

H. Input Switches (S1, S2)

An 8-section DIP switch is used to configure each input. These switches are located on the bottom circuit board. S1 configures the input of Channel 1 and S2 configures the input of Channel 2. The switches activate a microphone preamp and enable phantom power. The preamp can be turned off (0 dB gain) or set to either 20 or 40 dB of gain.

I. P.I.P. Edge Connector

The gold-plated edge connector of the top IQ circuit board inserts into the P.I.P. connector inside the back of the amplifier. Use care when installing a P.I.P. module to be certain that the edge connector is properly inserted into the amplifier's P.I.P. connector.

J. Amplifier Output Pad Jumpers (JP4, JP5)

These jumpers enable the circuitry that pads the output signal feeding the IQ–P.I.P.–SMT so it can be properly scaled. They should be set to the "IN" position as marked on the digital circuit board for MA-600 - 3600VZ and SR I & II. Use the "OUT" position whenever the unit is installed into a PIP2-compatible. (CT "10" Series or MA 5000VZ).

K. PIP2 SIP Sockets (RN1, RN2)

These eight-pin SIP (single in-line package) sockets are provided for full PIP2 compatibility. IQ-P.I.P.-SMTPIP2 modules (required for PIP2-compatible amplifiers) should come with the SIP networks already installed. The SIP networks are not required and should be absent on standard IQ-P.I.P.-SMT modules.

L. IQ Circuit Board (Top)

The top circuit board contains the IQ communication circuitry, including the IQ address switch (SW1), amplifier output pad jumpers (JP4, JP5), PIP2 SIP sockets (RN1, RN2) and the P.I.P. edge connector.

M. Audio Circuit Board (Bottom)

The bottom circuit board contains the audio analog circuitry, including the input switches (S1, S2).

N. IQ Address Switch (SW1)

An 8-section DIP (dual in-line package) switch is used to set the IQ address of the unit. This switch is located on the top circuit board. Each IQ component on a Crown Bus is given a unique IQ address so it can be independently controlled and monitored. Two or more IQ components of the same type should NEVER have the same address on the same Crown Bus loop.

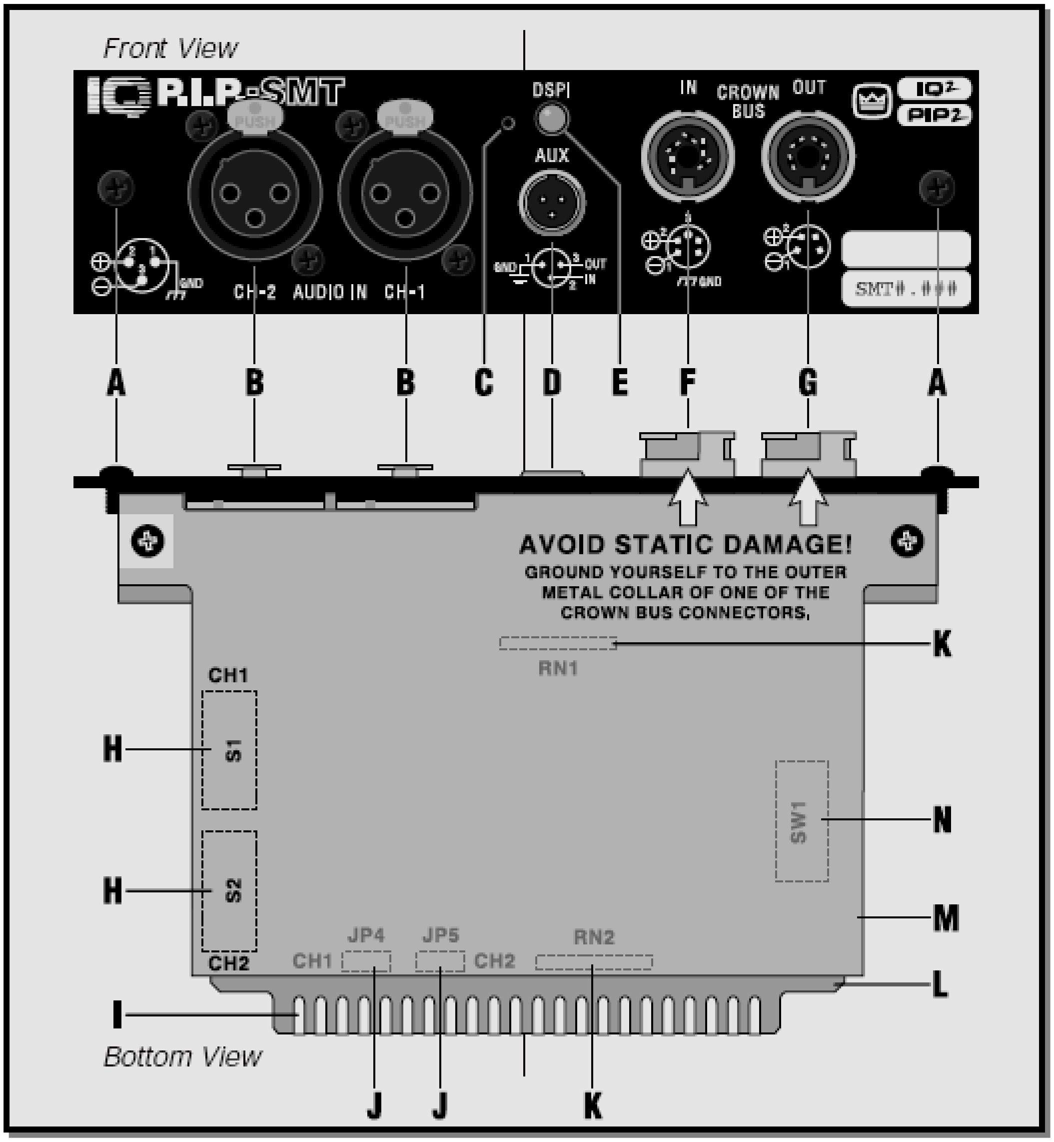


Figure 7-41.— IQ-PIP-SMT Facilities.

7.8.0 SRM 66 ROUTER MIXER

MIX INPUT HEADROOM meters
These assist setting of the rear panel GAIN switches as well as the output level of the preceding device. The 16 dB and 4 dB LEDs indicate the *remaining headroom* for each of the six Inputs. Optimal settings allow the 4 dB LEDs to flash only during signal peaks.

Edit Pages
This 2x40 backlit LCD screen displays the Edit pages for controlling and revealing all the functions of the SRM 66.

VIEWING ANGLE adjust
This recessed adjustment allows optimizing the LCD display contrast for various vertical viewing angles.

DATA wheel
Allows adjustment of a field parameter after it is selected with the Page and Cursor buttons. Turning the DATA wheel clockwise increases the parameter, and turning it counterclockwise decreases the parameter.

Page buttons
The Previous Page << and Next Page >> buttons scroll through all 10 Edit pages. When the EXE button is held and MAX >> is pressed, the selected parameter jumps to its highest value.

Cursor buttons
The Previous < and Next > cursor buttons scroll through each of the adjustable fields on each page. These buttons select each adjustable parameter along the bottom row by moving the underline left < or right >. When any parameter is selected, the DATA wheel adjusts that parameter. When the EXE button is held and MIN > is pressed, the selected parameter jumps to its lowest value.

EXE (Execute) button
Several commands are implemented with this button. Holding down EXE while pressing MAX >> alters the selected parameter to its highest nominal value. Holding down EXE while pressing MIN > alters the selected parameter to its lowest value or Off. Pressing EXE when the Copy, Paste, Recall, Store, and Zero commands are selected executes that function.

Power indicator
In case the backlit Edit display isn't enough assurance, this yellow indicator glows anytime adequate power is applied to the SRM 66, alerting you to its *on* condition.

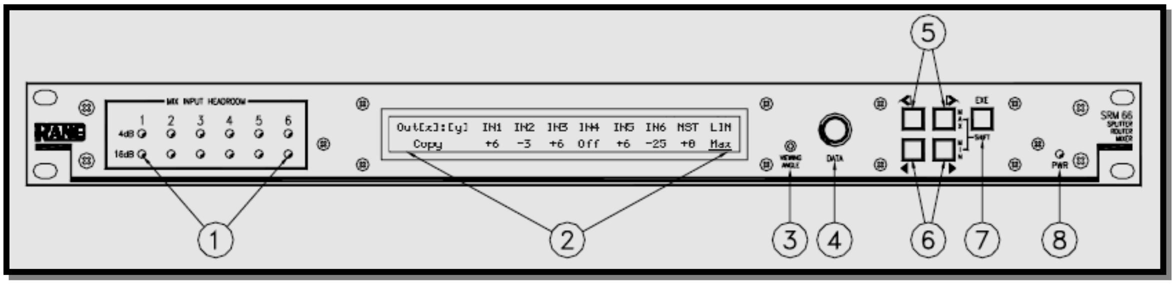


Figure 7-42.— SRM 66 Front Panel.

7.8.1 Operation

The User Interface

All SRM 66 programming is done with the Data wheel and the front panel buttons using one of the eleven LCD pages. Each page consists of the page name, multiple parameter fields and possible Command fields and status indicators. To navigate between pages use the Next Page (>>) and Previous Page (<<) buttons. Within a page the Next (>) and Previous (<) buttons move the cursor to each field. Above each parameter field is a label indicating its function. Once the cursor is positioned beneath the desired parameter field, the Data wheel is turned clockwise to increase the value and counter-clockwise to decrease it. To quickly jump to extreme maximum or minimum values, hold down the Shift (EXE) Button and press either the MAX (>>) or MIN (>) buttons. For added safety, executing MAX for the Input mix levels sets the level to unity or zero gain, not +6 dB which is the actual maximum.

Command Fields

Most pages contain a Command field. Here you can Copy settings from the current page to the clipboard, Paste settings from the clipboard, Recall page settings from memory, and Zero all page settings. To access a command, position the cursor under the Command field, use the Data wheel to select the desired command (not all commands are available in all pages) and press the EXE button.

Clipboard

There are actually three separate clipboards in the SRM 66: one for an Output's settings (shared by all Outputs), one for the Remote to Group settings, and one for the Output to Group settings. Using the clipboard can greatly simplify and speed setting up multiple Outputs or multiple Memories. *The clipboard settings are lost whenever power is removed.*

Status Indicators

Next to the page name in many pages is a Status Indicator. In the Output pages it shows the current amount of Limiter gain reduction or startup muting. If there is no gain reduction being applied, the field is blank. On the Memory page an asterisk (*) appears in this field whenever the current working Memory does not match the last recalled Memory.

Programming the SRM 66

Programming each SRM 66 Output requires only one edit page as in Figure 7-43. Note that unique Input mix levels are possible for each Output. All adjustments are in 1 dB steps.

The following parameters define each Output:

IN1 Input one mix Level +6 dB to -25 dB, Off
IN2 Input two mix Level +6 dB to -25 dB, Off
IN3 Input three mix Level +6 dB to -25 dB, Off
IN4 Input four mix Level +6 dB to -25 dB, Off
IN5 Input five mix Level +6 dB to -25 dB, Off
IN6 Input six mix Level +6 dB to -25 dB, Off
MST Master mix Level +0 dB to -59 dB, Off
LIM Limit Threshold Max (0 dB) to -28 dB re: clip point.

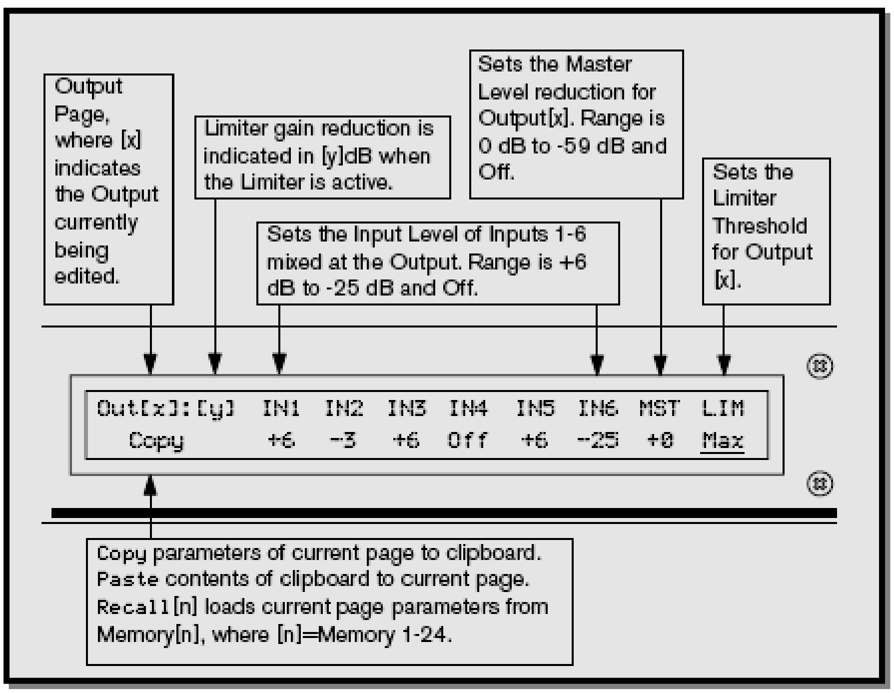


Figure 7-43.— Output Edit Page.

7.9.0 CRESTRON SERIES 3500 TOUCHPANELS

7.9.1 Functional Description

The Series 3500 Touchpanels are 10.4 inch (26.4 cm) active matrix touchscreen control panels for the CRESNET II remote control system (herein referred to as the CRESNET II system). There are four Series 3500 configurations available. Two of the four touchpanels offer a video window in addition to the 256 color display (255 color plus one video) and are commonly known as VideoTouch. The remaining two touchpanels offer 256 color display and are commonly known as ColorTouch. ColorTouch and VideoTouch are available in lectern-mount and adjustable tiltcase configurations. Configuration selection is based on application requirements.

The purpose of a ColorTouch and VideoTouch Series 3500 unit is to replace hardwired panels in either a CRESNET II or an RS-232 based control system. The touchpanel is capable of replacing large, complicated panels with a series of simpler screens, each specific to the control problem at hand. Thus, very large numbers of functions can be made available to the user without the confusion associated with hardware panels of that complexity. Series 3500's icons, graphics, and text can dramatically increase any user's comprehension of the control environment. Devices, functions, and control zones are quickly organized and more easily accessed. The Series 3500 Touchpanels offer:

- 256 color active matrix display
- full color video window capability, NTSC or PAL, full or partial
- screen (VideoTouch only)
- pop-up sub panels to reduce memory requirements, providing optimal
- speed and performance
- multiple button, slider control, and icon configurations
- up to 999 functions and 96 screens
- imported photographs, drawings, and icons
- support for downloadable fonts - proportional and non-proportional
- foreign language text
- RS-232 interface for stand-alone applications (lectern-mount configurations only)
- VGA OUT port (lectern-mount configurations only)
- printout of screen designs on standard printer
- Position Lock feature provides durable support of panel at any angle of inclination between 0 and 70 degrees (tiltcase configurations only).

7.9.2 Physical Description

The 10.4 inch (26.4 cm) touch sensitive viewing screen is located on the front of each Series 3500 Touchpanel. The electronic hardware is housed in a high impact, black molded plastic enclosure for the adjustable tiltcase configurations, shown below. These two touchpanels are designed to be placed on a counter and possess a hinged base which can tilt from 0 to 70 degrees. Depress the button located at the front of the base when pivoting the touchpanel to the horizontal position. A 6-pin, 6-position RJ11 modular jack is located at the rear of the CT-3500's base. Use the cable assembly to connect the touchpanel to the CN-RJ11, which attaches directly to the CRESNET II network. The VT-3500 has an 8-position, 8-pin modular telephone jack on the base. An 11 to 12 foot network cable with 8-position, 8-pin connectors on each end connects the panel to the VT-3500IMC or VT-3500IMW. Each VideoTouch interface module has video connectors and a 4-pin network connector for attachment to the CRESNET II network.

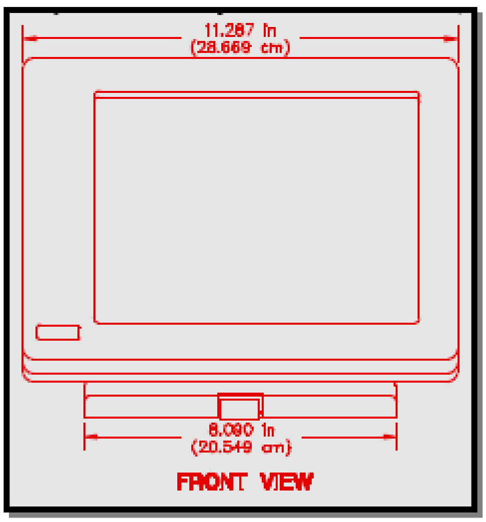


Figure 7-44.— Physical View of CT and VT3500.

PIN #	SIGNAL	COLOR
1	+24 V (Network)	GRY
2	GND (Network)	ORG
3	Y (Data)	BLK
4	Z (Data)	RED
5	GND (Lum.)	GRN
6	Y (Lum.)	YEL
7	C (Chrom.)	BLU
8	GND (Chrom.)	BRN

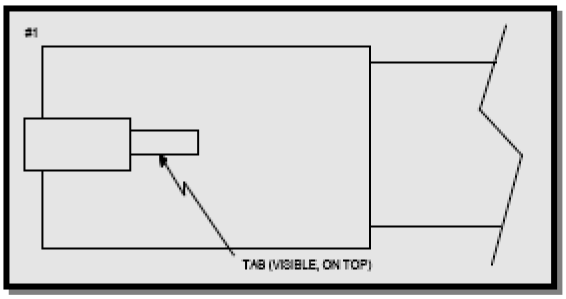


Table 7-8.— 8-Position, Pin Jack Pinout (for VT-3500IMC and VT-3500IMW).

7.10.0 ADVANCED ANNOUNCING SYSTEM/LPD-17 CLASS ANNOUNCING SYSTEM

The Advanced Announcing System provides for the transmission of alarms, orders, and information to various shipboard locations. Transmissions are handled simultaneously by means of microphones and loudspeakers connected through the Announcing Cabinets located in the forward and aft IC Gyro Rooms. The Announcing Cabinets manage the routing and hierarchy of alarms and announcements throughout the ship. (Alarms are initiated externally to the system and are routed through the Announcing Cabinets for processing and transmission.)

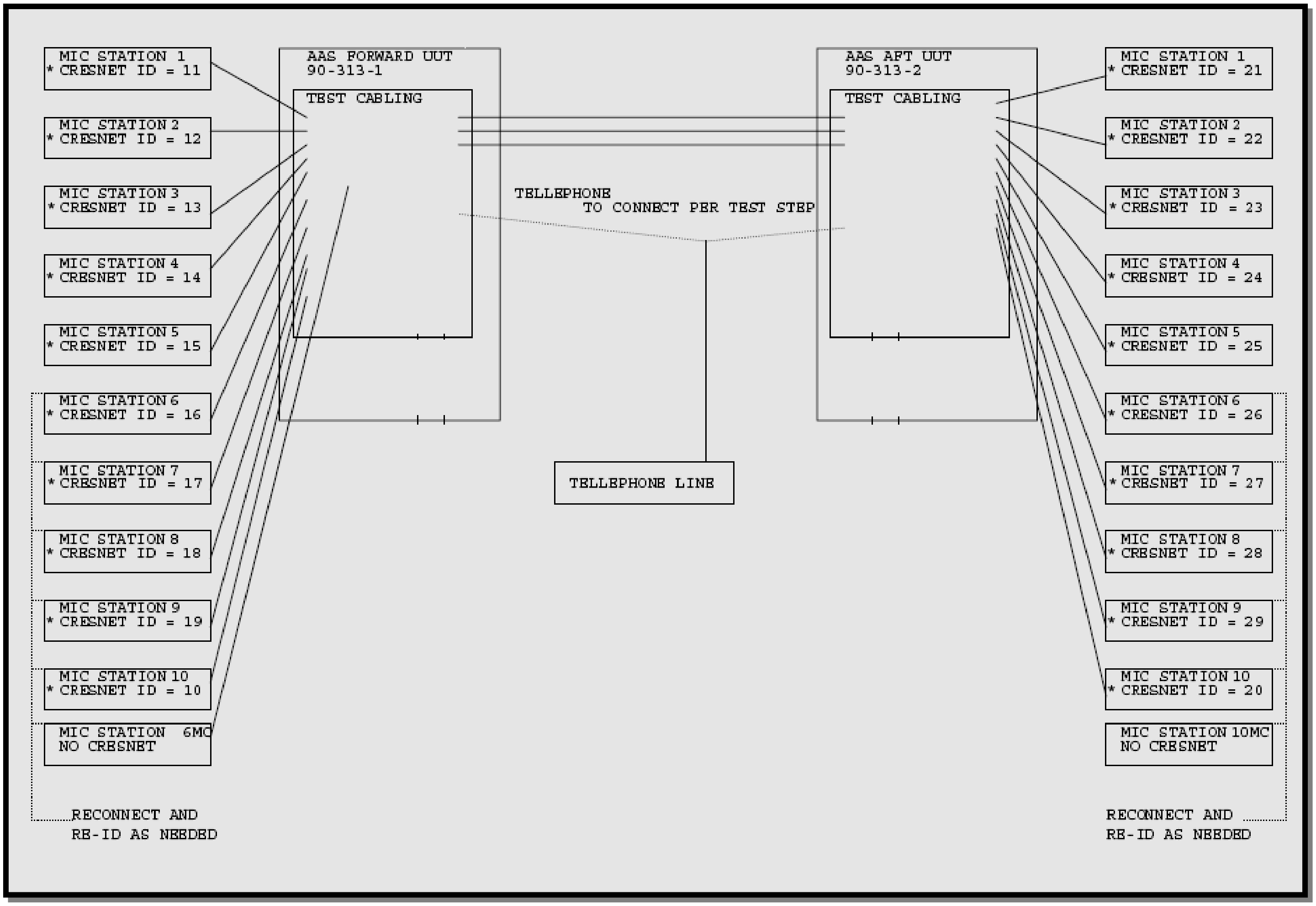


Figure 7-45.— Relationship of Units.

7.10.1 Announcement Types and Areas Covered

The Advanced Announcing System transmits the following types of announcements:

1MC–General: General orders, information, and alarm signals to all areas within the ship and to all topside areas where personnel are stationed or normally located. Alarm signals are transmitted over loudspeakers. The 1MC system collision alarm is provided to the 5MC for broadcast over the 5MC speaker groups.

3MC–Aviators: Aviators orders and information to the Flight Deck, Flight Deck Catwalk, and Hangar areas. This circuit provides for separate transmission of troop orders and information to the Flight Deck, Flight Deck Catwalks, and troop areas. Also, 1MC transmissions are transmitted over 3MC loudspeaker groups when selected at combination 1MC/3MC Microphone Control Stations. When 3MC speaker groups are selected at combination 1MC/3MC Microphone Control Stations, the 1MC announcements will override 3MC announcements.

5MC–Flight Deck: Flight Deck orders, information, and alarm signals to personnel on the Flight Deck, Flight Deck Service Areas, and Flight Deck Catwalks. The 5MC circuit provides an output to the Wire Free Communications System for distribution of 5MC voice transmissions.

6MC–Intership: Orders and information to nearby shops and landing craft and to shore via loudspeakers installed topside facing port and starboard. These speakers are selected by switching in the Pilot House to direct the sound to the port, starboard, or both. Alarm signals are not transmitted over this circuit.

10MC–Intership: Orders and information to lighterage and amphibious craft. Alarm signals are not transmitted over this circuit.

SYSTEM ID NUMBER	QTY	UNIT NAME	LOCATION
90-313		**Advanced Announcing System**	
90-313-1	1	Announcing Cabinet–FWD	FWD IC Gyro Room
90-313-2	1	Announcing Cabinet–AFT	AFT IC Gyro Room
90-249	15*	Microphone Control Station **Note:** Although the Microphone Control Stations are identical; the ID code set in their internal software enable them to control different announcement types.	Pilot House, Central Control Station, CIC TAO Station, Debark Control Center, Helicopter Control Station, OOD Stations (3), Well Deck Control/ Conflag Station 5, Secondary DCC, Conflag Station 1, Conflag Station 2, Conflag Station 4, Accommodation Ladder Room No 1
20-177	2	Audio Pre-Amp	Pilot House, Well Deck Conflag Station

Table 7-9.— Equipment Covered.

ANNOUNCEMENT TYPES	MAY BE MADE FROM MICROPHONE CONTROL STATION IN	MAY BE MADE TO LOUDSPEAKER GROUP	ADDITIONAL NOTES
1MC and 3MC	CIC TAO Station, Debark Control Center, Pilot House, Secondary DCC	Officers –1MC Speaker Group 1 Topside – 1MC Speaker Group2 Crew – 1MC Speaker Group 3 Engineers –1MC Speaker Group 4 Troops –3MC Speaker Group 5 Well Deck –3MC Speaker Group 6 Flight Deck Port–3MC Speaker Group 7 Flight Deck Starboard–3MC Speaker Group 7 Flight Deck –5MC Speaker Group 9	These Microphone Control Stations provide the ability to select among the eight speaker groups.
1MC Only	OOD Stations (3), Central Control Station, Accommodation Ladder Room No 1	Officers –1MC Speaker Group 1 Topside – 1MC Speaker Group2 Crew – 1MC Speaker Group 3 Engineers –1MC Speaker Group 4	
3MC Only	Well Deck Control/ Conflag Station 5, Conflag Station 1, Conflag Station 2, Conflag Station 4	Troops –3MC Speaker Group 5 Well Deck –3MC Speaker Group 6 Flight Deck Port–3MC Speaker Group 7 Flight Deck Starboard–3MC Speaker Group 7	
1MC, 3MC, and 5MC Only	Helicopter Control Station	Flight Deck –5MC Speaker Group 9	
6MC Announcements	(Generated outside of the Advanced Announcing System, via microphones in the Pilot House, Port Bridgewing, and Starboard Bridgewing.)	Intership Hailing	

Table 7-10.— Announcement Types/Loudspeaker Groups.

ANNOUNCEMENT TYPES	MAY BE MADE FROM MICROPHONE CONTROL STATION IN	MAY BE MADE TO LOUDSPEAKER GROUP	ADDITIONAL NOTES
10MC Announcements	(Generated outside of the Advanced Announcing System via microphone in the Well Deck/Conflag 5)	Lighterage	
IVCS Announcements	(Generated outside of the Advanced Announcing System from the IVCS)	1MC/3MC Loudspeakers	

Table 7-10 (Cont'd).— Announcement Types/Loudspeaker Groups.

NOTE:
All Microphone Control Stations operate on a first come, first served basis on the audio basis, with no priority levels between them. All alarms override any voice announcement and alarms of higher priority override alarms of lower priority.

Speaker Groups
Table 7-10 lists the loudspeaker groups controlled by the various Microphone Control Stations.

Hierarchy of Announcements and Alarms
The Advanced Announcing System manages the priority levels for announcements and alarms, and automatically overrides transmissions with lower priority. All Microphone Control Stations operate on a first come, first served basis on the audio basis, with no priority levels between them. All alarms override any voice announcement and alarms of higher priority override alarms of lower priority. The system also is capable of overriding other ship systems (television system, external lights, etc) to ensure that ship personnel are aware of announcements and alarms.

7.10.2 General Description of the Units in this System
The equipment listed in Table 7-9 is covered in this section. Figure 7-45 shows the relationship of the units.

The units are constructed of aluminum and located according to ships plans. The units are painted grey and are mounted directly to the ship's substructure.

The units together enable the broadcast of alarms and announcements to various locations throughout the ship. The following sections briefly describe the units.

Announcing Cabinets, FWD and AFT

There are two Announcing Cabinet assemblies (90-313-1 and 90-313-2); one is located in the forward IC Gyro Room, and the other is located in the aft IC Gyro Room. Figure 7-46 illustrates an Announcing Cabinet.

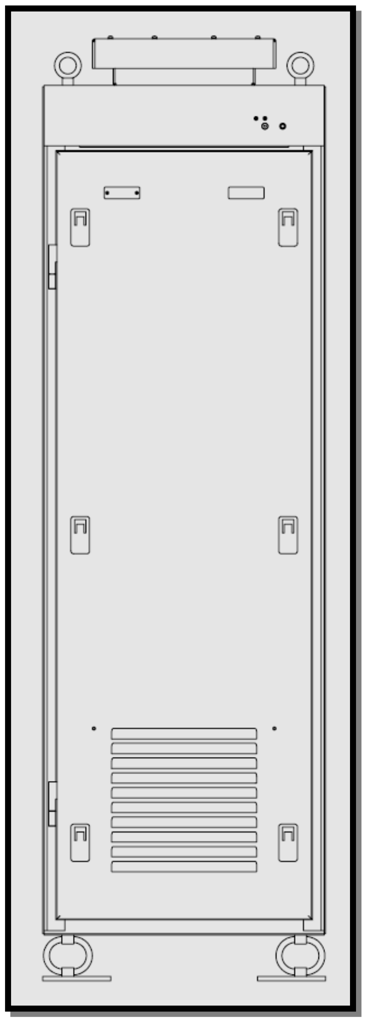


Figure 7-46.— Announcing Cabinet.

The two Announcing Cabinets are essentially the same. They both manage the delivery and priority of announcements and alarms in the Advanced Announcing System. Inputs to the Announcing Cabinets include inputs from the Microphone Control Stations which are part of the system, and also from equipment external to the system, including alarm selection signals and Integrated Voice Communications System (IVCS).

The main differences between the two Announcing Cabinets are:

- They interface with different speaker groups, so the labeling on the terminal bar where they connect to the ships wiring is different.
- The internal Crestron software is set differently in each, so they can manage different signals and priorities.

Microphone Control Stations

There are fourteen (14) Microphone Control Stations in the system. Although the Microphone Control Stations are identical, setups performed on their internal Crestron software enable them to function differently, controlling different announcement types. The Microphone Control Stations are identified by their location, as listed in Table 7-10.

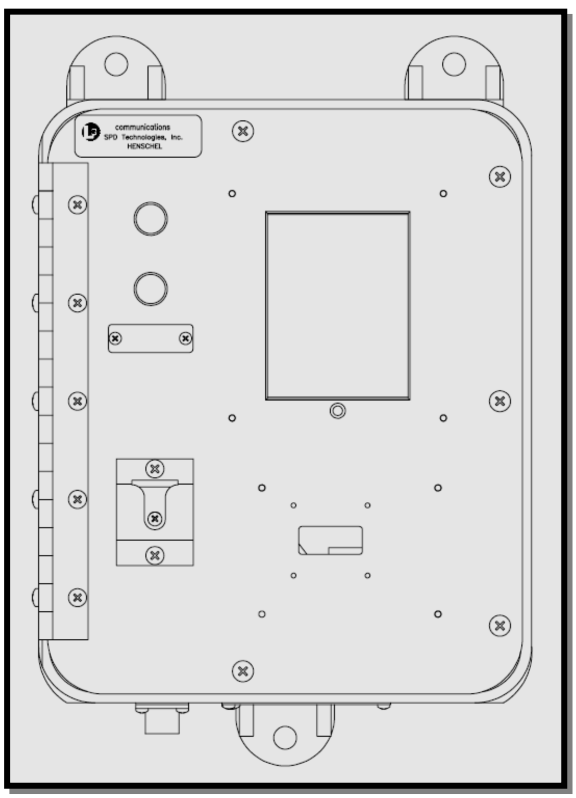


Figure 7-47.— Microphone Control Station.

Audio Pre-Amplifier

Two Audio Pre-Amplifiers receive inputs from microphones external to the system and provide inputs to the Announcing Cabinets which route them to the corresponding speaker groups. One unit is located in the in the Pilot House and receives 6MC inputs from microphones in the Pilot House, the Port Bridgewing, and Stbd Bridgewing. The other is located in the Well Deck Conflag Station and receives input from the Audio Pre-Amplifier used with the 10MC Lighterage and Amphibious Announcing system.

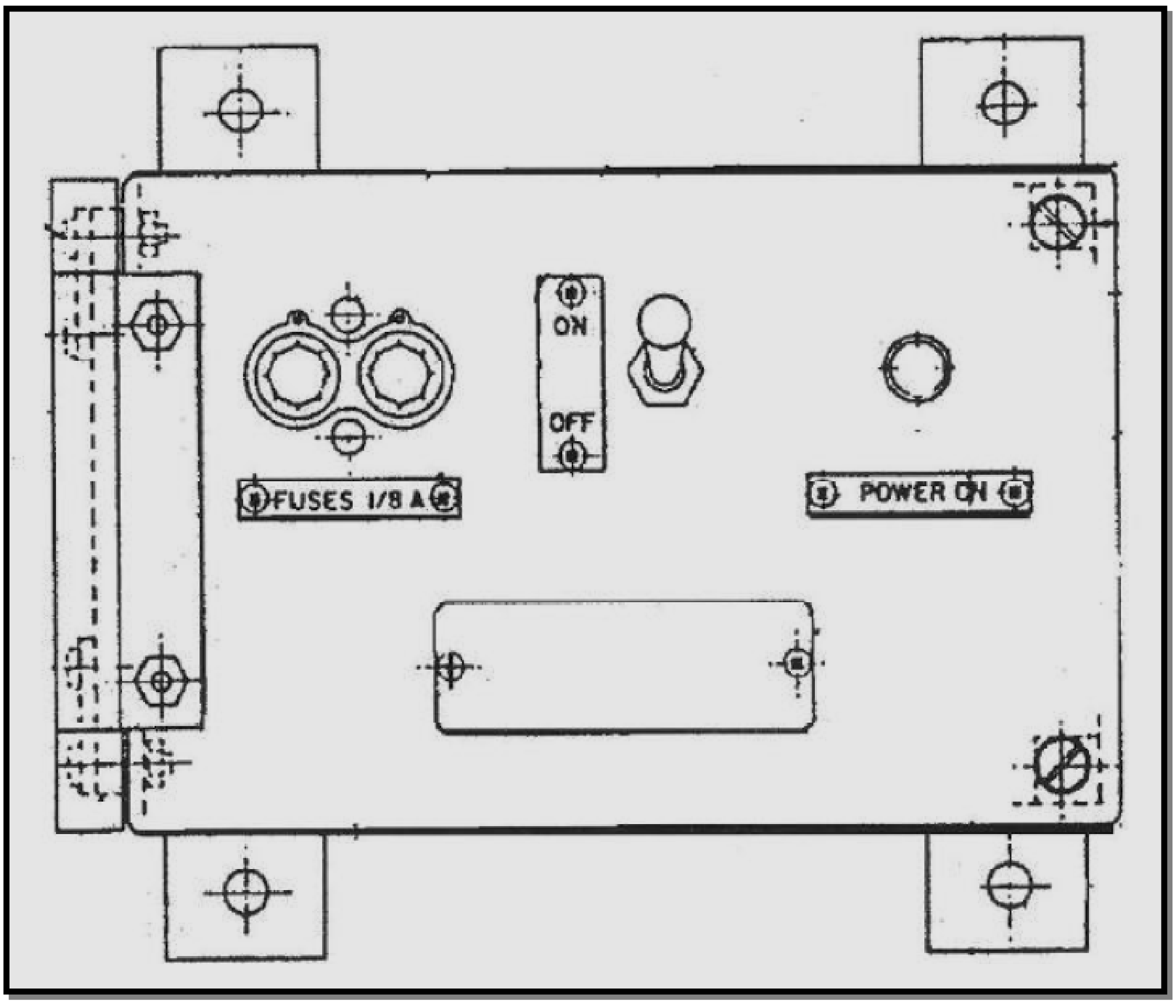


Figure 7-48.— Audio Pre-Amp.

Table 7-11 describes the electrical characteristics of each unit. Table 7-12 describes the environmental characteristics of the system.

UNIT	INPUT POWER	AUDIO INPUT (NOMINAL)	AUDIO OUTPUT (NOMINAL)
Microphone Control Stations	24VDC	5.0 mVRMS	5.0 VRMS
Announcing Cabinets	115VAC (60 Hz) 30 AMP (max)	5.0 mVRMS	70 VRMS
Audio Pre-amp	24VDC		

Table 7-11.— Electrical Characteristics.

Operating Temperature (^{o}C)	0 to 50
Humidity Limits	up to 90%

Table 7-12.— Environmental Characteristics.

Test Equipment and Tools

There is no test equipment required. No special tools are required other than those normally used to install and service equipment.

7.10.3 Relationship to other Shipboard Systems

TV System External Interface

The system interfaces with the television and audio muting circuit to control the closed-circuit 27TV system during alarms and announcements. Any alarm transmission causes the television system to be muted (with manual reset), and 1MC/3MC voice transmissions cause it to be attenuated (with automatic reset).

Integrated Voice Communications System (IVCS)

The system allows selected telephones to make announcements over the 1MC/3C speaker groups.

Alarm Initiation

Alarms are initiated externally to the system and are routed through the Announcing Cabinets for processing and transmission.

Loudspeakers

The loudspeakers required are provided by the ship building facility.

7.10.4 Operators Maintenance

Operators maintenance is limited to procedures that do not require the need for internal alignment or complex adjustment. Operators maintenance procedures for this system consist of routine cleaning and daily checks. The procedures for replacement of defective lamps, fuses, and switches are covered in the technical manual. All other fault indications must be serviced by a technician.

7.10.5 Controls and Indicators

Before operating the Advanced Announcing System, operating personnel should thoroughly familiarize themselves with the nature, location, and function of all switches, controls, and instrumentation used in the Advanced Announcing System.

Figure 7-49 and Figure 7-50 show the controls and indicators for each unit in the Advanced Announcing System and Table 7-13 and Table 7-14 describe them.

7.10.6 Microphone Control Station Controls and Indicators

While the Microphone Control Stations in the Advanced Announcing System are mechanically identical units, ID codes assigned to them during installation and setup configure their internal software so they can offer different options on their touchpad controls. Additionally, the ID codes are used by the software within the Announcing Cabinets to maintain the relative priority of announcements made from each Microphone Control Station.

The controls and indicators of the Microphone Control Station are shown in Figure 7-49, with details about the touchpad shown in Figure 7-50 and are described in Table 7-13.

Microphone Control Station Priority Levels All Microphone Control Stations operate on a first come, first served basis on the audio basis, with no priority levels between them. Alarms routed through the Announcing Cabinet have priority over announcements made from the Microphone Control Stations.

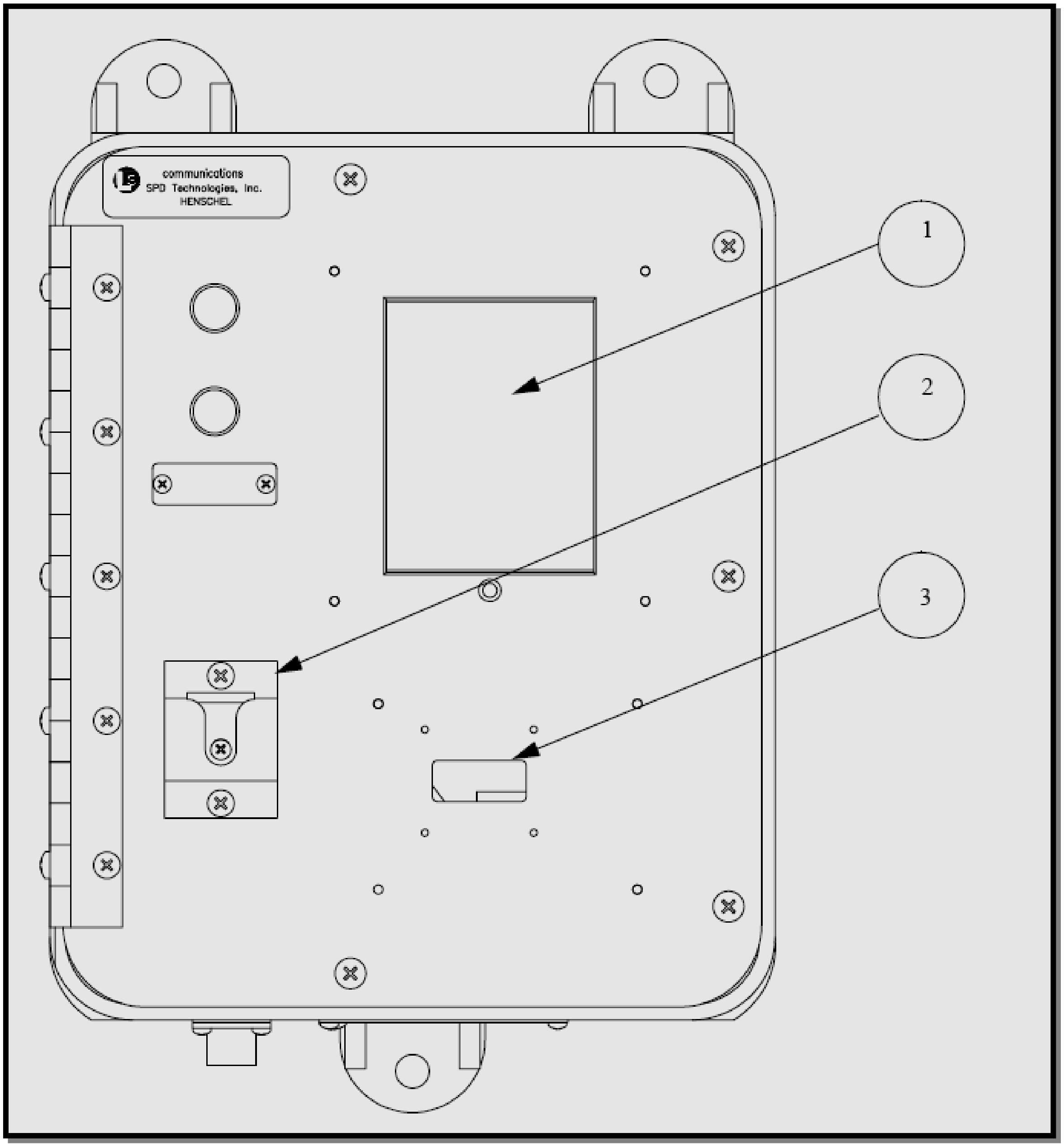


Figure 7-49.— Microphone Control Stations (990-249) Controls and Indicators.

1MC BUSY	24:00	3MC BUSY
OFFICER	TOPSIDE	TROOPS
CREW	ENGINR	WELL DECK
MENU	FLIGHT 3MC PORT	FLIGHT 3MC STBD
DAY NIGHT	5MC	

Figure 7-50.— Detail of the Touchpad on the Microphone Control Stations (Example Only).

ITEM FIGURE 7-49	CTRL OR IND	NAME	FUNCTION	IN USE POSITION OR INDICATION
1	C/I	Touchpad (Detailed on Figure 7-50)	Displays multiple controls and indicators for the Microphone Control Station.	
	I	Circuit indicators	Indicates busy announcing circuit(s).	Red indicates circuit is in use.
	I	Time	Displays current time.	Current time.
	C	Speaker group selector buttons	Select speaker group(s) to broadcast announcements.	Green when active.
	C	Menu button	To toggle on the function buttons.	
	C	Day Night function button	Toggles the display between day and night illumination.	
2	C	Microphone	Receive voice announcement inputs.	Lifted from holder and key depressed while announcement is being made.
3	I	VU Meter	Indicates the level of the audio signal output.	

Table 7-13.— Microphone Control Stations (90-249) Controls and Indicators.

7.10.7 Announcing Cabinets (90-313) Controls and Indicators

The only control and indicator the Announcing Cabinets have are an on/off switch and a power available indicator on each. The majority of the controls and indicators are internal to the unit and are not intended for operator use. Those controls and indicators are for troubleshooting and corrective maintenance COTS equipment is covered in Appendix A of the Technical Manual.

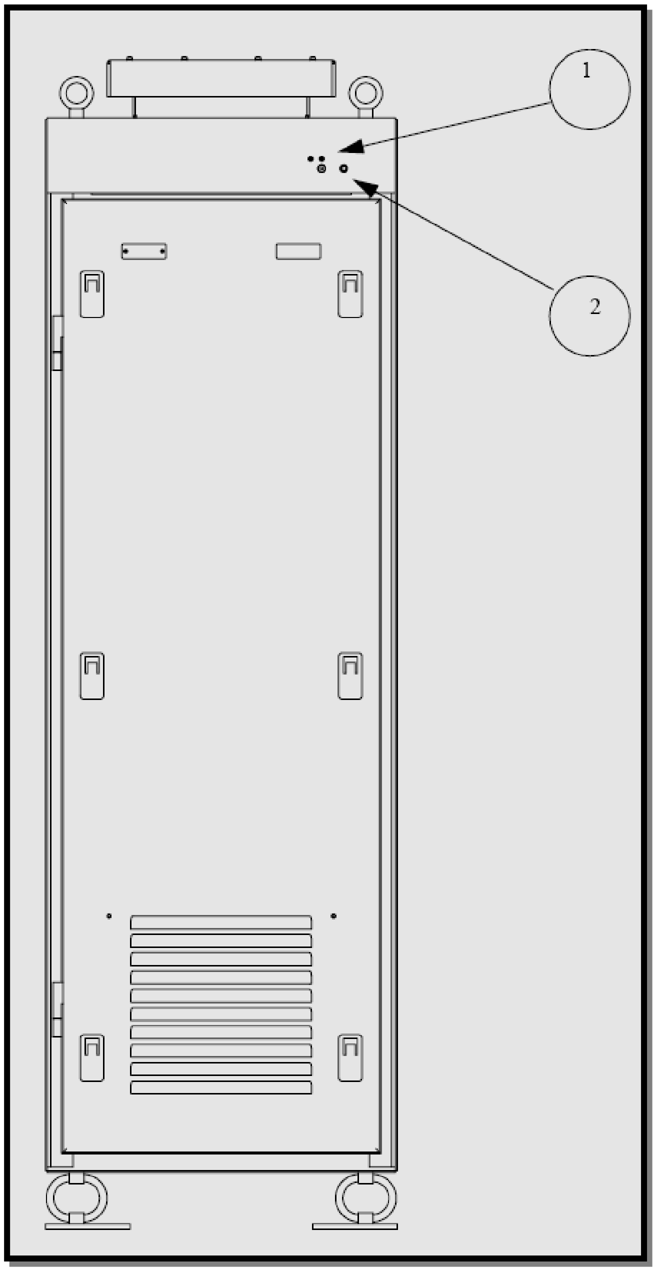


Figure 7-51.— Announcing Cabinet (90-313) Controls and Indicators.

ITEM FIGURE 7-51	CTRL OR IND	NAME	FUNCTION	IN USE POSITION OR INDICATION
1	C	Power On/Off switch	Allows the technician to shut down power to the unit for maintenance. NOTE: This may NOT remove all power from the unit. However, when the switch is in the OFF position, the system is powered down and rendered inoperable.	Normally set to On.
2	I	Power Available Indicator	Indicates that power is available to the unit.	Normally illuminated to show that power is available to the unit.
(Additional controls and indicators are internal to the Announcing Cabinet and are for troubleshooting purposes. They are described in the technical manual.				

Table 7-14.— Announcing Cabinet (990-313) Controls and Indicators.

7.10.8 Audio Pre-Amplifier (20-177) Controls and Indicators

The only control and indicator the Audio Pre-Amplifiers have are an on/off switch and a power available indicator on each.

7.10.9 System Applications

While the Advanced Announcing System was designed for the LPD Class amphibious assault ship, its modular and versatile design features make it ideal for multiple applications. The system's functional modular construction provides for ease of system installation, redesign, and for expansion of existing system.

Design Features

The standardized and Commercial off the Shelf (COTS) subassemblies within the Advanced Announcing System provide adaptability, maintainability, and expansion capability to meet future needs. Specifically, the Announcing Cabinets are designed to accommodate additional Microphone Control Stations.

Announcing Cabinets, FWD and AFT (also known as the Announcing System Nodes, FWD and AFT)

The Announcing Cabinets are the controlling units in the system. They manage the distribution of voice announcements from the Microphone Control Stations and priorities of alarms (initiated external to the system).

The two Announcing Cabinets (in the Forward and AFT IC Gyro Rooms) are essentially the same; they both contain the same major components, and they both manage the delivery and priority of announcements and alarms in the Advanced Announcing System. The main differences between the two Announcing Cabinets are:

While the two Announcing Cabinets are very similar, the differences between them are:

- They interface with different speaker groups, so the labeling on the terminal bar where they connect to the ships wiring is different. (FWD has TB11-TB17, AFT is TB21 - TB27).

- The software programming in the internal Crestron processor is factory preset differently in each, so they can each manage different Microphone Control Stations and speaker groups.

Each rack contains the subassemblies listed in Table 7-15.

ASSEMBLY	DESIGNATION ON 90-313-1, 90-313-2, AND WD-90-313
Terminal Connector Assemblies (D-3477, D-3487, and D-3497 in the FWD; D-3525, D-3526, and D35-27 in the AFT) (Left, Right, and Center)	A11
Hub Assembly (D-3519)	A12
Microphone Station Buffer Assembly (D-3476)	A13
Group Select Relay Assembly (D-3475)	A14
Monitor Alarm Generator Assembly (D-3474)	A15
Equalizer Assemblies (G-4622)	A16, A17
Processor Assembly (D-3534), also known as the Crestron Controller and the Controller Assembly	A18
Mixer Assembly (G-4617), also known as the Router	A19
Power Strip (G-4075), also known as AC Distribution	A20
Power Supply (G-4619)	A21
3600W Audio Amplifiers (G-4621)	A22, A23, A24
Transformer Assembly (D-3488)	A25
AC Filter Assembly (D-3516)	A26
Circuit Breaker (G-4420)	

Table 7-15.— Assemblies within the Announcing System.

7.11.0 DYNALEC INTEGRATED ANNOUNCING SYSTEM (DIAS)

The Dynalec Integrated Announcing System (DIAS) has been designed for use in shipboard announcing system applications requiring flexibility, expandability, and robustness. The system meets or exceeds the requirements for the Legacy systems while incorporating many features that overcome difficulties historically experienced with them. The modular nature of the system allows it to be used in applications previously requiring more than one system and also permits expansion to accommodate the ever-changing system.

Characteristics

- Size: 22.1”W x 63.8”H x 26.3”D (including shock mounts)

- Weight: 360 lbs. Maximum (for 2-Amplifier Chassis system with 12 amplifiers)

- Power Requirements: 115VAC ± 10% @ 60Hz ± 10%, single phase, 0.98 PF
    - Standby: 300mA maximum per 250W Amplifier Module
    - Rated Output: 2.8A maximum per 250W Amplifier Module

- Heat Dissipation: 72W at rated output per 250W Amplifier Module
  250 BTU/Hr at rated output per 250W Amplifier Module

- Operating Environment: Shipboard Sheltered Application
  0 to 65°C

- Enclosure: Drip-proof
  95% Relative Humidity, maximum

- Replaceable Assemblies:

  Ship’s Wiring Tray
  Main/Amp Interface Module
  Auxiliary Amp Interface Module
  Legacy Mic Interface Module
  PBX/IVCS Modem Interface Module
  Amplifier Chassis Assembly
  250W Amplifier Module
  Fan Tray Assembly

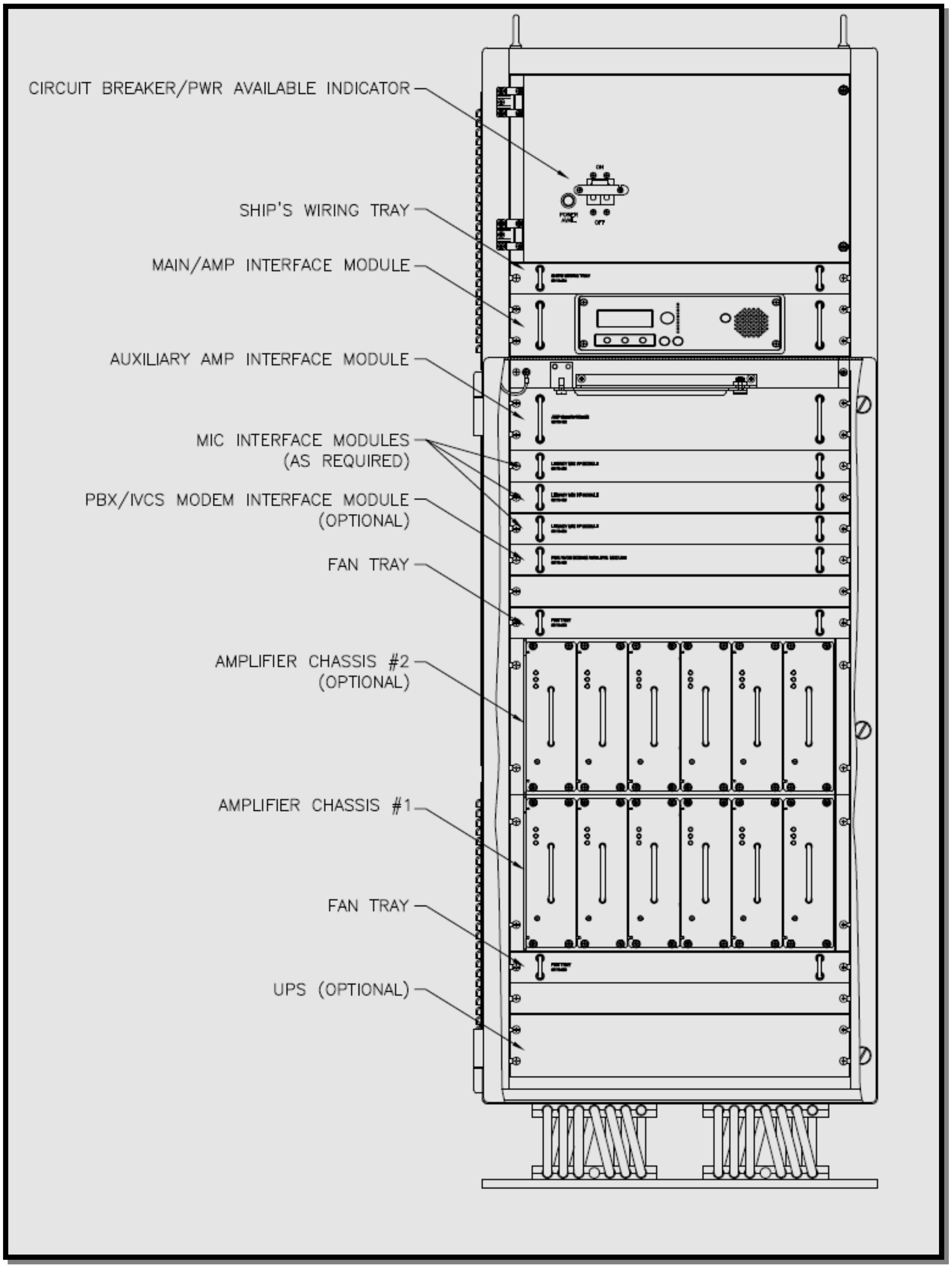


Figure 7-52.— DIAS Rack Components.

Refer to Figure 7-52 for locations of the various system components in the DIAS rack.

Main/Amplifier Interface Module

The Main/Amplifier Interface Module is responsible for the following system functions:

- Controlling the User Interface
- Routing audio from mic stations (or other sources) to amplifier modules in Amplifier Chassis #1 as dictated by the system configuration
- Generating alarm signals from one of two redundant Alarm Generators as dictated by the system configuration
- Maintaining periodic communication with the Amplifier Chassis to report faults in any of the system amplifier modules
- Generating auxiliary signals (entertainment system attenuate/mute, visual alarm indicator, alarm active contact closure) as necessary
- Converting 115VAC input power to the DC power required for all other modules
- Test amplifier modules and Alarm Generators as requested by the user via the User Interface
- Report test results to user via the User Interface

NOTE:

The Main/Amplifier Interface module is required for all systems, regardless of configuration.

Auxiliary Amplifier Interface Module (optional)

The Auxiliary Amplifier Interface Module is required only in systems that use a second Amplifier Chassis (since the Main/Amplifier Interface Module can only handle routing to 6 amplifiers). This module handles only the routing function described above and it is powered by the DC power generated in the Main/Amplifier Interface Module.

Legacy Mic Interface Module

The Legacy Mic Interface Module contains the interface circuitry to interface with any combination of four Legacy Mic Control Stations (IC/MSB-2), Mic Jack Boxes (IC/MJB-2), or M-136A/SIC Microphones.

Each interface consists of a transformer-coupled input audio pair, which can accommodate standard mic level (-50dBm) or can be switched via an internal DIP-switch to accommodate standard line level (0dBm) (see PBX/IVCS Modem Interface below). In addition, each interface accepts group select signals for up to 10 announcing system groups and a PTT signal. Each interface provides a busy signal for each group “block” an audio output derived from the actual amplifier output(s) for driving the visual indicator on an IC/MSB-2, and a cutout signal for local loudspeaker cutout.

Connectivity to the Legacy Mic Interface Module is accomplished through the Ship's Wiring Board. Each mic interface has its own connectors and the signals are labeled on both the board silkscreen and on the C-size print included in the pocket provided inside the door of the system.

PBX/IVCS Modem Interface Module

The PBX/IVCS Modem Interface Module also contains four interfaces to the announcing system. However, this module is more specialized in that one of the four interfaces is dedicated to connecting to a Modified IVCS Modem to allow announcements through a STC-II telephone system.

In addition, one of the four interfaces is dedicated to connecting to up to six standard analog line interfaces (POTS interfaces). In this manner, the functionality of the IVCS Modem is duplicated without an extra piece of hardware and is accomplished using industry standard analog line interfaces.

The remaining two of the four interfaces are identical to the Legacy Mic Station interfaces on the Legacy Mic Interface Module (see description above).

Amplifier Chassis

The Integrated Announcing System can accommodate up to 2 Amplifier Chassis. Each chassis can hold up to six 250W Amplifier Modules and can be configured so that one of the six is a spare module which is automatically switched in upon detection of a fault in one of the other five.

Each amplifier module incorporates its own independent circuitry and is separately fused so that any faults that may occur are isolated from the other modules. Each module also has its own power switch so that amplifiers may be swapped without affecting the operation of the other modules.

Each Amplifier Chassis connects to the Main/Amplifier Interface Module through internal rack wiring and input audio is routed from the various input interface modules (Mic Interface Module or PBX/IVCS Modem Interface Module) to each amplifier module based on the system configuration. Each amplifier output is directed to the Ship's Wiring Tray (see below) and is also connected to the Main/Amplifier Interface Module for routing back to Mic Control Stations for VU meter indications.

The Main/Amplifier Interface Module also periodically obtains diagnostic information from each Amplifier Chassis and reports any faults to the User Interface.

At least one Amplifier Chassis is required for *all* systems.

Ship's Wiring Tray

All connections between the ship's wiring and the Integrated Announcing System are made at the Ship's Wiring Tray. The Ship's Wiring Board mounted in the tray has connectors for 16 Mic Station Interfaces, Alarm Contactor Inputs for the 5 alarm signals, IVCS Modem Interface, Analog Line Interfaces (6 lines), and Loudspeaker Interfaces (including Local Loudspeaker Disconnect connections). All connectors are Euroblock-type connectors to facilitate simple wiring of the system.

7.12.0 MARINE INTEGRATED COMMUNICATIONS SYSTEM

The Marine Integrated Control Cabinet (1338-ICSC) is a compact and highly reliable yet versatile interior communications control unit that is exclusively used on PC-1 Class Ships. It is designed specifically for use in marine Public Address (PA), Talkback (TB) and Telephone Exchange (MPBX) integrated systems as shown In the Sample System Block Diagram (Figure 7-53). A system can be configured to meet vessel requirements. Some custom design features are available.

The compact control cabinet housing is constructed of sheet steel. With Its foamed-on door gasket seal, the unit is both dust and moisture proof. Dual latches on the door and four elastomeric shockmounts contribute to the overall rugged construction of this unit for use in the demanding marine environment. .The unit has a factory preset thermostatically controlled cooling fan.

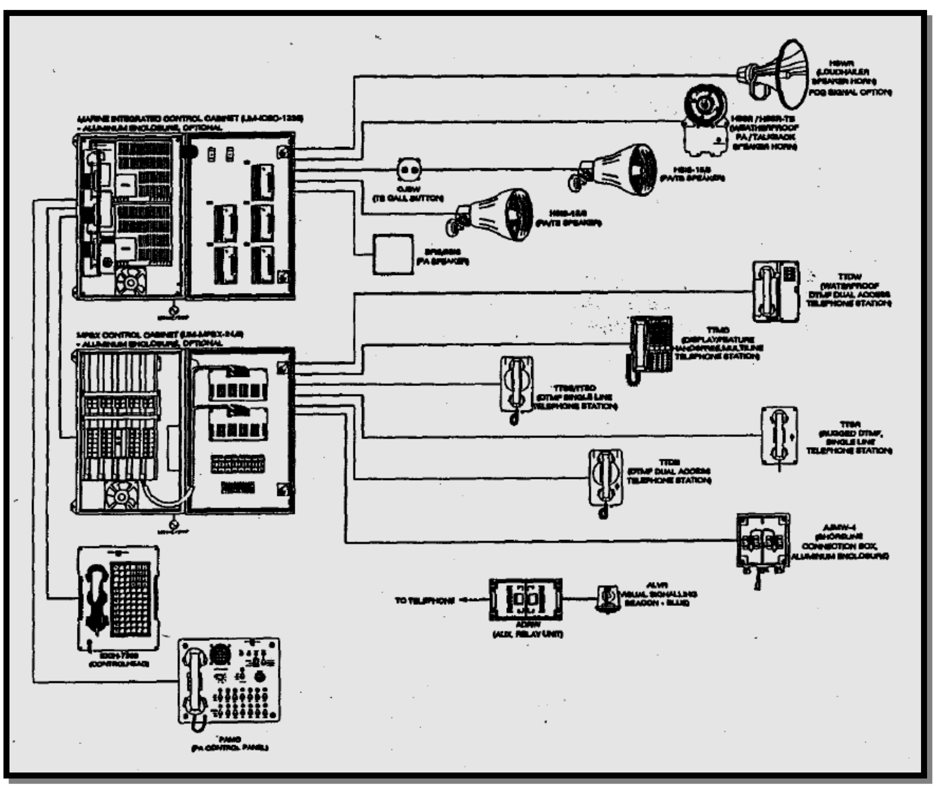


Figure 7-53.— Sample Marine Integrated Communication System Block Diagram.

A standard control cabinet assembly comes equipped with two 100 Watt amplifiers one PA and one TB/Standby. The control circuitry is secured to the front of a hinged swing panel and is connected via ribbon cable connectors to the live Field Termination (Fl) blocks mounted on the door mounting plate. On the back of the swing panel the Thermostat, GARE Unit, AC Distribution Box and Power Supply Unit are mounted.

Both the amplifiers arid the power supply require 115VAC feed. Field devices are connected to the FT blocks. Each FT block has fifty screw terminals. Field device cabling for the field cable harness is supplied by the shipyard.

<u>System Specifications</u>

MASTER STATIONS:	IDCH-7200, PAMC Series.
PA ZONES:	8 single run zones, 4 A/B zones; includes Allcall.
PA/ALARM AUDIO POWER:	100W/2OOW; 70V-LINE; 60W per run.
TBZONES:	8, LH11LH2; call-in, aux controls supported; group Allcall (Others Programmable)
TB AUDIO POWER:	100W TB-group Allcall; 100W Loudhailer (Individual) 100W FOG Loudhailer (FWD, AFT)
ALARMS:	4 prioritized Inputs, 5 tones/envelopes available.
PRE ANNOUNCEMENT TONE:	Includes handset receiver feedback.

<u>Features</u>

- Simultaneous use of DTMF. Dial Pulse and Rotary Dial Telephones
- Use of Data Terminals and Data Sets
- Optional Use of Central Answering Consoles
- Extensive Selection of Standard and Optional Features
- Automatic Diagnostic and Fault Detection
- Compact Bulkhead Mounted Cabinet
- Off-Line Standby Power (inverter UPS) (Optional)
- Noiseless Operation
- Specifically Engineered for Use in Marine Environment (NEMA 4/12)
- Main Distribution Frame Built into Drip-proof Shock Mounted Cabinet
- Thermostatically Controlled Cabinet

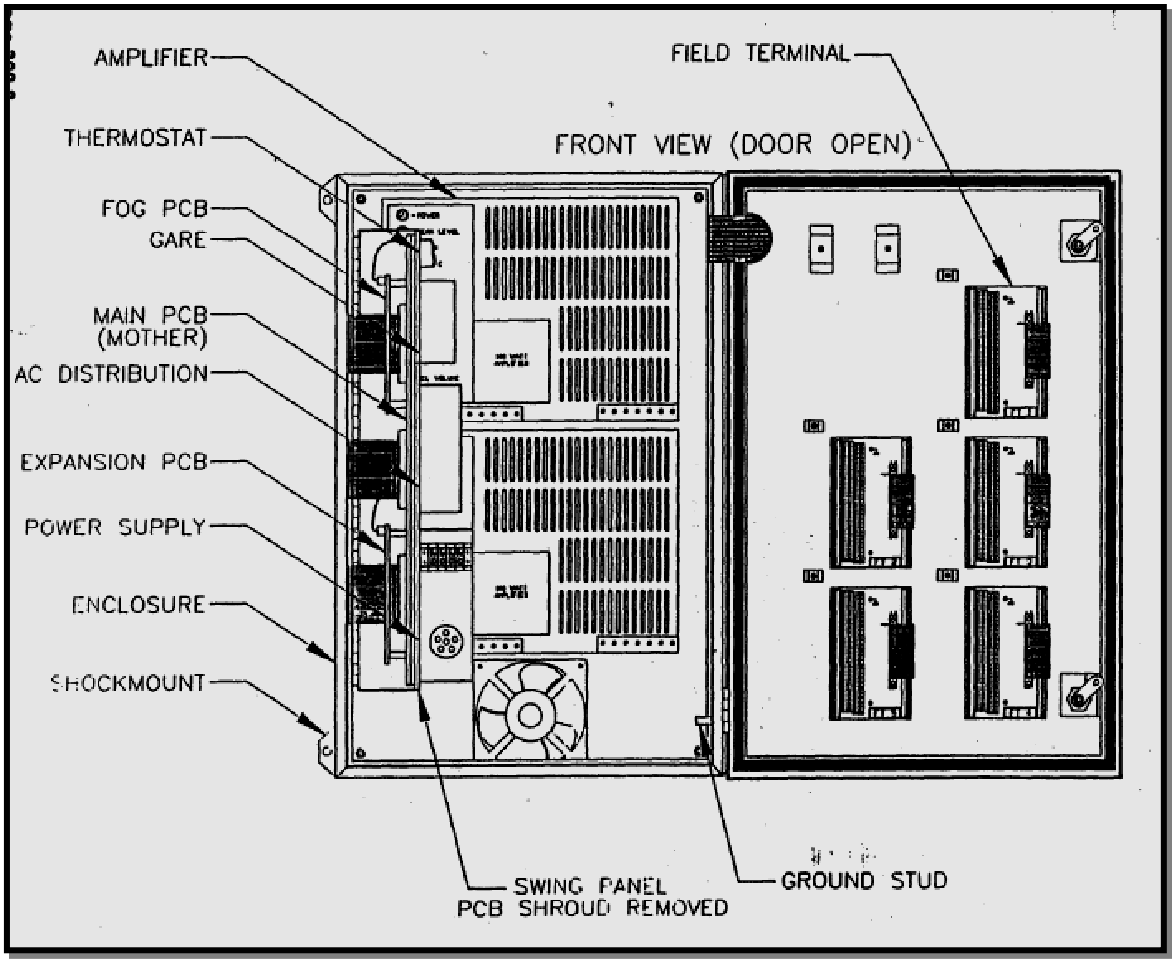


Figure 7-54.— Control Cabinet Configuration.

Description

The MPBX-24/8 is an advanced digital marine private branch exchange fully electronic, featuring PCM switching and stored program control. With a configured capacity of 32 ports, the MPBX can handle voice and data transmissions simultaneously with 24 telephone and data devices and 8 trunks.

The MPBX is electronically compatible with most existing marine DTMF telephones. Shore based telephone and PBX systems and telephone company type central office equipment. This system can also interface with marine paging systems via the page port. The Standard Basic System includes the following:
24 Voice/Data Ports (for use as telephone stations, data terminals, data sets and other digital transmission or reception devices).
8 - Shoreline/Radio Trunks
1 - Page Port Interface

7.12.1 Intelligent Digital Controlhead (IDCH-7200)

The Intelligent Digital Controlhead is a modern microprocessor controlled station unit providing bridge users with centralized access to multi-line telephone, public address, loudhailer, talkback radio, satellite and cellular communications systems. Control of fag and alarm signals as well as other functions is also possible through the array of multi-function keys provided.

User control elements include a monitor speaker standard telephone handset and touch tone keypad contained within a sealed membrane multi-key array. Individual controlheads may be connected in parallel to facilitate distributed access to various systems and functions at key locations.

- Shoreline Transfer Incoming/Outgoing
- Telephone call Incoming/Outgoing
- Allcall & Page Zone Pushbuttons
- Call Hold/Transfer/Conference
- Direct Line Control
- Fog & Alarm Signal Pushbuttons
- Shoreline Exclusion
- Illuminated Membrane Keypad with Power Saver Feature
- Automatic Fault Diagnostics & Lamp Test Functions
- Adjustable Speaker Volume & Backlighting
- Spare Pushbuttons (Future Functions)

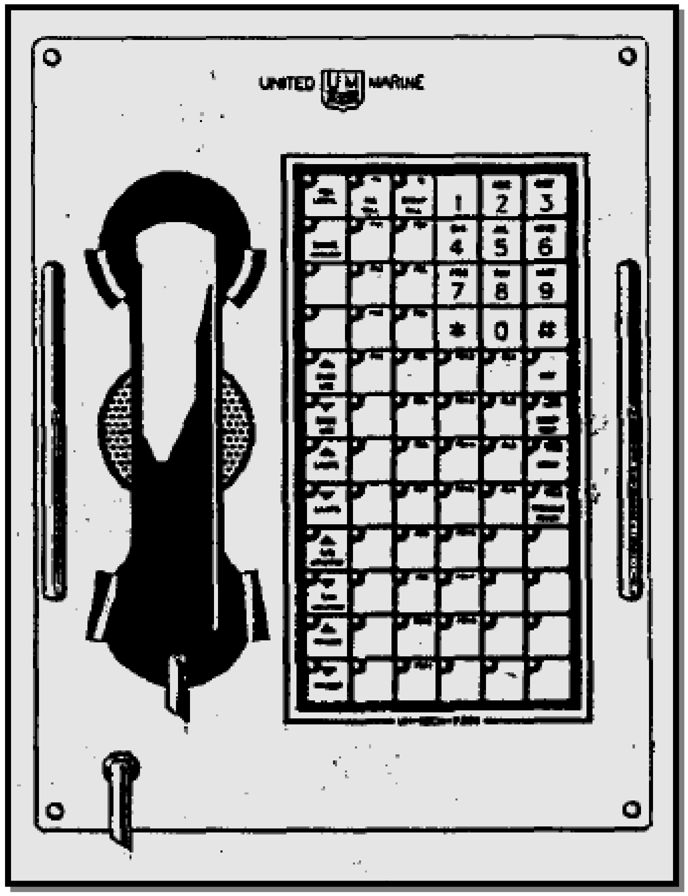


Figure 7-55.— Intelligent Digital Controlhead.

7.12.2 Master Station (PAMC)

The Master PA Station is the primary input to the Ship's Announcing System overriding all other inputs. Provided with PA group select switches for individual group call or A-call paging the unit also controls the General Alarm signal with an on/off switch and monitor TB speaker with on independent level control. The Master PA Station is supplied complete with a handset.

The unit's sturdy steel construction lends itself to the marine environment, complete with its foamed-in front cover gasket.

- Water Resistant Rugged Steel Construction (IP66, NEMA 4)
- Foamed-In Front Cover Gasket
- Primary Input to the Ship's Announcing System
- PA Group Select. Allcall Paging, General Alarm and Talkback (TB)
- Monitor Speaker with Level Control
- Audible Annunciator for System Trouble and TB Call-In

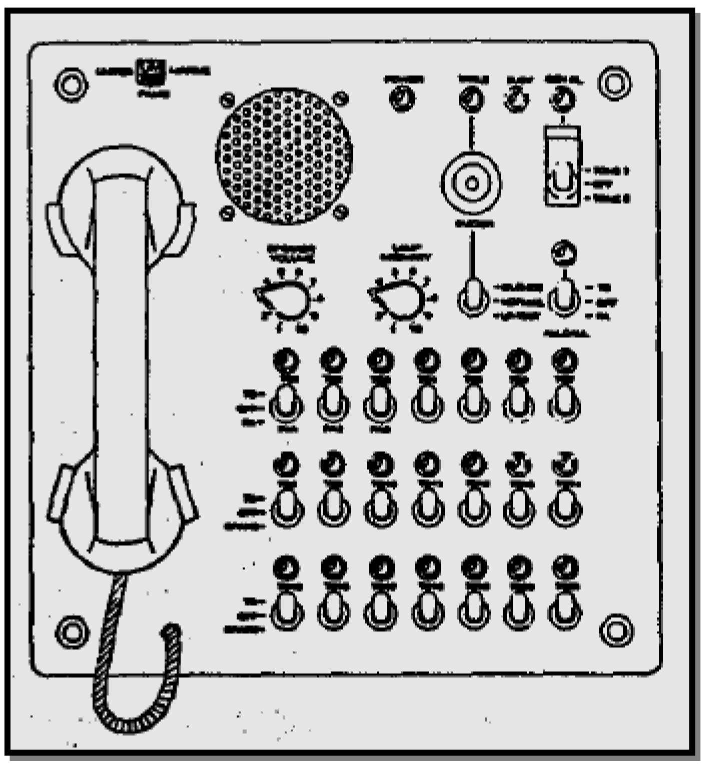


Figure 7-56.— Master Station (PAMC).

7.13.0 CENTRAL AMPLIFIER SYSTEM (TWO-WAY)

The two-way central amplifier announcing system provides two-way transmission of orders and information using central amplifiers. One example of a two-way central amplifier announcing system is the AN/SIA-120. The AN/SIA-120 comprises the circuit 29MC (sonar control and information amounting system) and provides two-way communications between the sonar control room and various remote stations. The sonar control room transmits to loudspeakers at the remote stations, and the remote stations transmit to the loudspeakers in the sonar control room. The AN/SIA-120 operates on 115-volt, 60-cycle, single-phase ship's service power. The major components of the system are the control rack and the additional sound equipment used with the system.

7.13.1 Control Rack

The control rack for the AN/SIA-120 (fig. 7-57) is a bulkhead-mounted enclosure containing two identical amplifier channels, A and B. Each channel uses one self-contained modular audio-frequency amplifier capable of 20-watt output power. The amplifiers are located in two compartments in the upper half of the rack. The bottom half of the rack is a control panel. All the system's switching, testing controls, and indicators are located on the front of the control panel. The system control relays, relay power supply, and various other components are mounted on a bracket behind the control panel. Terminal boards, which are used for making connections to the ship's wiring, are located on the lower rear wall of the rack and are accessible by opening the control panel.

The control rack has input facilities for one portable microphone and five microphone control stations. The control rack also has the facilities for connecting five individual loudspeaker groups to the outputs of the amplifiers. In addition, the rack has a circuit with an amplifier priority control feature, which will connect an alarm signal provided from an external source to the inputs of the amplifiers while inhibiting operation from the microphone control stations.

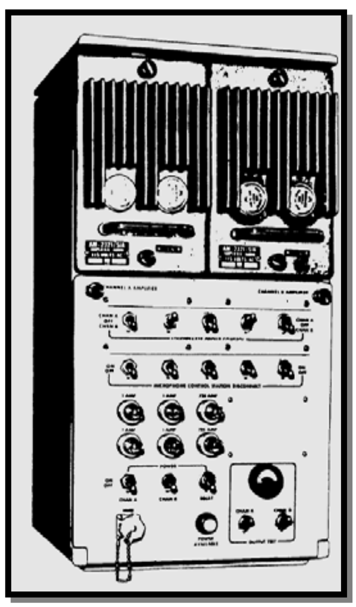


Figure 7-57.— Control Rack.

Audio-Frequency Amplifiers

The two amplifiers located in the upper half of the control rack are used for complete amplification of the microphone outputs. The inputs to the amplifiers are parallel connected. The output transistors are physically located on the front of the panel. This design allows the use of the whole front panel as a heat sink, providing cooler operating temperatures than would otherwise be possible. Figure 7-58 is a block diagram of an amplifier.

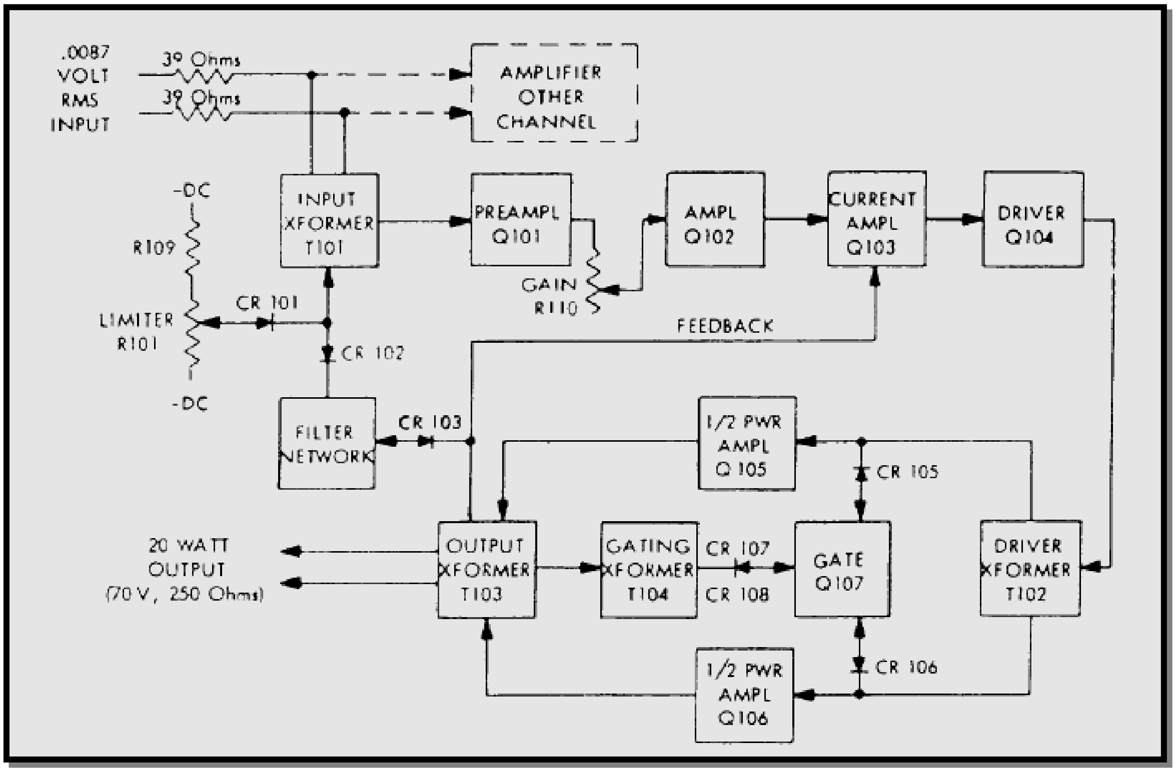


Figure 7-58.— Block Diagram of an Amplifier.

Switches, Timing Controls, and Indicators

The microphone control station inputs to the amplifiers are controlled by five 2-position toggle switches located on the front of the control panel. In the ON position, the microphone control stations are connected to the amplifiers, and in the OFF position, they are disconnected.

The outputs of the amplifiers are individually connected to the loudspeaker groups by five 3-position toggle switches located on the front of the control panel. In the up position, the loudspeaker groups are connected to channel A; and in the down position, they are connected to channel B. Under normal operating conditions, the switches should be positioned so that the loudspeaker load is evenly divided between both amplifier channels. When the switches are in the center position, the loudspeaker groups are disconnected from the amplifier outputs. Separate connections provide for local speakers located adjacent to the associated microphone control stations, and muting features are accomplished in the control rack.

An output test meter and two toggle switches, designated CHAN A and CHAN B, are provided on the control panel for testing the output of each amplifier channel. A portable microphone jack is also provided. This jack can be used for local testing of the system or for talking.

Three toggle switches located on the front of the control panel provide power to the amplifiers and the relays.

A power available lamp and six blown-fuse indicators are also mounted on the front of the control panel.

7.13.2 Additional Sound Equipment

Additional sound equipment used with the system consists of (1) microphone control stations and (2) loudspeakers.

Microphone Control Stations

The microphone control stations located in the sonar control room consist of both microphones and foot operated switches. A portable microphone and an associated jackbox is provided for the sonar control area supervisor, and a flexible microphone and foot-operated switch is provided for each sonar operator’s position. The flexible microphones and foot-operated switches are wired in parallel to permit hands-free operation by the operators. The microphone inputs from the operators’ positions connect to the control panel relay assembly in such a manner that only one microphone is connected to the amplifier input at a given time. This prevents multiple inputs to the amplifier, which could result in unintelligible transmissions to the remote loudspeakers.

The microphone control stations located at the remote stations consist of a flexible microphone and an associated microphone jackbox. These remote stations are connected to the amplifier as separate inputs.

Loudspeakers

Loudspeakers are located in the sonar control area and at each remote location. Loudspeakers located adjacent to control stations are wired so that they are disconnected from the amplifier when the adjacent control station is operated.

Maintenance

Maintenance of the system consists of routine preventive maintenance and corrective maintenance. Maintenance for the two-way system is essentially the same as for the one-way system. Routine preventive maintenance consists of inspecting, cleaning, and testing. Corrective maintenance consists of troubleshooting and replacing parts.

As with the one-way system, operation of this equipment involves the use of high voltages with no interlocks provided. Therefore, all safety regulations and precautions must be observed at all times when you are performing corrective maintenance on this equipment.

Malfunctions can usually be localized by using the comparison method. A problem common to all microphone control stations usually indicates a failure within the circuits of the control rack. A problem peculiar to only one station indicates the fault could be located in the control rack the microphone control station, or the cables connecting the control station to the control rack.

If the entire system is inoperative, check the POWER AVAILABLE indicator lamp on the control rack. If the lamp is not lit, check the switch that provides power to the control rack. If the lamp is lit, check the position of the switches on the control panel. If all the control panel switches are in their proper positions, check for blown fuses. If there is no indication of a blown fuse(s), refer to the applicable technical manual and schematic diagram for the system.

The system's dual channel design, with switching controls, permits continued operation of the system when one channel fails. If there is a failure of the channel A amplifier, place all loudspeaker group control switches to channel B. If there is a failure of the channel B amplifier, place all loudspeaker group control switches to channel A. When operating under this condition, with all loudspeaker groups connected to one amplifier, be careful not to overload the amplifier. Use the OUTPUT TEST switch and meter to test the output of the channel in use. Proper output is indicated when the meter fluctuates with peaks occurring about midscale (0 dB).

7.14.0 INTERCOMMUNICATION SYSTEMS

Intercommunication (intercom) systems provide for two- way transmissions of orders and information between stations. Each intercom unit contains its own amplifier.

7.14.1 Intercommunicating Units LS-433A/SIC and LS-434A/SIC

Regardless of their construction, intercommunicating units on naval vessels are connected together electrically in a system. The electrical characteristics that must be identical to permit interconnection in a system are (1) audio-amplifier input and output requirements, (2) amplifier output impedance to the loudspeaker line transformer, (3) supply voltages and currents, (4) call and busy signal voltages, and (5) interconnection circuits.

One type of intercom unit, the LS-433A/SIC (fig. 7-28), can originate calls up to a maximum of 10 other stations. Another type of intercom unit, the LS-434A/SIC, can originate calls up to a maximum of 20 other stations. There is, however, no operational difference between these two types of units.

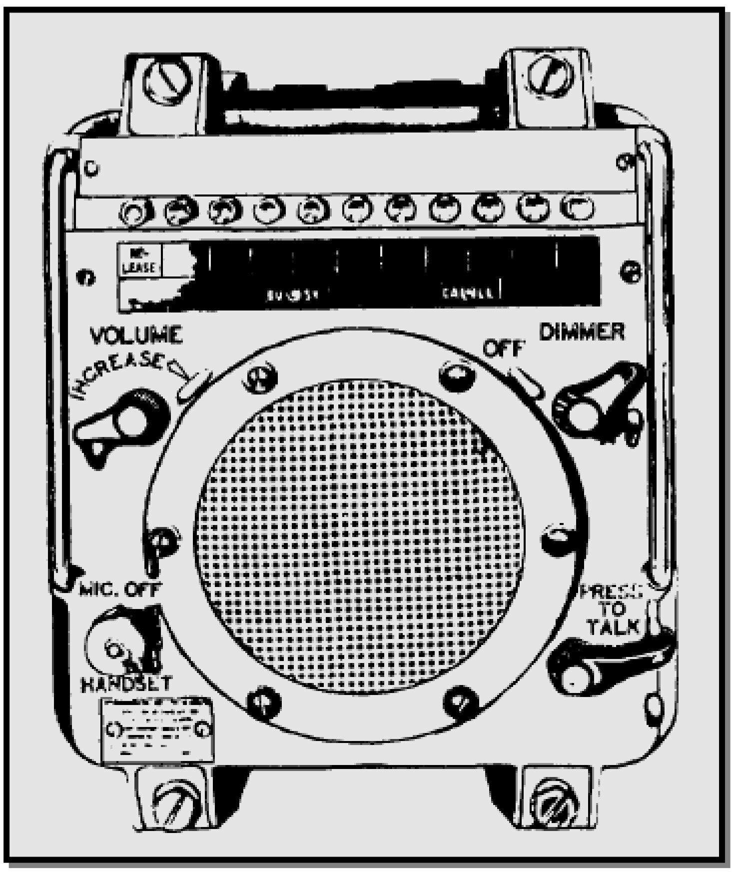


Figure 7-59.— Intercommunicating Unit (LS-433A/SIC).

Reproducer

The reproducer serves a dual function. When it is the transmitting station, it performs as a microphone; when it is the receiving station, it performs as a normal speaker; amplification occurs in the calling unit.

Controls and Indicators

The controls consist of the push-button assembly, talk switch, volume control, and dimmer control. The indicators consist of the busy light, call light, release light, and station designation lights.

PUSH-BUTTON ASSEMBLY.— The pushbutton assembly, or station selector switches, are located at the top of the front panel. The locations of the various units associated with the push button is engraved on the station designation plate immediately below the push button. When the button is depressed, it will lock into the operated position until the release push button is depressed to return them to the non-operated position.

The 10-station unit (LS-433A/SIC) is provided with one bank of 10 selector switches. The 20-station unit (LS-434A/SIC) is provided with two banks of 10 selector switches each. During standby periods, the release push button is kept in the depressed, or operated, position. When any station selector switch is depressed, the release push button is restored to the non-operated position and the release lamp under the push button will be lighted. At the conclusion of the conversation, the release push button should again be depressed, restoring the station selector switches to the non-operated position and extinguishing the release lamp.

TALK SWITCH.— The talk switch serves to select the function of the reproducer. When the switch is depressed, the reproducer functions as a microphone and couples the reproducer (microphone) signal to the amplifier and from the amplifier to the receiving station. When the spring-loaded talk switch is released, the reproducer functions as a loudspeaker and is ready to receive information.

A handset can be used with the intercom unit in place of the reproducer. The operation is the same, except that the push button on the handset is used as the talk switch in place of the normal talk switch. Incoming calls will be heard in the handset and the reproducer simultaneously.

A portable microphone can also be used with this equipment. The operation is the same, except the push button on the portable microphone is used instead of the normal talk switch.

VOLUME CONTROL.— The volume control is associated with a variable impedance transformer inside the unit. As the knob is rotated, the electrical energy passing through the transformer to the loudspeaker is increased and the volume or sound output of the loudspeaker increases correspondingly. The volume control has no effect on the volume of the signal transmitted from the amplifier; thus, each unit in the system can control the incoming volume to the desired level.

DIMMER CONTROL.— The dimmer control controls all illumination of the unit. The signal lights (release, busy, and call) are off when the control knob is in the extreme counterclockwise position and are fully lighted for all other positions. The station designation lights are lighted for all positions of the control knob, and illumination increases as the knob is turned clockwise.

RELEASE LIGHT.— The release light is located under the release push button. When the release push button is in the depressed, or operated, position, the light will be out. When the release push button is in the non-operated position, the light will be on.

BUSY LIGHT.— The busy light is lighted when a station selector switch is depressed and the station being called is busy. When the busy light is lighted, depress the release push button and restore the station selector switch and call later.

CALL LIGHT.— The call light is lighted when a station is being called by another station. The call light will remain lighted until the calling station releases the called station's push button.

DESIGNATION LIGHTS.— The designation lights are located at each end of the station designation plate. These lights remain lighted at all times and illuminate the various stations engraved on the designation plate.

Amplifier

The amplifier is a three-stage, push-pull amplifier that uses transformer input and output coupling. The amplifier uses an internal ac power supply provided by an unregulated dual diode. The primary advantages from push-pull amplifier arrangements are high gain and low distortion. Transformer coupling not only allows the amplifier to be isolated, but also provides impedance matching between the input and the output.

Operation

To call a particular station, depress the station selector push button for that station, depress the talk switch, and speak directly into the reproducer grille. Release the talk switch to listen. When the conversation is completed, depress the release push button to restore the selector switch.

To answer a call from another station, simply listen to the conversation, and answer by depressing the talk switch; it is not necessary to operate the station selector switch. The call light on your unit will be illuminated to indicate your station is being called by another station. If the call light remains illuminated at the completion of your conversation, depress the talk switch and remind the calling station to depress the release push button.

The audio circuit between two stations is illustrated by the simplified schematic diagram in figure 7-60. The talk switches at both stations are shown in the restored (listen) position. When talk switch S26 at either station is depressed, the voice coil leads of the loudspeaker are shifted from terminals 7 and 13 of the secondary of T2 to input transformer T1 of the amplifier. Thus, talk relay K1 is operated, which applies plate voltage to the amplifier at the talking station and places the amplifier in the ready condition. The voice signals are amplified and applied to terminals 14 and 15 of T2 at the listening station and appear across terminal 7 of T2 and the moving contact of volume control S25, and from there to the loudspeaker. The amplifier in the listening unit is in standby.

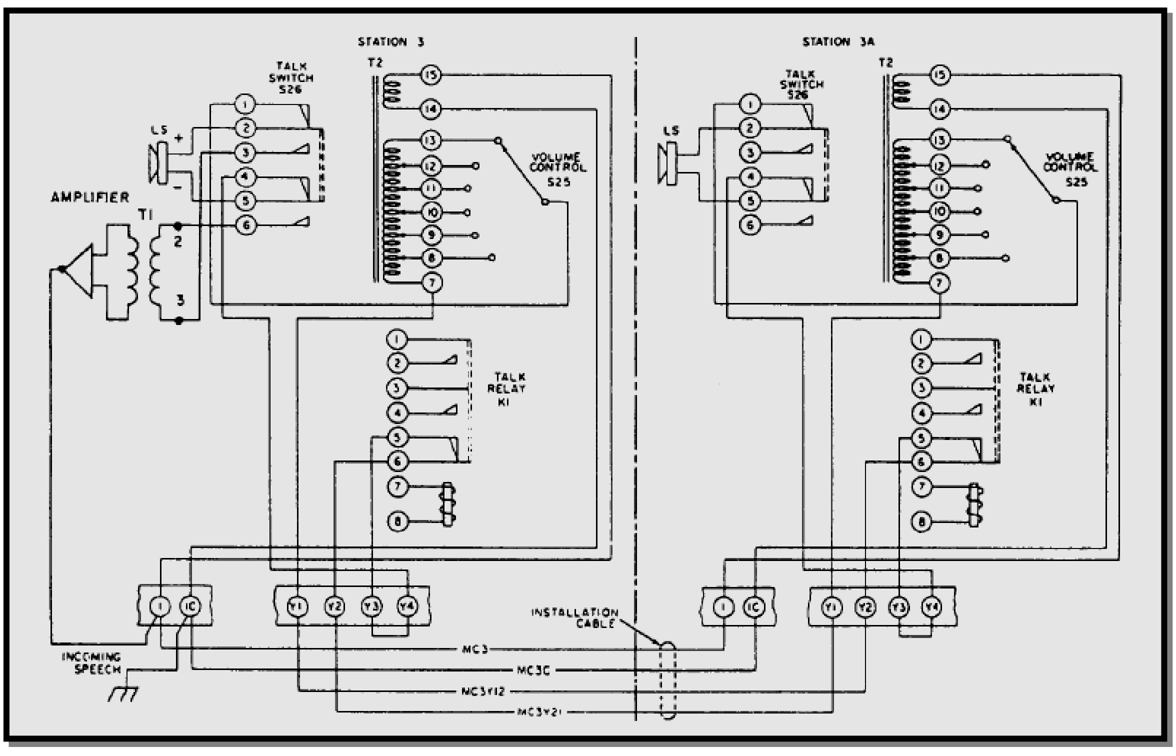


Figure 7-60.— Schematic Diagram of Two Stations in Parallel.

The operation of two intercom stations in parallel is illustrated by the simplified schematic diagram in figure 7-60. The incoming speech from a remote station will be heard at both stations 3 and 3A, and replies can be made from either station. Either station can call a third station, but both stations cannot call at the same time. When talk switch S26 at station 3 is depressed to transmit a message, talk relay K1 at station 3A is operated to open the circuit to the loudspeaker and prevent acoustic feedback (not shown).

Incoming speech lines 1 and 1C of station 3 are connected to terminals 15 and 14, respectively, on transformer T2.

The 14-15 winding of T2 at both stations couples the incoming speech to the tapped windings of T2, which include volume controls S25. Thus, the incoming signals appear across terminal 7 of T2 and the moving contact of volume control S25 at both stations. These signal sources are connected in series addition through a closed loop containing both loudspeakers.

The circuit is from the arm of S25 at station 3, contact 1-2 of S26, the loudspeaker, contact 4-5 of S26, terminals Y4 and Y3, contact 5-6 of K1, terminal Y2 over line MC3Y21 to terminal Y1 of station 3A, terminal 7 of T2, the arm of S25, contact 1-2 of S26, the loudspeaker, contact 4-5 of S26, to terminals Y4-Y3, contact 5-6 of K1, terminal Y2, over line MC3Y12, terminal Y 1 in station 3, to complete the circuit at terminal 7 of T2.

The volume at both stations will be the same and can be controlled by either volume control S25. Both volume controls, however, should be kept at the same setting.

If talk relay K1 is operated at either station, the input to the audio circuit will be open for both stations.

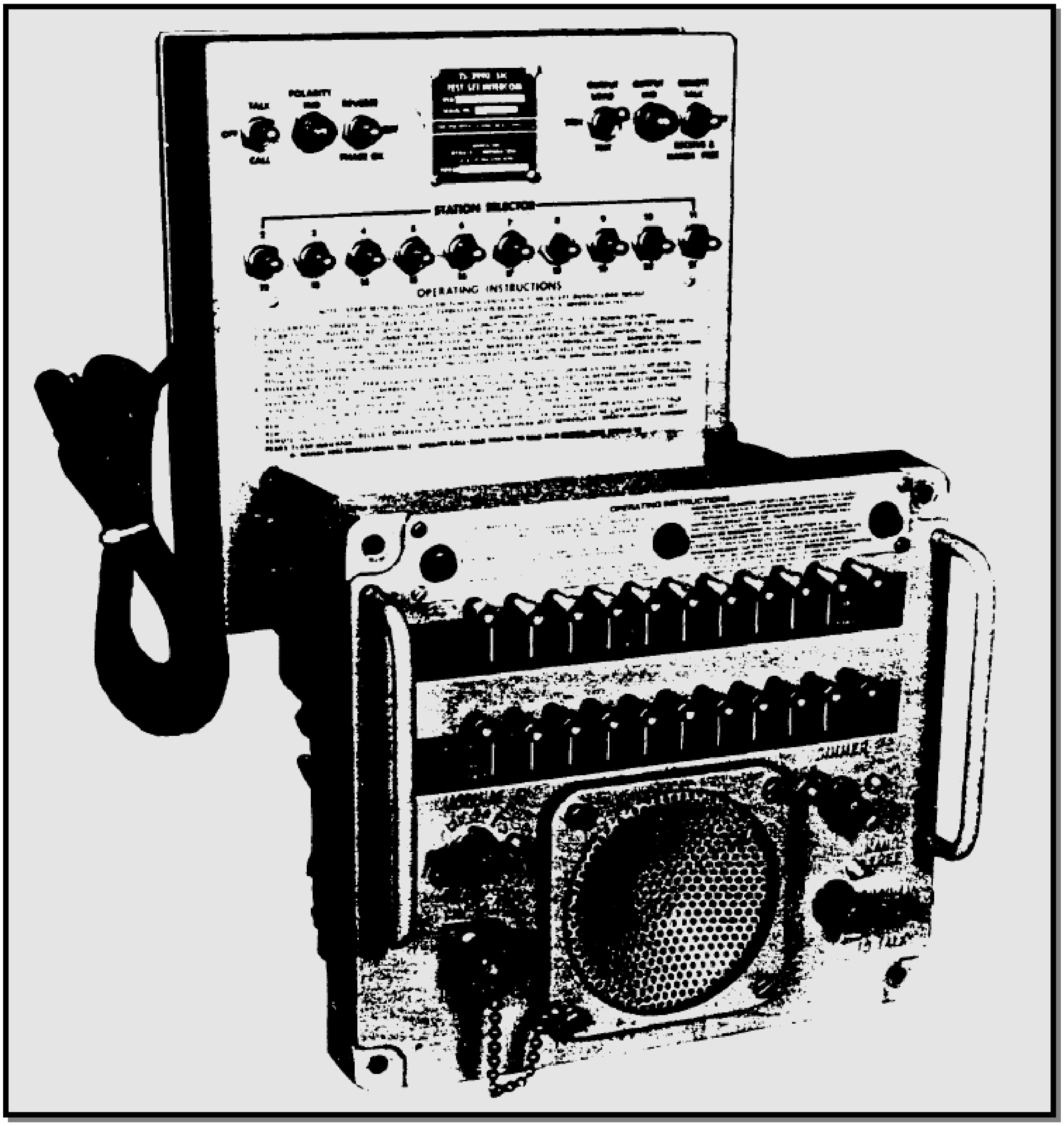


Figure 7-61.— Master Station and Test Fixture, Connected.

Maintenance

A test fixture is provided with the maintenance parts of the equipment to facilitate testing the intercom units. The test fixture is housed in a metal case and includes the necessary switches, resistors, and controls to perform all essential tests on a unit. It is provided with a line cord and plug for connection to the ship's 115-volt, 60-Hz power supply, and suitable female connectors for attaching it to the rear of the unit under test. The front cover contains 11 double-pole, double-throw (DPDT) test switches, S201 through S211, a single-pole, single-throw (SPST) call lamp test switch, S212, an SPST talk test switch, S213, a DPDT polarity test switch, S214, and an indicator lamp, I201. A wiring diagram of a test fixture is illustrated in figure 7-62.

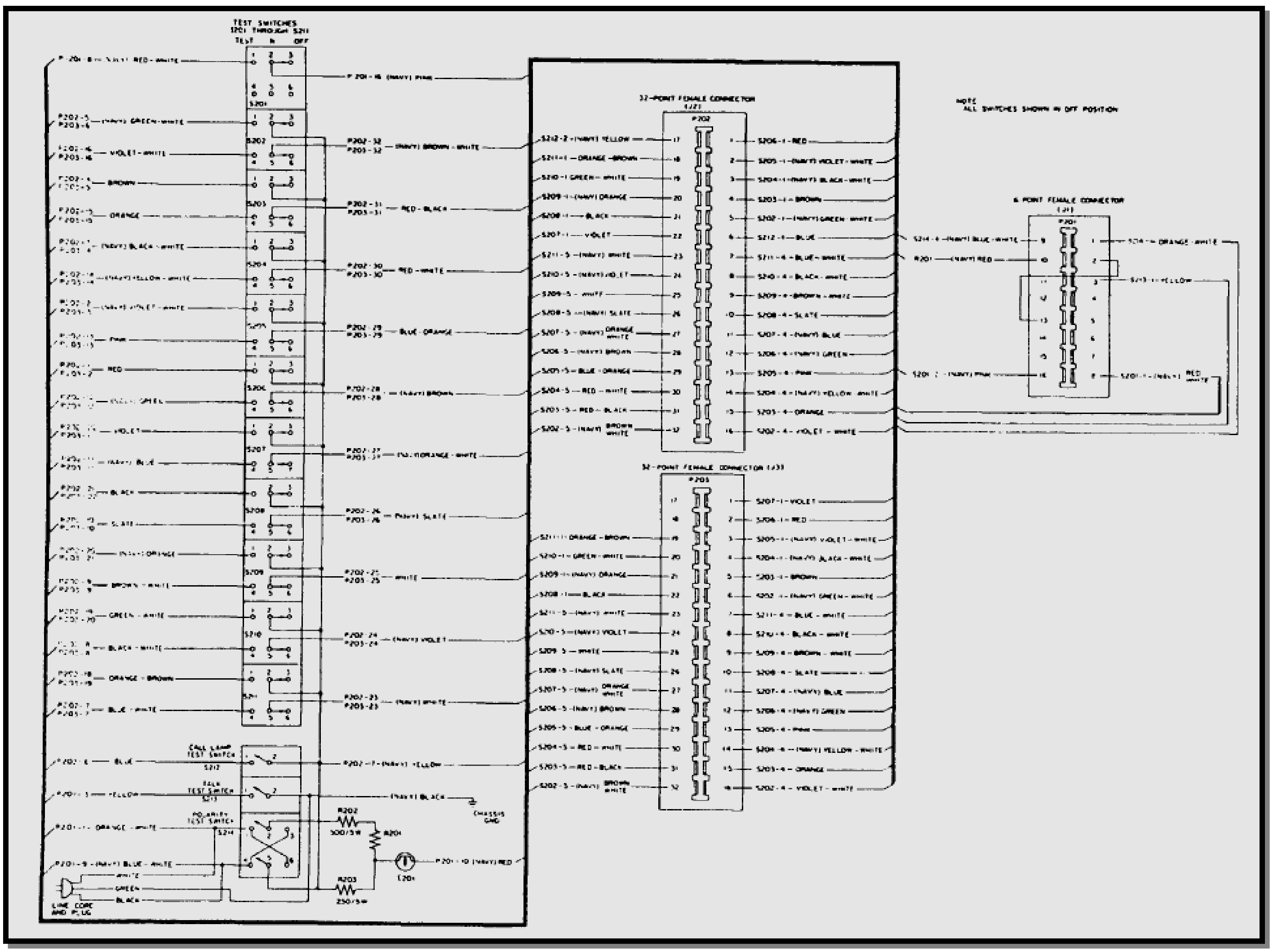


Figure 7-62.— Example of Wiring Diagram of Test Fixture for LS-433A/SIC.

To use the test fixture, remove the intercom unit to be tested from its case. Attach the test fixture to the rear of the unit by plugging it into the unit. Connect the line cord and plug to the ship's 115-volt, 60-Hz power. On the test fixture, operate talk switch S213 to the OFF position and the 11 test switches, S201 through S211, to the STANDBY position. On the unit under test, depress release push button S1, turn volume control S25 and dimmer control S27 to the extreme clockwise positions, and connect a microphone or handset into microphone jack J6.

Polarity Test

To test the polarity of the unit, operate polarity test switch S214 (fig. 7-62) to the OK WHEN LIT position (not shown). Indicator lamp 1210 should light with full intensity if the polarity is correct. Now operate polarity test switch S214 to the REVERSED position (not shown). The indicator lamp should go out if the polarity is not correct. The lamp may glow faintly, but it is not important. The polarity test checks the polarity of the line and signal voltage windings (terminals 10-11 and 8-9, respectively) of the power transformer, T3.

Call Lamp Test

To test the call lamp of the unit, operate call lamp test switch S212 on the test fixture. Call lamp 12 on the unit under test should be lighted.

Amplifier and Reproducer Test

To test the amplifier and reproducer, depress the talk switch microphone and talk into the microphone. The talker should hear his/her voice clearly through the reproducer. Rotate volume control knob S25 on the unit under test while talking into the microphone, and observe the effect on the output volume. Now place the microphone close to the reproducer. A microphone feedback should be observed when the volume control is in the full-volume position as well as at one step below full volume. This test provides a rough indication of the amplifier gain, power output, and the general performance of the entire unit, except for the signaling circuits.

Station Selector Circuit Test

On the test fixture (fig. 7-62), operate talk test switch S213 to the TALK position with the microphone reasonably close to the reproducer to produce a microphonics howl. Reduce the volume control to the minimum position at which the howl can still be obtained by moving the microphone as close to the reproducer as required. This position will produce the minimum objectionable howl during the subsequent station selector circuit tests.

When test switch S201 is in the TEST position, it places a short circuit across terminal 1 and 1C to interrupt the microphonics howl.

On the unit under test, depress station selector push button S2 (adjacent to release push button S1). On the test fixture, operate test switch S202 to the STANDBY position and depress release push button S 1 on the unit under test. This test checks the continuity between terminals 2 and 2C through switch S2U and busy relay K2 to the line winding terminals 14 and 15 of transformer T2.

Similarly, on the unit under test, depress the remaining station selector push buttons, S3 through S11, using the corresponding test switches, S203 through S211, on the test fixture for each test. This test checks the continuity of the various audio circuits. If the unit under test is provided with facilities for originating calls to 20 stations, repeat the foregoing tests, using the second row of station selector pushbuttons, S12 through S21.

Signal Circuit Test

On the test fixture (fig. 7-62), operate talk test switch S213 to the OFF position and the 11 test switches, S201 through S211, to the STANDBY position. On the unit under test, depress release push button S1 for the subsequent signal circuit tests.

On the test fixture, operate test switch S202 to the TEST position, and on the unit under test, depress station selector push button S2. Busy lamp I1 should light. On the unit under test, depress release pushbutton S1, and again depress station selector switch S2. Busy lamp I1 should go out and again light. Repeat this test several times in rapid succession. On the test fixture, restore test switch S201 to the STANDBY position, and on the unit under test, depress release push button S1.

When test switch S202 on the test fixture is operated to the TEST position, it makes station 2 busy by connecting terminal 2X to terminal XX. When station selector push button S2 on the unit under test is depressed to select station 2, it checks the busy circuit through lower switch assembly S2L, busy relay K2, latch-bar switch S23, and associated wiring. It also checks the operation of upper switch assembly S2U and associated wiring.

Test the remaining push buttons by operating first the test switches, S204 through S211, to the TEST position on the test fixture, and then depressing the corresponding station selector push buttons, S4 through S11, on the unit under test. If the unit under test is a 20-station type, repeat the foregoing tests, using the second row of station selector pushbuttons, S12 through S21.

The manufacturer’s technical manual furnished with the equipment installed in your ship contains more detailed information concerning the operation, repair, and maintenance of intercommunicating units.

7.14.2 Intercommunicating Units LS-518/SIC and LS-519/SIC

The LS-518/SIC and LS-519/SIC intercoms (fig. 7-63) are 10-station and 20-station units, respectively. Both are fully transistorized intercoms that operate in much the same way as the older 433A and 434A types (refer to the overall functional diagram, fig. 7-64). The darkened solid line in this figure shows that the audio from the calling loudspeaker is amplified and transmitted via the station selector switches to the called station. The darkened broken line shows that the audio from the calling station goes into the speaker of the local called station, via output transformer T3, volume control S25, and relay contacts K1, K4, and K3.

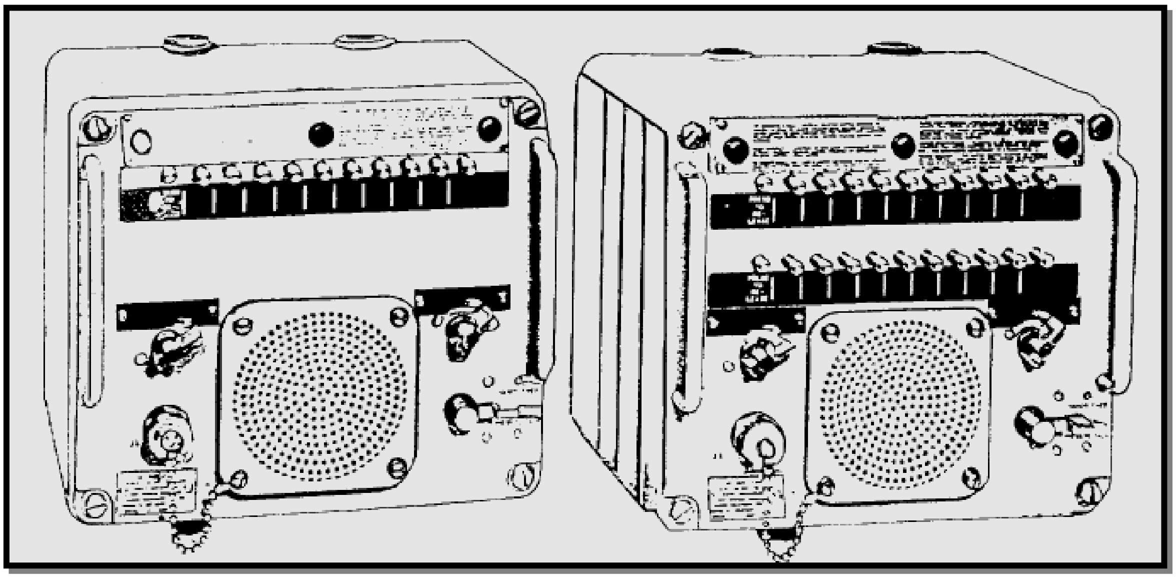


Figure 7-63.— Intercommunicating Units, Types LS-518/SIC and LS519/SIC.

The main differences between the older intercoms and the fully transistorized units concern the connection of a remote loudspeaker (model S-223) and the addition of a hands-free position to the press-to-talk switch. Connecting the loudspeaker calls for some minor wiring changes, such as cutting the leads on the switch assembly. Complete instructions for connecting the loudspeaker are contained in the manufacturer's technical manual. When the press-to-talk switch is in the hands-free position, the calling station controls the transmitting or receiving function; the receiving station need not press the switch to talk.

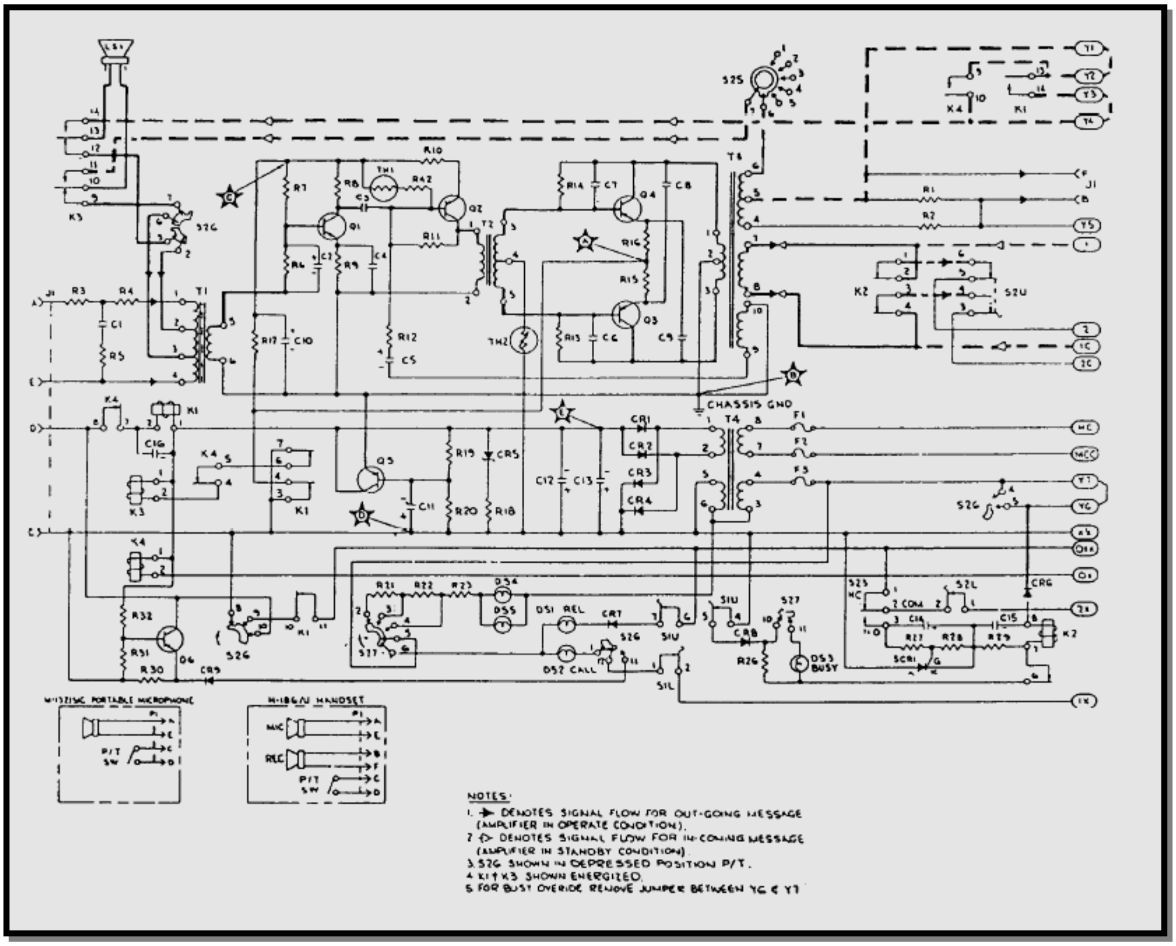


Figure 7-64.— Example of Overall Functional Diagram.

Figure 7-65.— Intercommunication Station LS518D/LS-519E.

Controls and Indicators

All front panel controls and indicators are illustrated in Figure 7-66 and are described below.

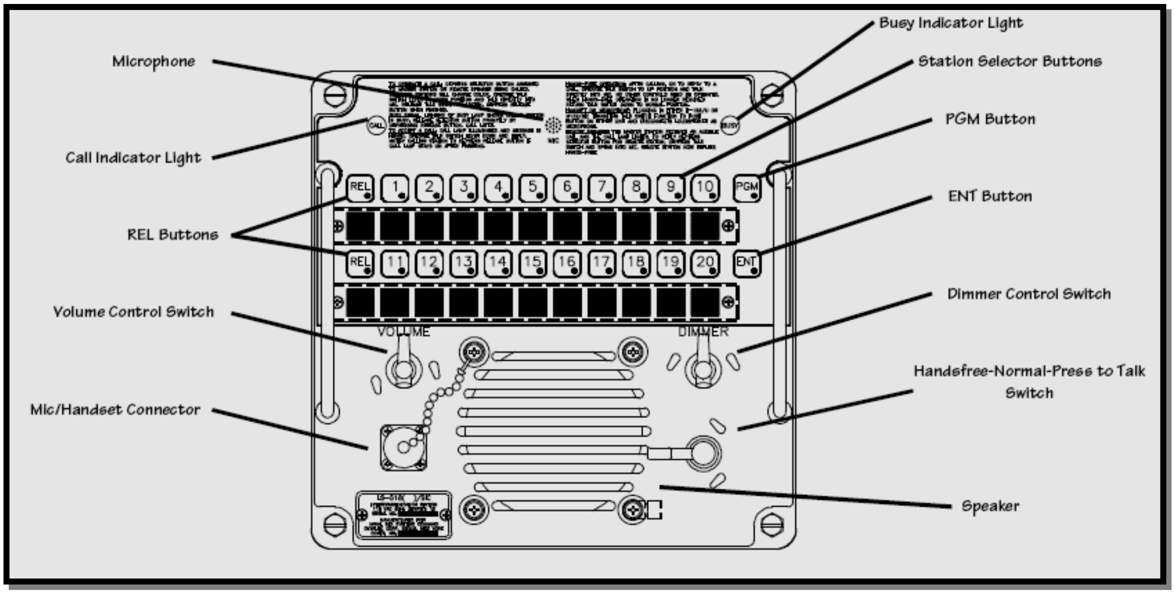


Figure 7-66.— Controls and Indicators.

a. Station Selector Buttons

The push-buttons labeled 1-20 are used to originate a call to another station. The LED behind each pushbutton is normally illuminated RED (intensity determined by DIMMER control switch – see below). When a station is selected (regardless of whether the station is busy or not), the LED behind the selected station push-button illuminates GREEN or turns off, depending on the *GreenOn* parameter setting.

For the LS-518(MOD), only the top row of station selector buttons is illuminated. The bottom row of stations selector buttons is not functional.

b. REL (Release) Buttons

The two push-buttons labeled REL are used to release any and all called stations. The REL button should be used after a call is completed. Both buttons perform the same function. As with the Station Selector Buttons, for the LS-518(MOD), only the upper REL button is functional.

c. PGM (Program) Button
The push-button labeled PGM is used to enter programming mode. To adjust the *AudioTimeout*, *GreenOn*, or *AllCallAssign* parameters, press and hold the PGM button to enter programming mode.

d. ENT (Enter) Button
The push-button labeled ENT is used in programming mode to verify changes made to any of the programmable parameters.

e. CALL Indicator Light
This indicator lights at the called station when it is selected by any other station in the system. It serves the purpose of visually alerting the user of an incoming call.

f. BUSY Indicator Light
This indicator lights at the calling station when the station being selected is already busy.

g. VOLUME Control Switch
This control is a six-position rotary attenuator switch having five 6dB steps and providing a maximum attenuation of 30dB. Use the control the output volume of the station speaker.

h. DIMMER Control Switch
This control is a four-position rotary switch which controls the panel illumination. The LED lights behind each push-button and the backlighting behind the legend bar have adjustable intensities based on the setting of this control switch. The CALL and BUSY lights do not have adjustable intensities. With this control switch in its most counter-clockwise position, the CALL and BUSY lights are extinguished.

i. HANDSFREE-NORMAL-PRESS TO TALK Switch
This control is a three-position rotary switch having two locking positions HANDSFREE and NORMAL) and one momentary position (PRESS TO TALK). The NORMAL position is used for listening. The PRESS TO TALK position is used to transmit audio via the front panel microphone. The HANDSFREE position is used in situations where talk/listen mode is to be determined by the calling station.

j. MIC or HANDSET Connector. Used to connect either a microphone or a handset to the station.

k. SPEAKER
The 4-inch loudspeaker is used for the amplification of incoming audio.

l. MICROPHONE
The front panel microphone is used for transmitting audio to a connected station.

Operating Procedures

a. Communicating Between Two Master Stations

Originating a Call:
To originate a call, depress the selector push-button of the station desired. The LED behind the push-button pressed will change from RED to GREEN if the *GreenOn* parameter is set to ON and will change from RED to OFF if the *GreenOn* parameter is set to OFF. If the BUSY Indicator Light illuminates, depress the REL button and call later. If BUSY Indicator Light does not illuminate, operate the HANDSFREE-NORMALPRESS TO TALK switch to the PRESS TO TALK position and speak into the microphone. To receive a reply, allow the HANDSFREE-NORMAL-PRESS TO TALK switch to return to the NORMAL position. When communication is completed, press the REL push-button.

NOTE: The master station is provided with a Busy Override feature. This allows the calling station to connect to another station even if it is busy. To enable this feature, engage dipswitch S1 on the Interconnect PCB (ASSY 61690-650) to the BUSY OVERRIDE ON position.

Answering a Call:
To answer a call (CALL Indicator Light is illuminated), operate the HANDSFREE-NORMAL-PRESS TO TALK switch to the PRESS TO TALK position and speak into the microphone. When conversation is finished, observe the CALL Indicator Light. It should be extinguished. If not, instruct the calling party to press their REL push-button.

The units are equipped with an Audio Timeout feature which eliminates the possibility that stations can be “locked up” if the REL push-button is not pressed when communication is complete. Transmit and receive audio for the station is monitored and, if neither is present for a period indicated by the *AudioTimeout* parameter setting, the station releases any and all called stations. The Audio Timeout is adjustable from 30 seconds to 3 minutes in 30-second intervals.

Busy Override:
If the Busy Override feature is enabled (see NOTE above) and a BUSY indication is received, operate the HANDSFREE-NORMAL-PRESS TO TALK switch momentarily to the PRESS TO TALK position. This will unlatch the busy circuit, extinguish the BUSY Indicator Light, and permit two-way communication to begin. When communication is completed, press the REL push-button.

b. Parallel Operation of Two Master Stations:
If desired, two units may be connected for parallel operation. To enable parallel operation, dipswitch S1 on the Interconnect PCB (ASSY 61690-650) must be engaged to the Parallel Mode ON position and the units must be connected. In this configuration, the operation is the same as for a single unit with the following exceptions:

- Incoming speech will be heard at both units,
- Either station may answer a call but not both (inadvertent answering by both units simultaneously will not cut off transmission of speech to the calling units).
- Operation of VOLUME control switch at either unit will control the receive volume of both units.
- Outgoing speech from one paralleled unit will not be heard at the unit to which it is paralleled.
- Operation of a station selector at either of the paralleled units, in addition to the lighting of the CALL Indicator Light at the called station, will cause the CALL Indicator Light to illuminate on the paralleled station.

c. Handsfree Operation of the Master Station:
A called master station may be switched to Handsfree Mode, if so desired, by operating the HANDSFREENORMAL-PRESS TO TALK switch to the HANDSFREE position. The unit may also be switched to the Handsfree Mode prior to receiving a call. Under this condition, the calling station operator achieves control of the talk and listen circuits between the two stations. The operator at the called station need only talk into the microphone when necessary.

d. Master Station Operation with Remote Loudspeaker Stations:
The master station may be operated with Remote Loudspeaker Stations. In order for this functionality to be supported, a station button on the master station must be *dedicated* to communication with the Remote Loudspeaker Station. To accomplish this, the 12-position dipswitch S1 on the Main PCB (ASSY 61690-620) is used to isolate *either* the Station 10 push-button *or* the Station 20 push-button for this purpose. The chart below illustrates the 3 configurations of dipswitch S1 (these are also printed directly on the PCB):

OPERATIONAL CONFIGURATION	DIPSWITCH SETTINGS (left position 1 to right position 12)
Normal (no remote LS)	111111010101 (a 0 indicates the OPEN position)
Remote LS on Station 10	000111101010 (a 0 indicates the OPEN position)
Remote LS on Station 20	111000010101 (a 0 indicates the OPEN position)

Table 7-16.— Dipswitch S1 Configurations.

Programming

The master station has three programmable parameters. They are as follows:

a. Audio Timeout Duration (*AudioTimeout* parameter) between 30 seconds and 3 minutes

b. Green LED Operation (*GreenOn* parameter) either OFF or ON

c. All-Call Button Assignment (*AllCallAssign* parameter) for any one (or none) of the station select buttons

Entering Programming Mode

To adjust any of the three programmable parameters above, the master station must be placed in Programming Mode. This is accomplished by pressing *and holding* the PGM push-button. Releasing the PGM push-button at any time takes the unit out of Programming Mode.

When the PGM push-button is pressed and held, the following changes will occur on the display:

a. All station select RED LED lights will be extinguished except for those beneath the Station 1, Station 2, and Station 3 buttons.

b. The REL push-button RED LED lights will remain illuminated.

c. The ENT push-button RED LED light will be flashing.

Each of the Station 1-3 push-buttons corresponds to an adjustable parameter. Pressing the Station 1 push-button will allow the *AudioTimeout* parameter to be adjusted. Pressing the Station 2 push-button will allow the *GreenOn* parameter to be adjusted. Pressing the Station 3 push-button will allow the *AllCallAssign* parameter to be adjusted.

When the station button corresponding to the parameter to be adjusted is pressed, the display will again change to illustrate the present setting and the other setting choices for the given parameter. The tables below illustrate the possible settings for each parameter. The setting in **red** indicates the default factory setting.

When the *AudioTimeout* parameter is selected, the RED LED behind station select push-buttons 1-6 will be illuminated. Each button represents one of the following six parameter settings.

Select Station Push-Button Number	Parameter Setting
1	**Audio Timeout Duration of 30 seconds**
2	Audio Timeout Duration of 60 seconds
3	Audio Timeout Duration of 90 seconds
4	Audio Timeout Duration of 120 seconds
5	Audio Timeout Duration of 180 seconds
6	Audio Timeout Duration of 240 seconds

Table 7-17.— Parameter Settings.

When the *GreenOn* parameter is selected, the RED LED behind station select push-buttons 1 and 2 will be illuminated. Each button represents one of the following two parameter settings.

Select Station Push-Button Number	Parameter Setting
1	**Green LEDs ON**
2	Green LEDs OFF

Table 7-18.— Parameter Settings.

When the *AllCallAssign* parameter is selected, the station select push-button corresponding to the All Call button (if any is assigned) will be flashing. Pressing any other station select push-button will reassign the All Call function to that push-button. Pressing the REL button will eliminate the All Call function assignment to any push-button. The factory default setting for the *AllCallAssign* parameter is NO BUTTON ASSIGNED. During normal operation, pressing the station select push-button assign to the All Call function will call all 10 stations (20 for LS-519(MOD)).

After a new setting is chosen for a programmable parameter (choice should be flashing), the ENT push-button confirms the setting change and saves it to memory. *Neglecting to press the ENT push-button will result in* ***no change*** *to the selected parameter*. After pressing the ENT push-button, the PGM push-button can be released.

All parameter settings are held in non-volatile memory and will be held even if there is a loss of power to the unit.

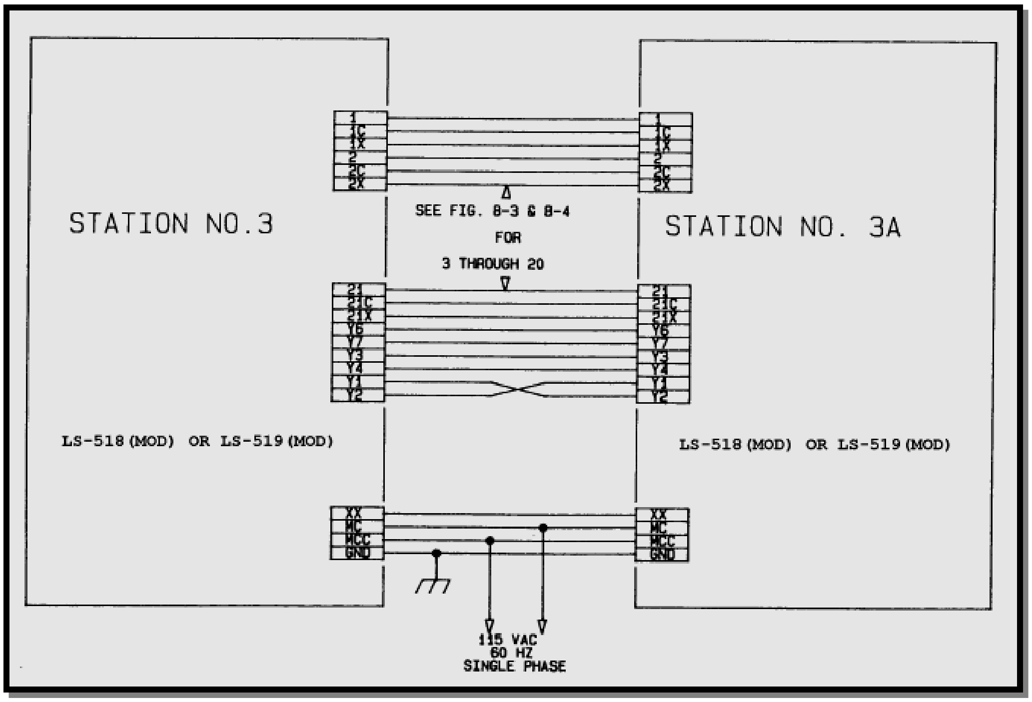


Figure 7-67.— LS-518 (MOD) or LS-519 (MOD) Stations.

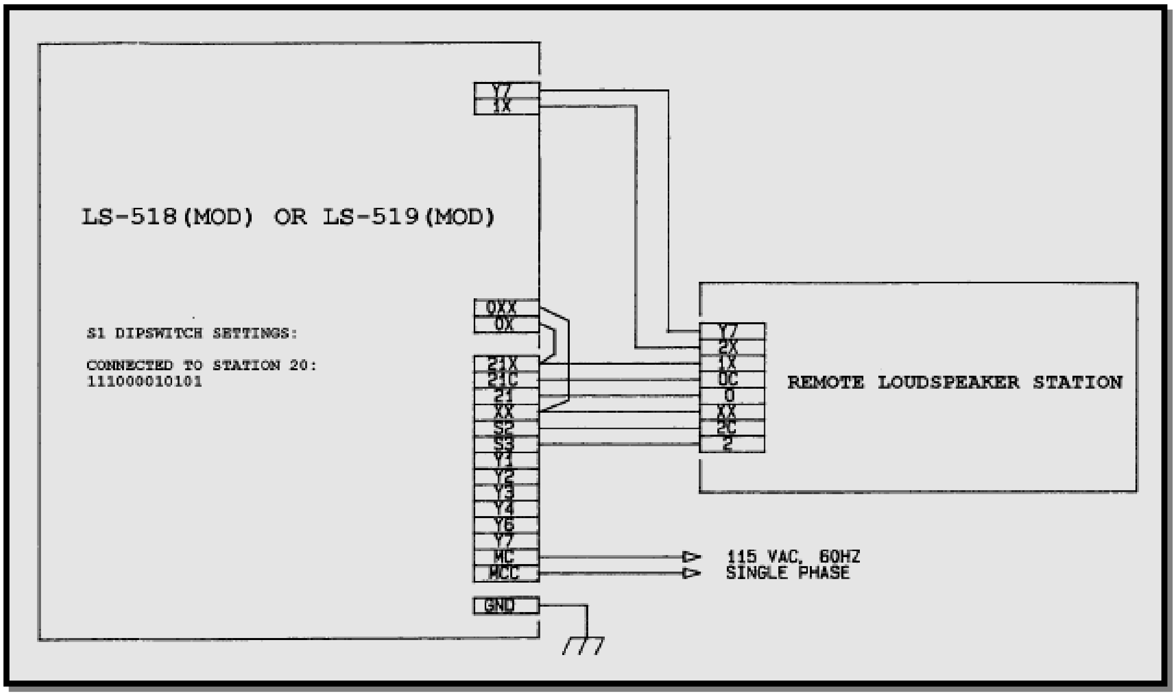


Figure 7-68.— LS-518 (MOD) or LS-519 (MOD) S1 Dipswitch Settings.

SYMPTOM	SUGGESTED SOLUTION(S)
Unit fails to operate (no front panel illumination, no keypad functionality, no BUSY or CALL light illumination).	Verify 115VAC connection to the Interconnect PCB (1A6) at MC and MCC terminals. Check for blown fuses 1F1, 1F2, and/or 1F3.
No receive or transmit audio.	Check the audio line connections to the Interconnect PCB (1A6) at the {station} and {station}C terminals. Replace Main PCB Assembly (1A3).
Receive audio present but no transmit audio.	Replace power transistors 1Q1 and 1Q2. Replace the Front Panel PCB Assembly (1A1). Replace the Audio/Logic PCB Assembly (1A2).
Unit can receive calls (CALL LED illuminates) but there is no keypad functionality (no push-button illumination and no station select functionality).	Check connections from keypad (1A4P1 and 1A4P2) to headers on Main PCB (1A3J7 and 1A3J8, respectively). Replace Keypad Assembly (1A4).
Unit cannot place a call to another station.	Check the control line connection to the Interconnect PCB (1A6) at the {station} X terminal. Check the connection to the Interconnect PCB (1A6) at the XX terminal.
No BUSY LED indication when busy stations are called.	Check the connection to the Interconnect PCB (1A6) at the XX terminal. Replace Audio/Logic PCB Assembly (1A2).
No CALL LED indication for incoming calls.	Replace Front Panel PCB Assembly (1A1).

Table 7-19.— Troubleshooting Guide.

7.15.0 PUBLIC ADDRESS SETS

Public address sets are used at fleet landings and in amphibious operations to direct the movement of personnel, vehicles, and small boats; to communicate between ships and small boats; and to address personnel aboard ship where high noise levels are present or where the installed announcing system is inoperative or impractical. They are also used for entertainment and such functions as church services, wardroom and ready room briefings, change-of-command and other ceremonies, and personnel training. The two types of public address sets are the electronic megaphone type and the portable amplifier or lectern type.

7.15.1 Public Address Set AN/PIC-2

The AN/PIC-2 is an electronic megaphone-type public address set designed to perform under extremes of temperature and high humidity. The set consists of a loudspeaker horn, a microphone, a transistor amplifier assembly, a driver unit, eight D-size batteries, and a pistol-grip handle with a press-to-talk switch, battery selector switch, and external battery connector. All components are housed in one assembly (fig. 7-69). A 15-foot external power cable is provided for connecting the set to an external 12-volt battery when desired. The driver unit, microphone, amplifier enclosure, and battery enclosure are watertight.

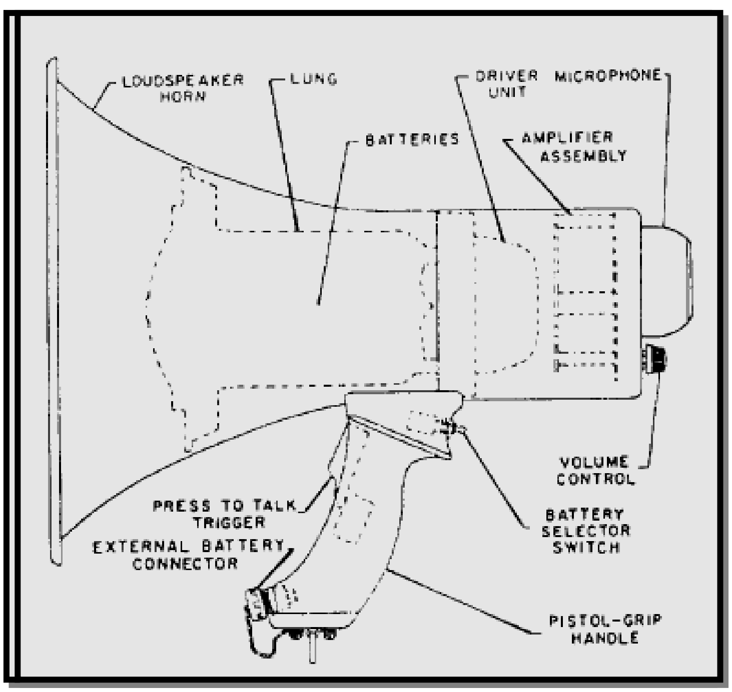


Figure 7-69.— AN/PIC-2 Public Address Set.

To operate the set, put the battery selector switch to the INT. position (or to the EXT. position if operation is to be from an external battery). Grasp the pistol-grip handle with one hand, raise the unit so that the rubber microphone is almost touching the mouth, and direct the horn in the direction it is desired to communicate. Press the press-to-talk switch and speak directly into the microphone in a strong voice. Release the press-to-talk switch when the message is completed. The set is specially designed to eliminate acoustic feedback to the extent possible. Acoustic feedback may occur, however, if the horn is directed toward a reflecting surface, such as a deck or bulkhead. When using the set below decks, back the volume control knob off until feedback stops, and then advance it gradually to a point where maximum volume without feedback is obtained.

Amplifier Circuit

The transistor transformer-coupled, volume control R1, amplifier is a three-stage, push-pull type. It consists of input transistor Q1, interstage coupling transformer T2, push-pull power transistors Q3 and Q4, and output inductor L1.

DC Power Circuits

The 12-volt dc supply is selected from either the internal or external batteries by battery selector switch S2. Press-to-talk switch S1 supplies dc power to the amplifier only while the switch is held closed.

Microphone and Loudspeaker Assemblies

The Mk 1 magnetic microphone has an impedance of approximately 150 ohms. The microphone output is applied to transistor Q1 through volume control R1 and capacitor C1. A selected portion of the sound radiated to the rear by the loudspeaker horn acts on the back of the microphone diaphragm. This sound is phased so as to reduce acoustic feedback.

Loudspeaker LS1 is a moving-coil, permanent magnet type. Amplifier output signals actuate the voice coil and diaphragm, and the resulting sound waves are amplified and directed by the loudspeaker horn.

Maintenance

Preventive maintenance consists of replacing batteries, routine cleaning, and inspections. When the batteries are replaced, inspect the battery contact springs and clean them if necessary. If the springs are badly corroded, they should be replaced. Keep the external power cable free of dirt and corrosion. Clean the spring clips with sandpaper and apply a thin coat of petrolatum to reduce corrosion. Inspect the connector and clean it if necessary.

Periodically check the microphone housing. Keep the opening to the microphone free of dust, dirt, oil, grease, salt crystals, or other foreign matter. Salt crystals left by the evaporation of salt water and spray should be dissolved and rinsed away with fresh water, and then the parts should be dried with a soft cloth.

Check the inside of the pistol-grip handle occasionally. Remove the handle cover and inspect the switch contacts. Clean if necessary.

The manufacturer's technical manual contains detailed instructions for troubleshooting and repairing the set. All components are designed for easy replacement.

7.15.2 Public Address Set, Lectern Type

Modern Navy ships are provided with the lectern-type public address set. This set (fig, 7-70) is a portable self-contained unit capable of reproducing sound for entertainment or dissemination of information. The set consists of an illuminated reading counter with a removable unidirectional dynamic microphone, a transistorized amplifier and controls, an extended range loudspeaker, a battery meter, and jacks for microphones, record player, tape recorder, and have external speakers. Power to operate the set is provided either by the self-contained dry battery, or an external 115-volt ac supply.

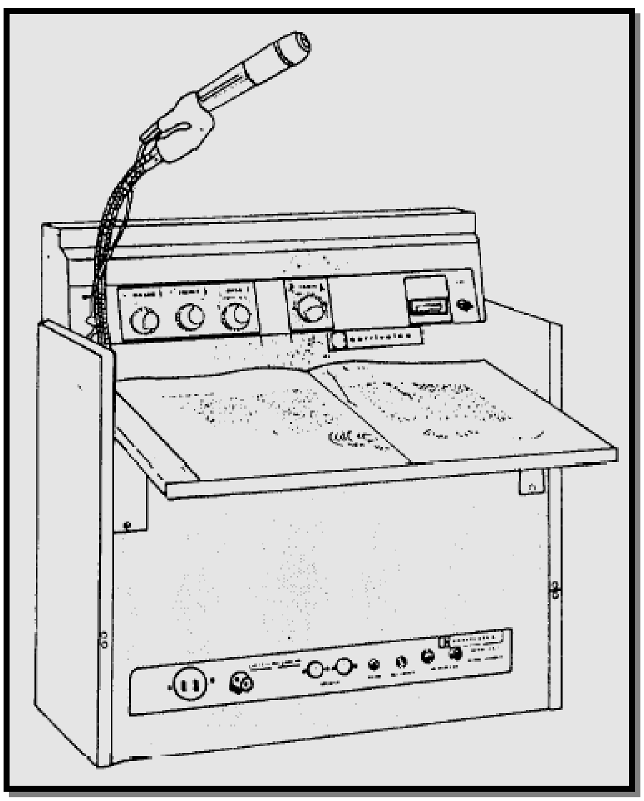


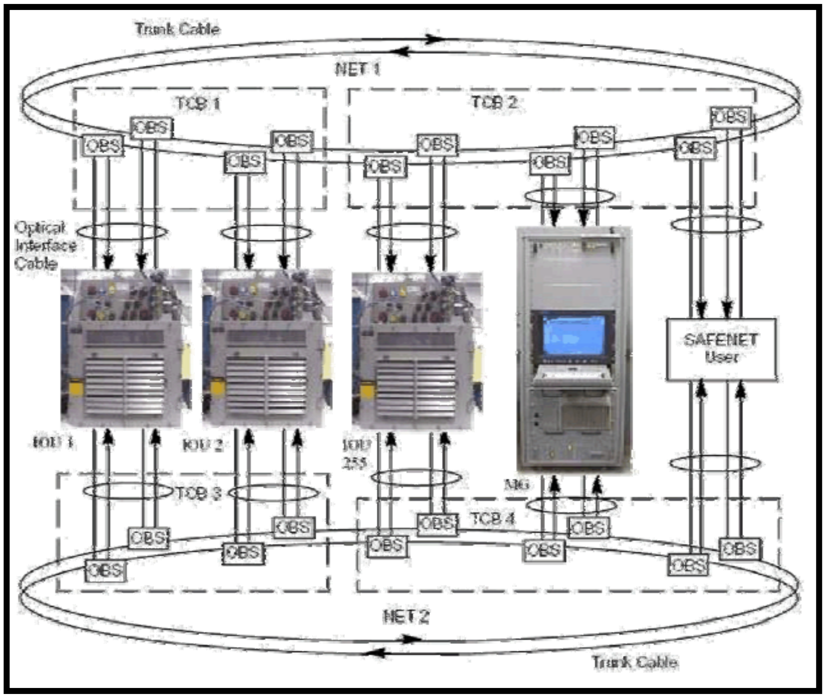
Figure 7-70.— Public Address Set, Lectern Type.

As an IC Electrician, you may be assigned the responsibility for setting up and checking out public address sets. To allow time for any minor adjustments or repairs that maybe required, always check the set or system well in advance of the time it is to be used.

7.16.0 SUMMARY
In this chapter, we have discussed how amplified voice systems are used to amplify and transmit both verbal announcements and alarm signals on board ship. We have identified the various announcing systems by their circuit designations.

We have explained how the various types of amplified voice systems operate and how to maintain the systems. Also, we have described the additional sound equipment used with the systems and the procedures for maintaining this equipment.

8 DATA MULTIPLEX SYSTEMS



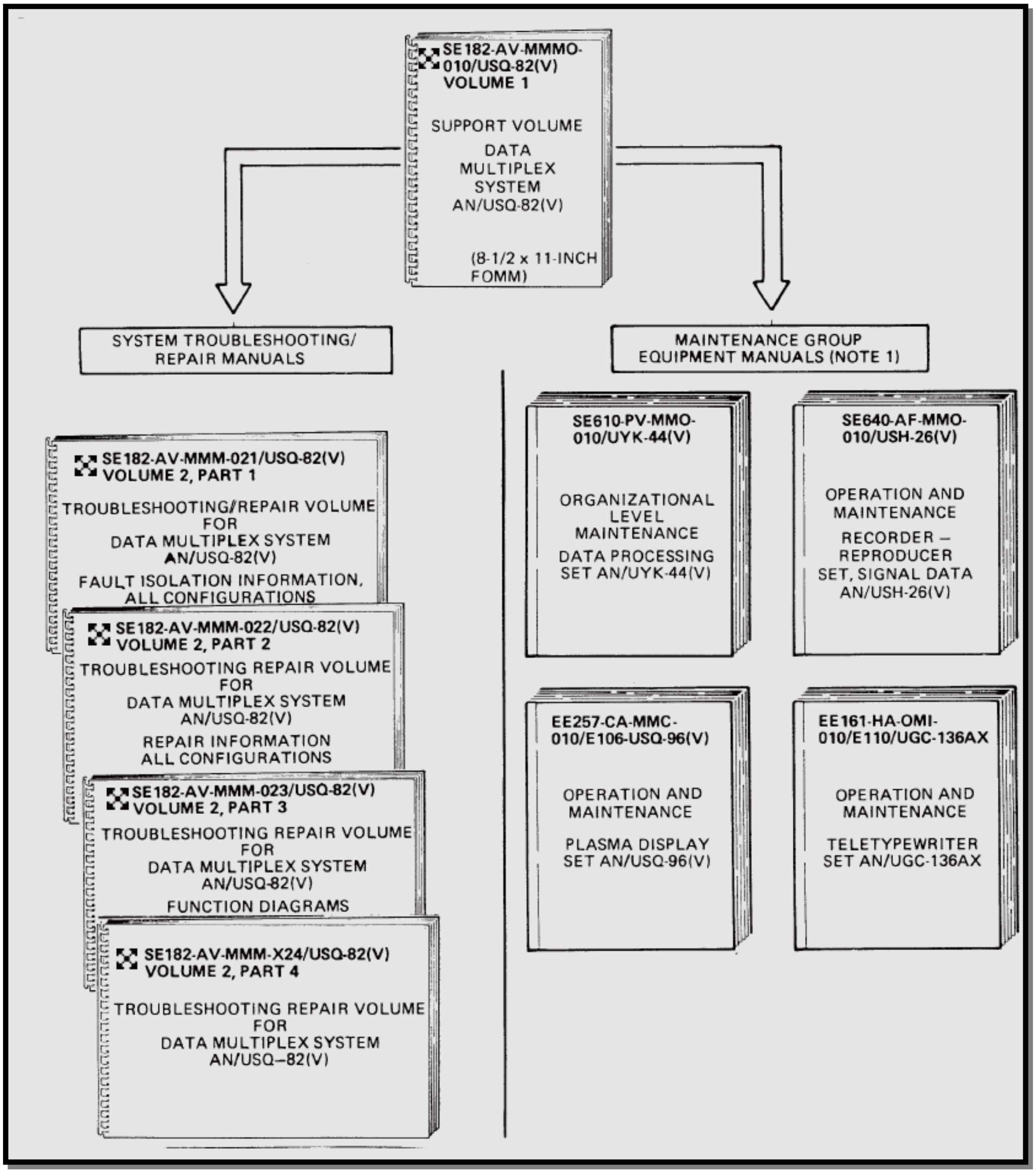
Upon completion of this chapter, you will be able to do the following:

- Discuss the purpose and function of Data Multiplexing Systems
- Describe the basic configurations of multiplexing systems
- Identify various Data Interfaces
- Describe Control Words and Messaging
- Discuss Data Routing
- Discuss Input/Output Unit and Input/Output Module purpose and functions

8.0.0 INTRODUCTION

Data Multiplex System (DMS) is a general purpose, user-oriented, micro-programmed, electronic information transfer multiplexing system. The system accommodates a variety of input signal formats from source user devices and provides output signals in the same or different formats, as applicable, to the sink user devices.

The technical manuals required to operate and maintain DMS are contained in two sets of manuals: (1) Data Multiplex System manuals and (2) Maintenance Group equipment manuals. These manuals are defined in Figure 8-1.



NOTES: (1) Maintenance Group OQ-288A/USQ-82(V) Consists largely of standard military equipment. Troubleshooting/repair instructions are provided in the equipment manual for each such item of equipment.

Figure 8-1. DMS Technical Manual Organizational Chart.

8.1.0 Modular Design

DMS consists of a group of stand-alone modular building blocks of electrical equipment and interconnecting cables. These building blocks (Figure 8-2 and Table 8-1) are specialized functional assemblies that can be assembled in an almost unlimited number of combinations to meet the electrical information transfer requirements of a wide variety of electrical equipment located on a wide variety of ships, from frigates to aircraft carriers, and from submarines to shore test facilities.

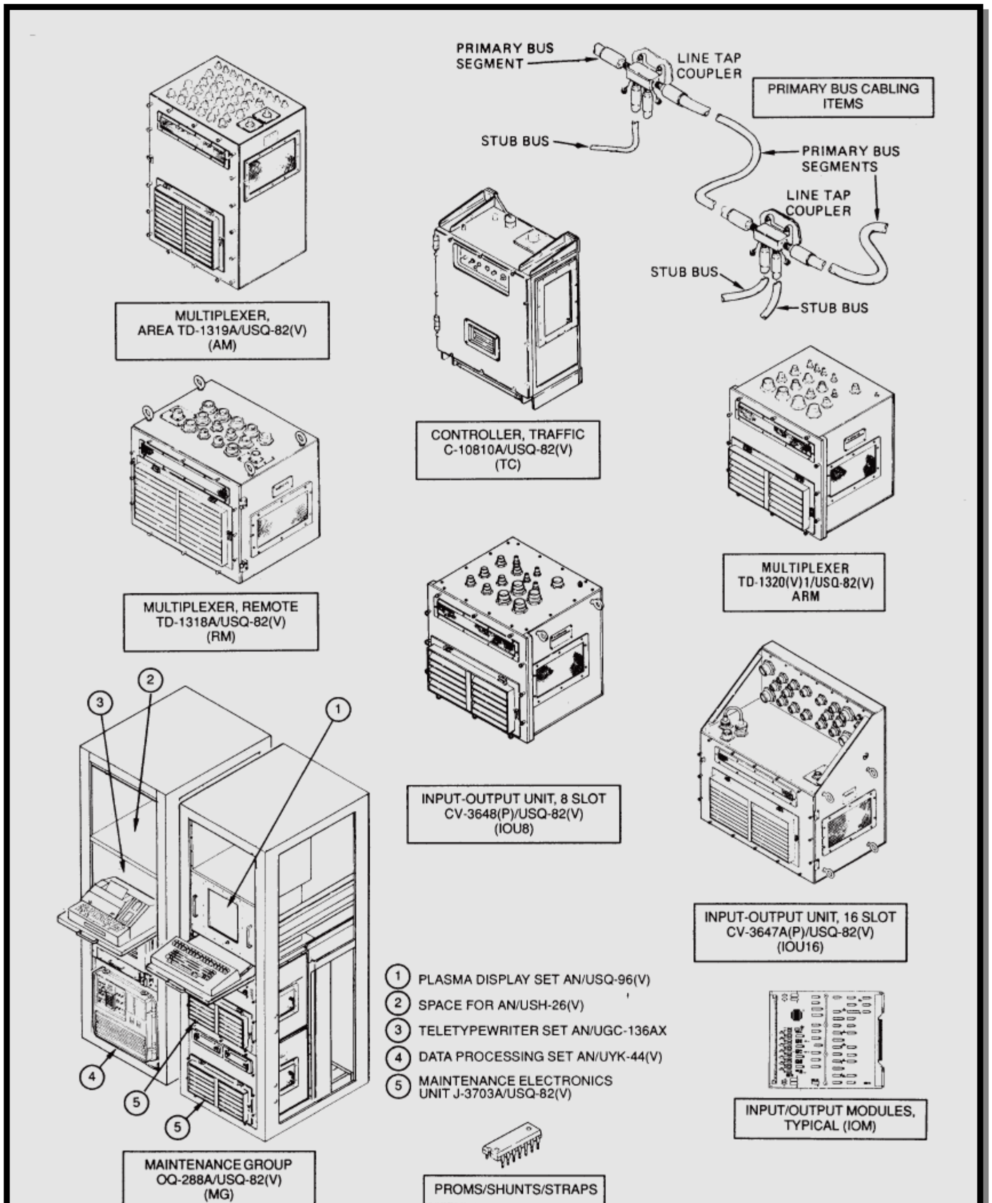


Figure 8-2. Data Multiplex System AN/USQ–82(V) Basic Building Blocks.

Equipment Nomenclature	
Official Nomenclature	Common Name
Data Multiplex System AN/USQ-82(V)	1. Dual-stage DMS 2. Special Configuration DMS
Input-Output Unit - 8 slot CV-3648(P)/USQ-82(V)	IOU8
Input-Output Unit - 16 slot CV-3647A(P)/USQ-82(V)	IOU16
Input-Output Modules	IOM Set
Multiplexer, Remote TD-1318A/USQ-82(V)	Remote Multiplexer or RM
Multiplexer, Area TD-1319A/USQ-82(V)	Area Multiplexer or AM
Multiplexer, Area Remote TD-1320(v)1/USQ-82(V)	ARM (LHD only)
Controller, Traffic C-10810A/USQ-82(V)	TC
Maintenance Group OQ-288A/USQ-82(V)	MG or Maintenance Unit (MU)
Maintenance Electronics Unit J-3703A/USQ-82(V)	ME
Loose Equipment* 10900-514	Loose Equipment
* Includes primary bus cabling components and other items.	

Table 8-1. DMS Units and Configurations.

8.1.1 System General Characteristics

DMS conveys electronic data for many shipboard subsystems such as fire control, sonar, navigation, alarm, sensor, and other similar subsystems. While providing reduced vulnerability to electromagnetic interference (EMI) and to physical damage, DMS significantly reduces the massive amount of cables, multi-pin connectors, junction boxes, line drivers and receivers, signal conversion equipment and switchboards that are required in conventional installations. Fewer bulkhead penetrations are required to interconnect user devices aboard ships and submarines.

8.1.2 Adaptability

DMS also improves integration of the interfacing ship's electrical subsystems without compromising the total system capability. It is readily adaptable to equipment modifications in established subsystems, and does not contain a single point of system failure.

Standard Cabling Plan

DMS transfers information with a network of multiplexers and with relatively few cables. The cables are installed according to a standard plan that does not vary with changes to the ship's electrical equipment locations.

Graceful Degradation

The redundancy inherent in the DMS architecture and programming precludes catastrophic failures in information transfer capabilities and eliminates single point of failure vulnerability. In general, failures in DMS have the effect of reducing the update rate of periodic signals and increasing the response time for periodic transfer requests in proportion to the quantity of failures existing simultaneously. This failure effect pattern is referred to as graceful degradation. (However, it is possible to have multiple failures without any degradation, depending on such factors as system load and failure types.)

Performance Monitoring and Fault Localization

DMS continuously monitors and displays its operating status from a centralized control station called a maintenance group (MG). The occurrence of a fault within DMS or within the data being transferred is visually and audibly indicated and localized in terms of (1) the major component or data transfer anomaly and (2) a replaceable part; i.e., a plug-in module, a group of not more than three plug-in modules, or a primary or secondary bus cable segment. The program for performance monitoring and fault localization (PM/ FL) is provided by a combination of (1) software resident in an AN/UYK-44 data processing set included in the MG and (2) decentralized BITE firmware located in the various DMS units.

8.1.3 Basic Configuration

DMS can be configured as a dual-stage or a special system. Configurations vary in the quantity of primary buses and other major units, in accordance with the requirements of the individual installations.

Dual-Stage System

A dual-stage system (Figure 8-3) includes Remote Multiplexers (RMs) and Area Multiplexers (AMs) but no Area-Remote Multiplexers (ARMs). In a dual-stage system, multiplexing is accomplished in two stages, the first stage of the multiplexing is done in the RMs and the second is done in the AMs.

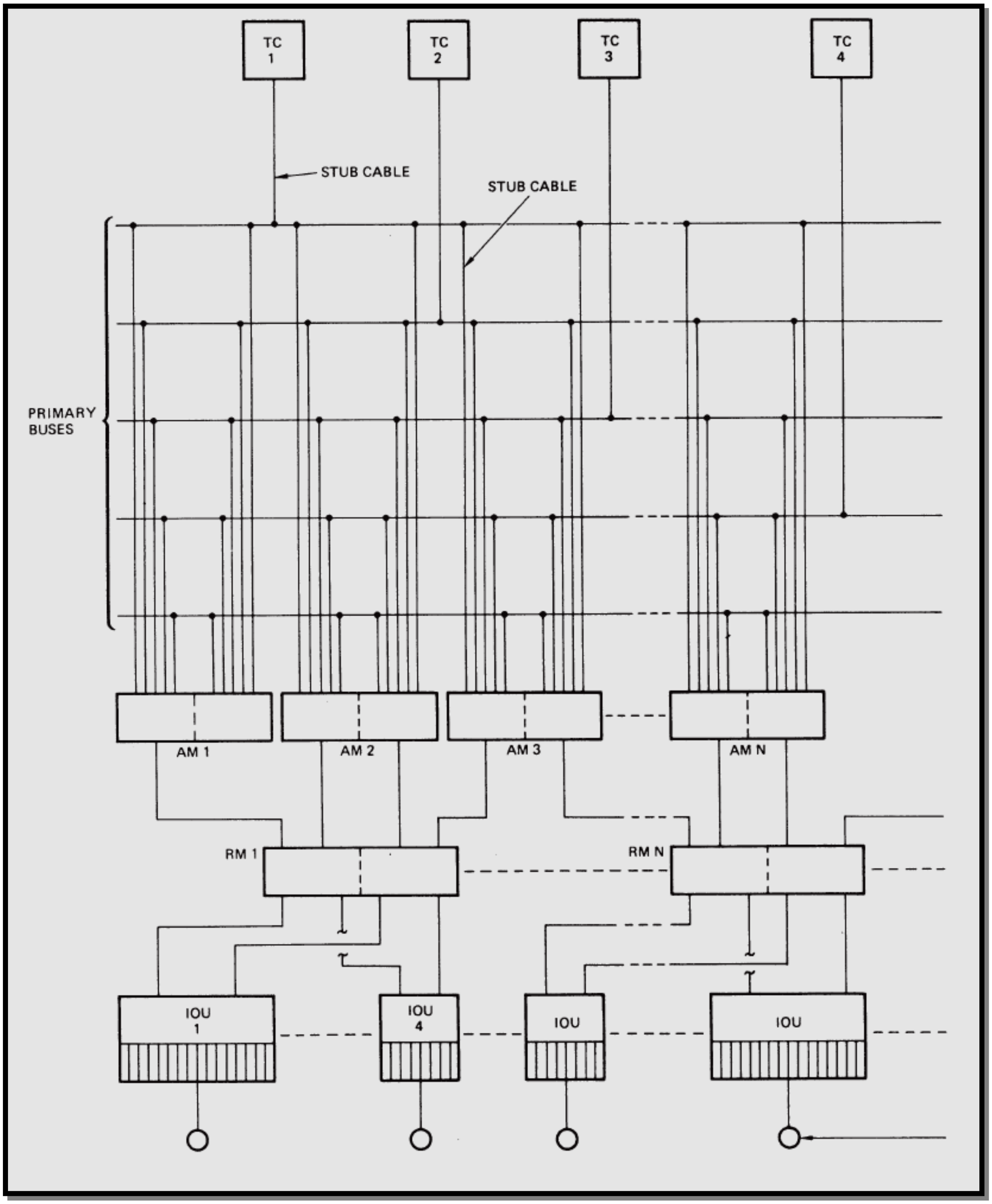


Figure 8-3. Dual–Stage DMS – Block Diagram (Sheet 1 of 2).

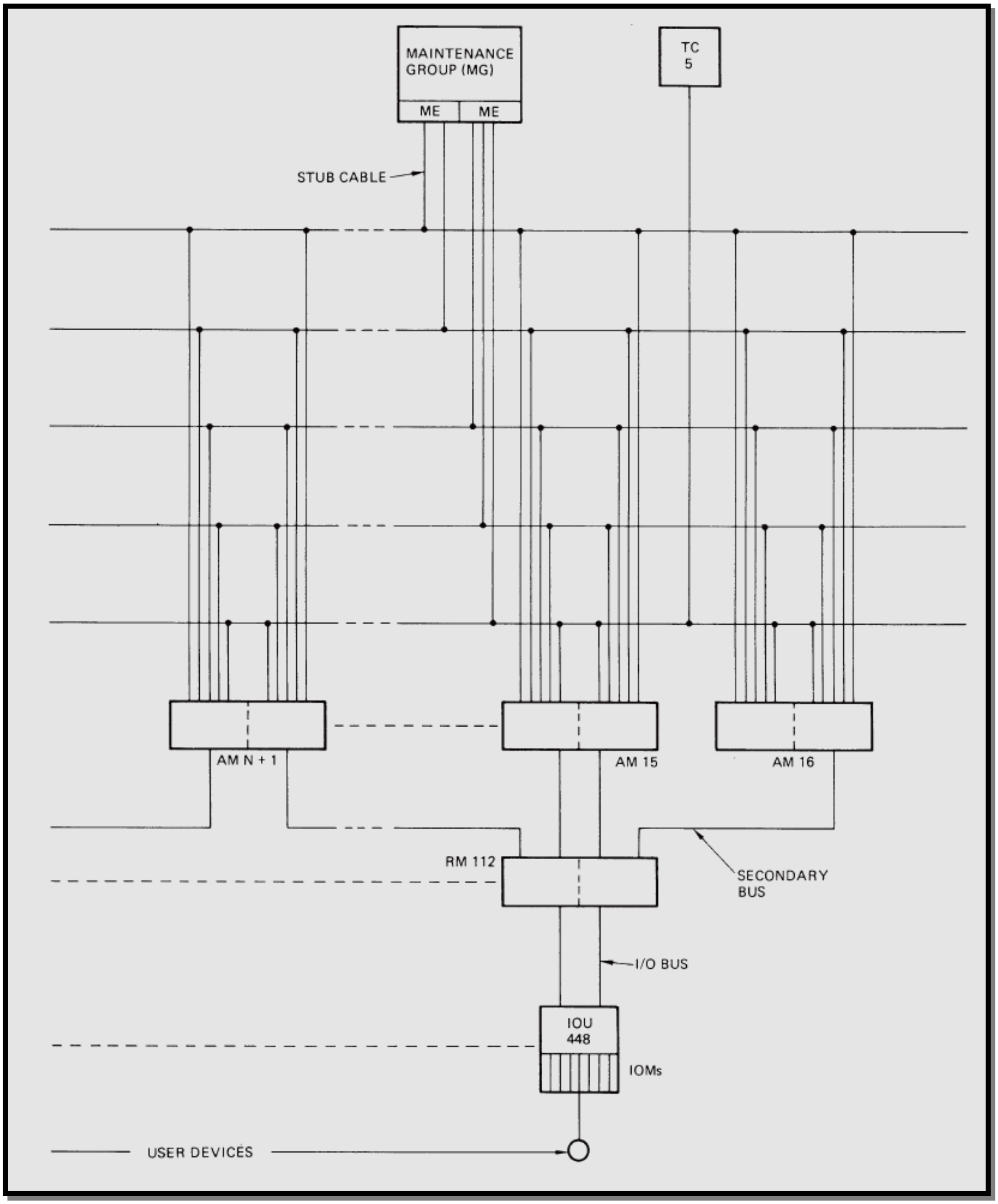


Figure 8-3. Dual–Stage DMS – Block Diagram (Sheet 2 of 2).

Special Systems

DMS building blocks can be assembled to perform special functions for limited applications. Such systems may or may not use an r.f. cabling system. When assembled without an r.f. cabling system performance monitoring and fault location is accomplished by means other than use of a Maintenance Group (MG).

8.1.4 Operational Summary of DMS

Although there are several possible configurations of DMS, they all function in basically the same way. Major functional differences among configuration types are pointed out in the following description of a typical DMS configuration shown in Figure 8-4.

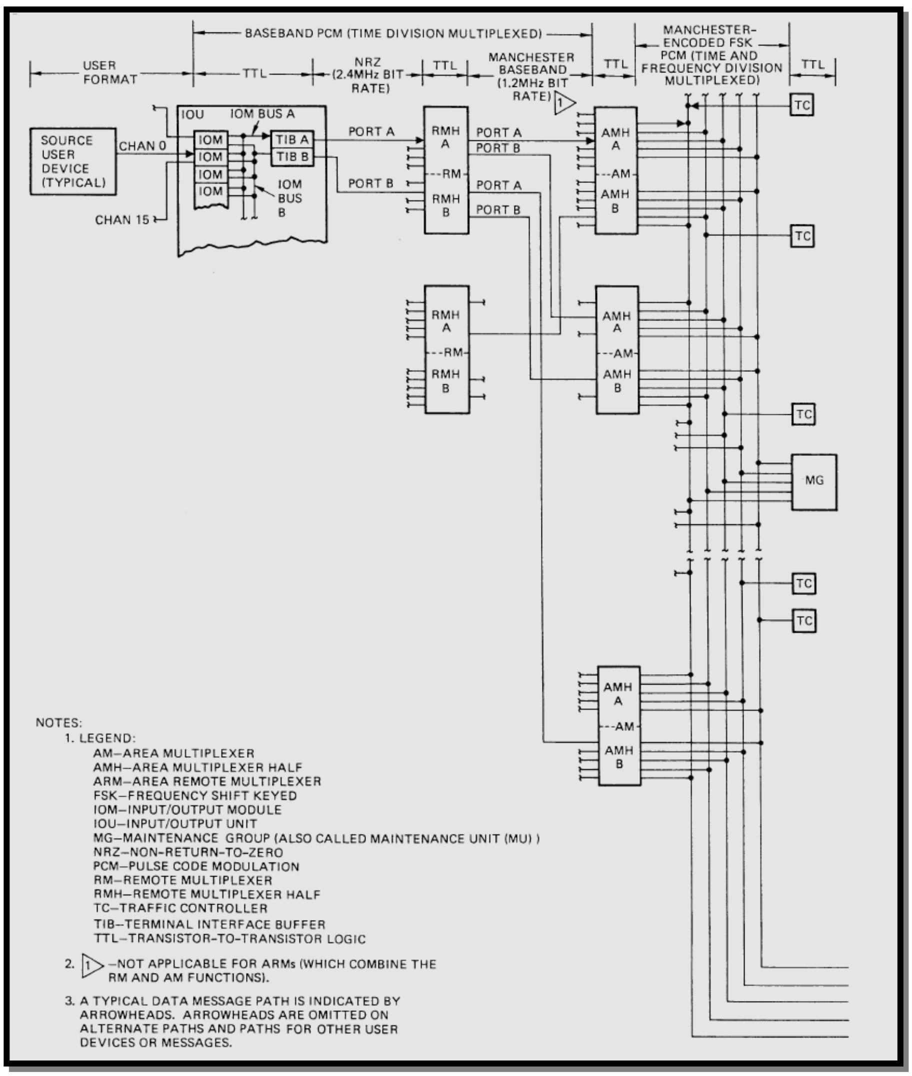


Figure 8-4. Typical User–to–User Data Flow Through a DMS – Block Diagram (Sheet 1 of 2).

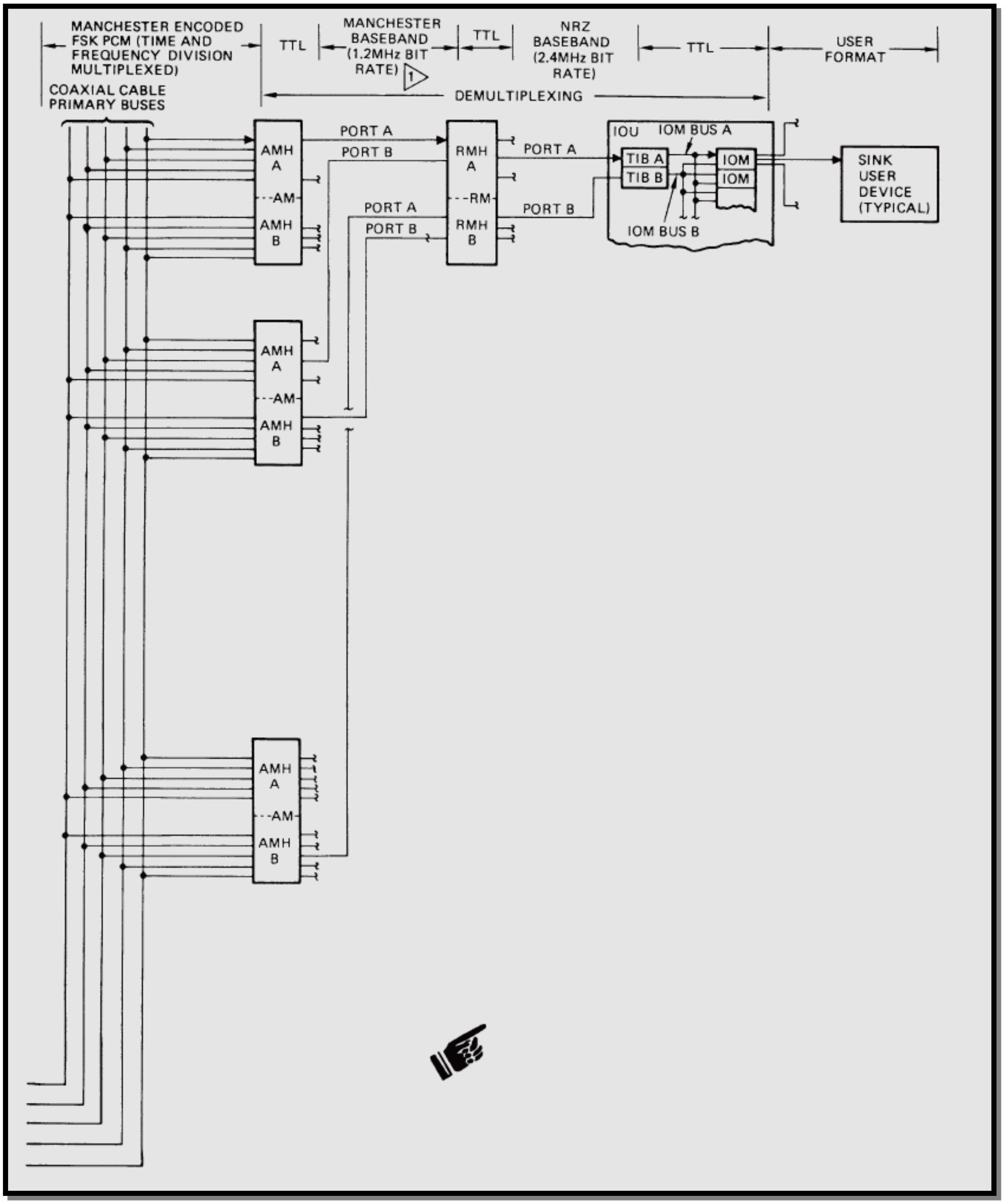


Figure 8-4. Typical User–to–User Data Flow Through a DMS – Block Diagram (Sheet 2 of 2).

System Redundancy Features

Most systems are fully redundant; that is, two or more units share the same task. If one fails, the survivors take up full task and service continues without interruption.

Fully Redundant System

A system with full redundancy and interconnectivity provides interconnections of all of, its terminals (RM halves (RMHs)) to each other via redundant primary buses. Figure 8-5 shows the dual-redundant paths provided by the RMs between the AMs and IOUs.

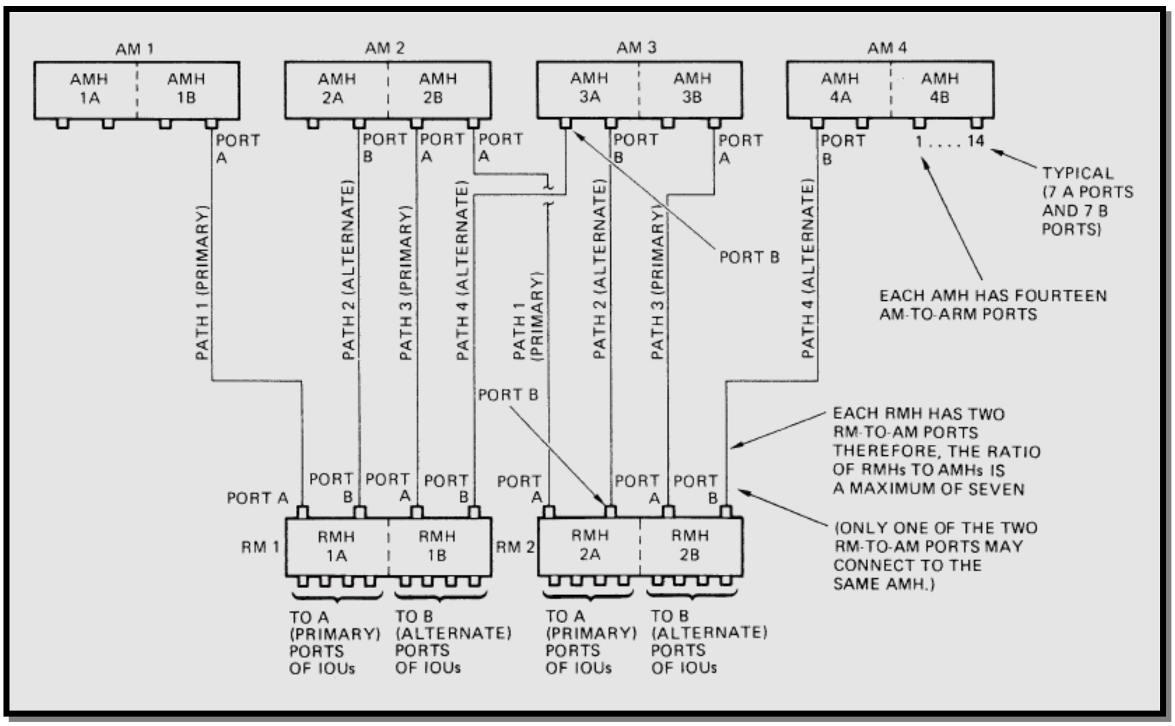


Figure 8-5. Redundant RM–to–AM Secondary Bus Connectivity – Block Diagram.

Data Interfaces

Table 8-2 describes the data interfaces of the DMS equipment units used during on-line operations.

Equipment Item	Input/Output Interfaces Connector(s)			Remark(s)
	Qty	Function	Interface Item(s)	
TC	1	Primary Bus Interfaces	Primary Bus	One TC is required for each primary bus. The TC communicates on the control channel assigned to the TC.
	5	Primary Bus Interfaces	Primary Bus	There are four data channels and one control channel per bus.
AMH A or B	7	A-Port RMH Interfaces	A-Ports RMHs via secondary buses	Each connector interfaces with an A-port of one RMH.
	7	B-Port RMH Interfaces	B-Ports RMHs via secondary buses	Each connector interfaces with an B-port of one RMH.
RMH A	1	AMH A-Port Interfaces	An A-Ports of AMH via secondary buses	Normally, these AMH A- and B- port connectors interface with different AMHs of AMs for survivability.
	1	AMH B-Port Interfaces	An B-Ports of AMH via secondary buses	Normally, these AMH A- and B- port connectors interface with different AMHs of AMs for survivability.
RMH A	4	IOU A-Port Interfaces	TIBs A-ports of IOU via I/O buses	Normally, these AMH A- and B- port connectors interface with different AMHs of AMs for survivability.
	1	AMH A-Port Interfaces	An A-Ports of AMH via secondary buses	
RMH B	1	AMH B-Port Interfaces	TIBs B-ports of IOU via I/O buses	Normally, these AMH A- and B- port connectors interface with different AMHs of AMs for survivability.
	4	IOU B-Port Interfaces	An B-Ports of AMH via secondary buses	
ARM (LHD Only)	3	IOU A- or B-port interfaces	TIB A- or TIB B-ports of IOU via I/O buses	These three connectors will either be all A- port or all B- port interfaces, depending on the role of the ARM (LHD only) on which they are installed.
	6	User interfaces	User devices via ship's cabling.	Used for interfacing between IOMs (four max) that can be installed in an ARM (LHD only), and user devices. Two connectors are for user triaxial cables.
IOU8	1	TIB A-interfaces	An A-port of the local RMH A or ARM (LHD only) A via secondary bus	
	1	TIB B-interfaces	An B-port of the local RMH B or ARM (LHD only) B via secondary bus	
	12	User interface	User devices via DMS adapter cabling and/or ship's cabling	Used for interfacing between IOMs (eight max), that can be installed in IOU8, and user devices. Four connectors are for triaxial user cables.
IOU16	1	TIB A-interfaces	An A-port of the local RMH A or ARM (LHD only) A via secondary bus	

	1	TIB B-interfaces	An B-port of the local RMH B or ARM (LHD only) B via secondary bus	
	26	User interface	User devices via DMS adapter cabling and/or ship's cabling	Used for interfacing between IOMs (sixteen max), that can be installed in IOU16, and user devices. Ten connectors are for triaxial user cables.
ME	3	Primary Bus	Primary buses	
	2	AN/UYK-44(V) interfaces	N/UYK-44(V) via DMS cabling.	

Table 8-2. DMS Interface Summary.

User Signal Input Processing and Multiplexing

User input signals are received by the input/output unit (IOU) through user cabling and are converted to nonreturn-to-zero (NRZ) 17-bit digital format by input/output modules (IOMs) in the IOU.

Data Transfer IOU-to-RM

From the IOU, the signals are serially transmitted in NRZ format to the local RM or ARM (LHD only) at a bit rate of 2.4 megahertz where they are combined to form data messages. In the RM, the data are converted to biphase Manchester code and sent on to an AM.

Data Transfer AM-to-Primary Buses

The AM provides frequency shift keying to the data messages and transmits them to one of the primary buses. The radio frequency (RF) is transmitted over the primary buses to all other AMs. The AMs sort the messages and start them on the way to their final destinations.

Data Message Characteristics Control and Routing

Signals which have a common RM destination requirement are serially sequenced into data messages to minimize the amount of addressing, minimize the quantity of message PROMs, and minimize circuitry that would otherwise be required.

Control Parameters

Control parameters include characteristics such as source and sink terminals (RMHs), update rate, and priority. These parameters are determined by message PROM programming.

Data Messages
Data messages include a data header word and at least one data word.

Control Messages
Control messages are single-word messages that precede and coordinate data message transmissions.

Data Words
The data words within data messages may be from a one-source-user device such as a computer or from multiple source devices via one IOM or more than one IOM. In the later case, entirely different types of user signals may be transmitted in one message. The formats for these two message types are shown in Figure 8-6 and Figure 8-7. The sequence of words in a data message is determined by coding in the message PROM for this message.

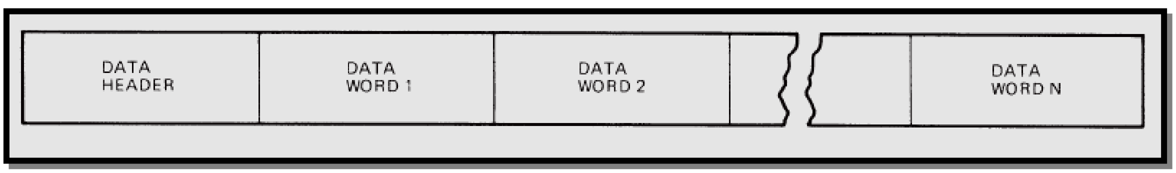


Figure 8-6. Message Format – Single Source.

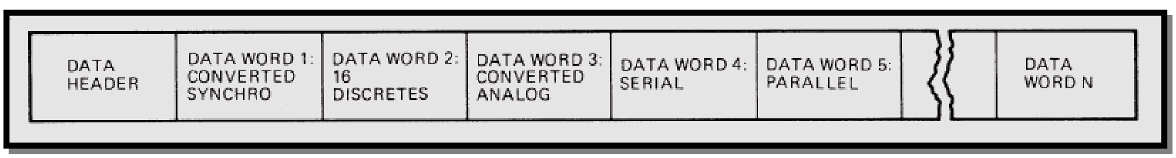


Figure 8-7. Message Format – Multiple Sources.

Control Words
For all data messages, control words are used to coordinate message transmissions. Control word types and formats are shown in Figure 8-8. Examples of control word usage and message transmission protocols are shown in Figure 8-9. A control message is a one-word message consisting of a control word.

ITEM	FORMAT	FUNCTION
*AM CHANNEL OFFER WORD	LSB 5 9 X X X X X 0 X X X AMID MU CHID P	TC OFFERS AVAILABLE DATA CHANNEL TO ONE OF THE AMHs
*MU CHANNEL OFFER WORD	1 5 9 0 0 0 0 0 1 X X X MU CHID P	TC OFFERS AVAILABLE DATA CHANNEL TO THE MU.
RECEIVE REQUEST WORD	1 8 9 14 17 0 X X X X X X X X X X X X X 0 1 X SR RMID MSGID WID P	SINK RM REQUESTS SOURCE RM TO SEND DATA MSG.
TRANSMIT REQUEST WORD	0 X X X X X X X X X X X X X 1 1 X SK RMID MSGID WID P	SOURCE RM REQUESTS SINK RM TO SEND AN ACKNOWLEDGE IF READY TO RECEIVE THE IDENTIFIED MESSAGE.
DATA MESSAGE (DATA HEADER WORD AND DATA WORDS)	X X X X X X X X X X X X X X 0 0 X SR RMID MSGID WID P 16 BITS X ----- 16 BITS X DATA P DATA P	1. SOURCE RM SENDS DATA TO SINK RM. 2. SOURCE RM SENDS CM OR BITE DATA TO MU. 3. AM SENDS CM OR BITE DATA TO MU.
REMOTE CONTROL MESSAGE (RCM) (DATA HEADER WORD AND RCM DATA WORDS)	X X X X X X X X X X X X X X 0 0 X SR RMID MSGID WID P X X X X X X X X X X X X X X X X X MSGID CA MSGID CA P X X X X X X X X X X X X X X X X X MSGID CA MSGID CA P	SOURCE RM SENDS ENABLE/DISABLE DATA MESSAGE AFTER SENDING A TRANSMIT REQUEST AND OBTAINING AN ACKNOWLEDGE. CA: 00 = NO ACTION, 01 = MSG DISABLE, 10 = MSG ENABLE, 11 = ONE-SHOT ENABLE
MU DATA REQUEST WORD	X X X X X X X X X X X X X X 1 0 X SR RMID P/A C/B DATA SELECT WID P	MU REQUESTS BITE OR CM DATA FROM RMH VIA PRIMARY OR ALTERNATE PATH P/A: 1 = PRIMARY PATH, 0 = ALTERNATE PATH, C/B: 1 = CM DATA, 0 = BITE DATA
	X X X X X 1 1 1 1 X X X X X 1 0 X AMID P/A C/B DATA SELECT WID P	MU REQUESTS BITE OR CM DATA FROM AMH
ACKNOWLEDGE WORD	0 X X X X X X X X X X X X X 0 1 X SK RMID MSGID WID P	SINK RM RESPONSE TO A TRANSMIT REQUEST IF READY TO RECEIVE THE IDENTIFIED MESSAGE.
EXTERNAL MESSAGE REQUEST (EMR) WORD	1 2 7 8 9 12 X X X X X X X X X S S X V MSGID CA P	IOM FORMULATES AND TRANSMITS EMR TO ITS LOCAL RMH. IN RESPONSE TO THE EMR, THE LOCAL RMH INITIATES A RECEIVE OR TRANSMIT REQUEST MESSAGE AS APPLICABLE IN ACCORDANCE WITH CODING IN MESSAGE PROM SEGMENT ADDRESSED BY MSGID FIELD OF THE EMR. DATA MESSAGE RECEIPT/TRANSMITAL IS ALSO COORDINATED BY THE MESSAGE PROM. CA: 00 = EMR LOOP TEST, 01 = MSG DISABLE, 10 =MSG ENABLE, 11 = ONE SHOT ENABLE

LEGEND:

- * - TRANSMITTED ON A CONTROL CHANNEL ONLY
- AMID - PHYSICAL ADDRESS OF AMH OR ARM
- CA - CONTROL ACTION CODE: 01 = INHIBIT, 10 = ENABLE, 11 = SINGLE INITIATION, 00 = NO OPERATION
- C/B - CONFIGURATION/BITE
- CHID - CHANNEL ID
- MSGID - MESSAGE ID
- P - PARITY (ODD)
- P/A - PRIMARY/ALTERNATE
- RMID - PHYSICAL ADDRESS OF RMH OR ARM
- S - SPARE BIT
- SK - SINK
- SR - SOURCE
- V - VALIDITY (1 = EMR TRUE)
- WID - WORD ID

Figure 8-8. DMS Message Words – Formats and Functions.

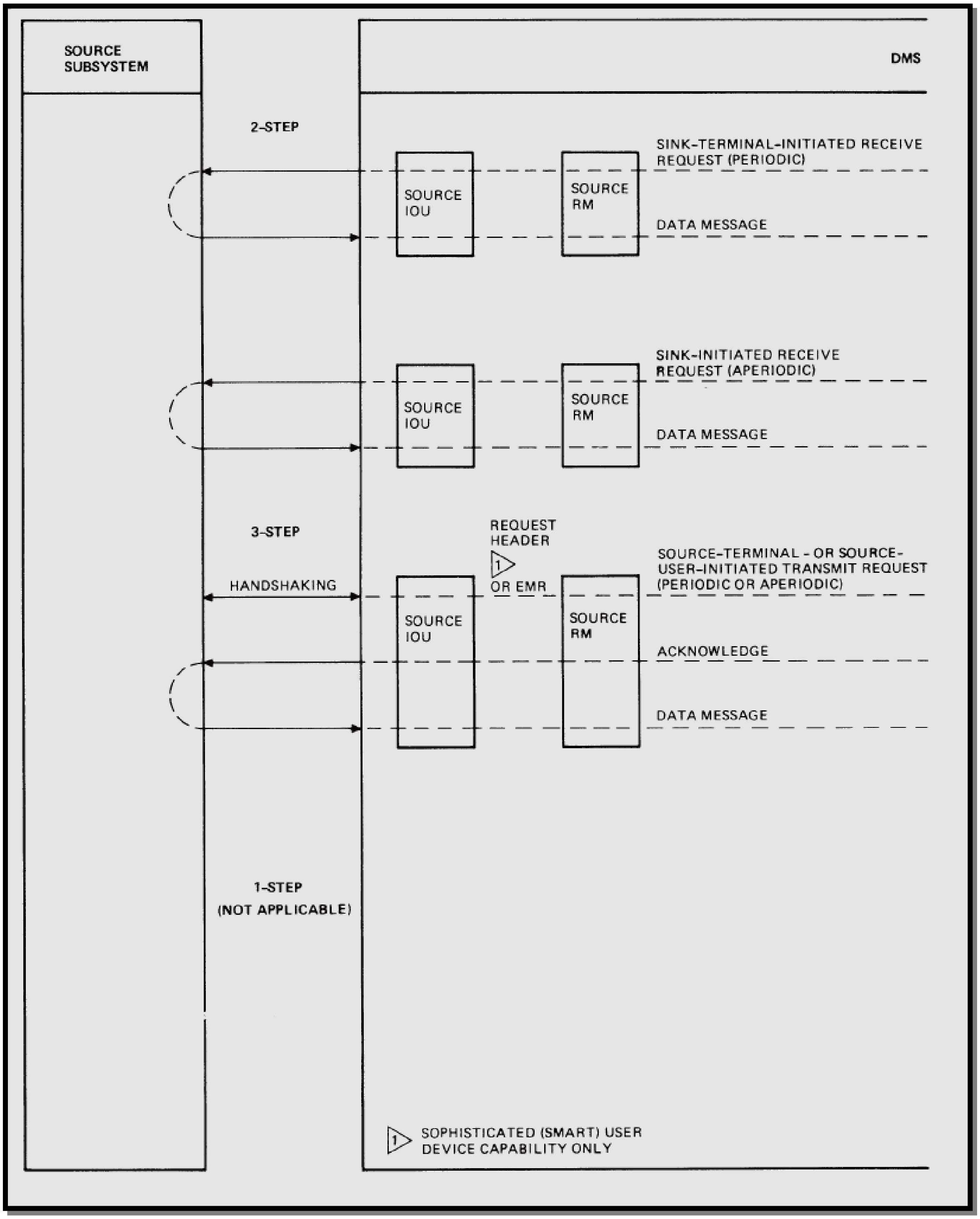


Figure 8-9. Examples of Messages Transmission Protocols Flow Diagram (Sheet 1 of 2).

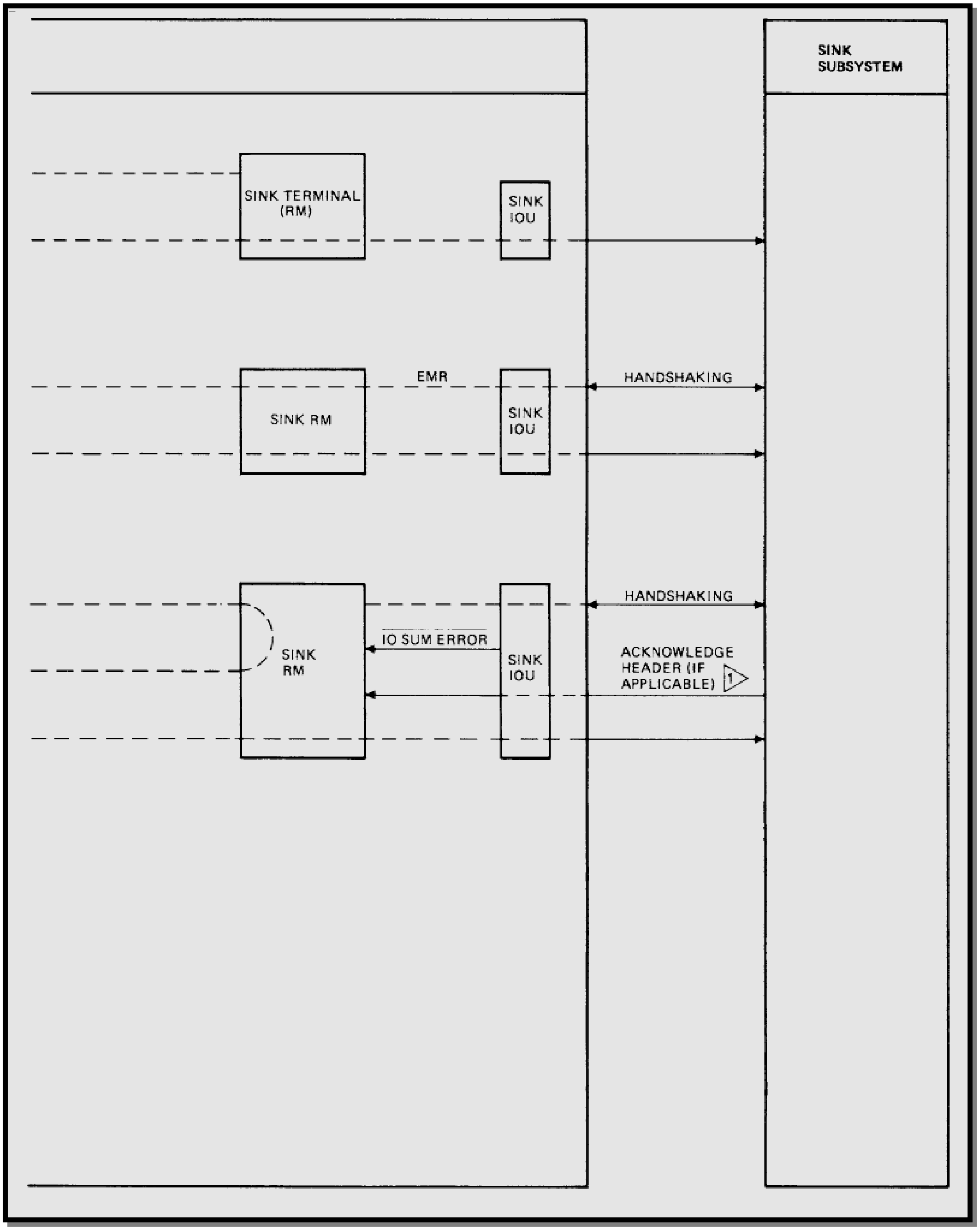


Figure 8-9. Examples of Messages Transmission Protocols Flow Diagram (Sheet 2 of 2).

DMS Firmware and IOM Combinations

Being a user-oriented system, DMS includes firmware (decentralized and resident in PROMs located in the various RMs) programmed in accordance with the requirements of the user devices which it services in order to accomplish efficient and reliable message transfers and to achieve total system throughput requirements. In addition, the specific combination of IOMs for a given installation provides the applicable input/output interface buffering and signal format conversions required by the user devices serviced. Because user devices vary in their communication coordination capabilities and requirements, DMS must coordinate message transfers in different ways to service the devices. Accordingly, several different message types and transfer protocols are required to automate communications between source and sink user devices, as indicated in Figure 8-8 and Figure 8-9.

RM-to-AM Message Transfer

When an RMH has a control word (either receive request or transmit request) to be forwarded to an AM, the RMH transmits a service request (SR) discrete to both AM halves (AMHs) connected to it. When the RMH receives a service offer (SO) discrete from one of the AMHs, it transmits the control word to this AMH. All data transmitted between an RMH and an AMH are encoded in the Manchester II biphase PCM format, are driven by a differential line driver, and are received by a differential line receiver on shielded twisted-pair cables. The Manchester bit rate is 1.2 megahertz. The signal levels transmitted by the line driver are +3.5 and 0 volts DC nominal, corresponding to logic levels 1 and 0, respectively.

AM-to-AM Message Transfer

The AMH that issued the SO and received the control word from the RMH issued this SO in response to (1) a channel offer (CO) message addressed to it from a traffic controller (TC) and (2) the SR received from the RMH. When the RMH forwards the control word to the AMH, the AMH transmits the control word on the data channel (identified in the CO control word) to all connected AMHs. Each AMH, other than the sending AMH, decodes the control word and determines whether the RMID contained in the message is in its RMID lookup PROM, thereby determining if the RMH addressed in the control word is connected to it. If the RMID is contained in the lookup PROM, the sink AMH forwards the control word to the addressed sink RMH via line drivers and shielded twisted-pair cables.

De-Multiplexing and Data Routing

The RMH addressed in the control word decodes the control word and routes either (l) the individual data words of the message or (2) the entire message including the data header to the appropriate IOUs, in accordance with coding in the message PROMs in the RMH. The information is transmitted at the 2.4 megahertz rate in the serial NRZ format to one of the two terminal interface buffers (TIBs) in the IOU; the addressing bits are transmitted in a parallel format on separate lines to the TIB.

Output Data Transfer from IOU-to-User Devices

The IOU TIB that is enabled by the sink RMH performs IOM address and subaddress decoding and data words routing to the addressed output IOM(s). The subaddress is transmitted by the RMH on the address lines immediately after the address is transmitted. Each address is decoded by the TIB into an IOM enable signal which is routed to the addressed IOM. The subaddress is routed to all IOMs in the IOU but only the enabled (addressed) IOM utilizes the subaddress. The subaddress provides data word transfer control for the IOM logic circuitry, e.g., channel select or mode select. The IOM converts the NRZ formatted data word(s) into the signal format required by the interfacing user device (analog, digital, synchro, etc...) and outputs the data to the device through user-compatible cabling.

ARM Function (LHD Only)

The ARMs (LHD only) are basically composites of AMs, RMHs and IOUs. Each ARM (LHD only) includes circuitry to accommodate up to four IOMs and interface with up to three IOUs.

Turnaround Mode (TAM)

The TAM is normally used when a source user device and a sink user device are served by the same RMH or ARM (LHD only) and when a reduced data throughput rate is not a problem. In the TAM, message PROMs are programmed to cause the local RMH or ARM (LHD only) to accept each data word, one by one, from the source and route it directly to the sink via the applicable local IOU, thereby reducing the load on the primary buses. Throughput is reduced in the TAM by approximately one-half because the source device and the sink device must be alternately addressed for input and then output of each data word. The TAM preserves full redundancy to local users, since the path can be completed through either RMH or ARM (LHD only). Without TAM, both RMHs or ARMs (LHD only) would be needed to send data up to the bus and back so that path redundancy would be decreased.

Message Characteristics and Types

The primary function of DMS is to convey information from one user device to another user device. DMS accomplishes this data conveyance via data packets called messages. Table 8-3 outlines and summarizes the various DMS message types and the characteristics of DMS messages.

Message Transfer Periodicity and Initiators
Periodic Sink-terminal (RM) initiated Source-terminal initiated
Aperiodic Sink-terminal initiated Source-terminal initiated User sink-initiated User source-initiated
Source/Sink Combinations Single sink, single source Single sink, multiple source Multiple sink, single source
Message Sizes One word (control messages) Multi-word (data messages and Remote control messages Maximum message length: 4096 words
Word Size - 16 bits plus odd parity bit
Basic Transfer Protocols 1-step: not applicable 2-step: receive request message from sink device; data message from source device 3-step; transmit request message from source device; acknowledge message from sink device; data message from source device.

Table 8-3. Summary of DMS Message Characteristics and Types.

8.1.5 Dual-Stage DMS Configuration

This section summarizes the characteristics of typical dual stage DMS configurations and contains a diagram (Figure 8-10) showing unit relationships.

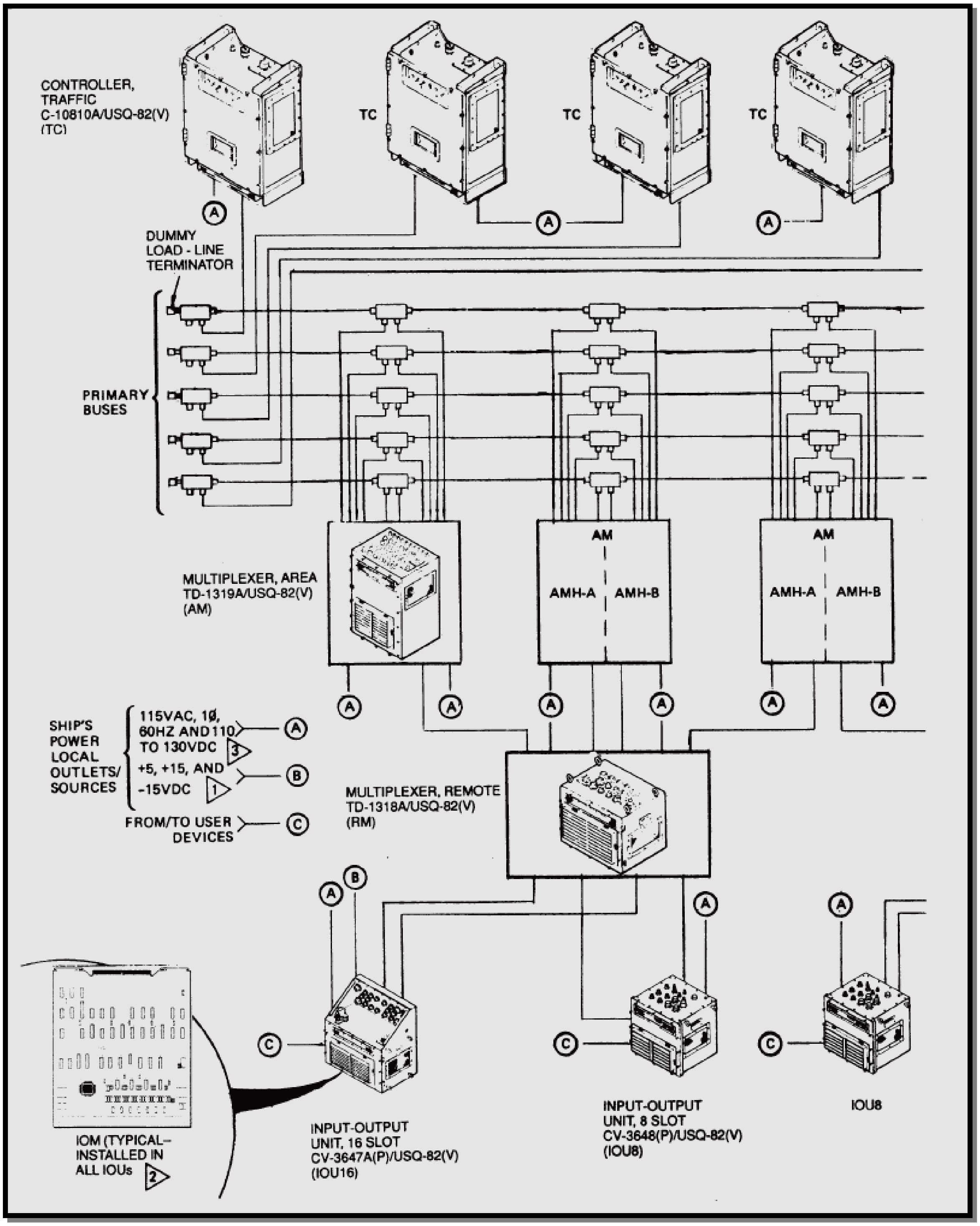


Figure 8-10. Typical Dual–Stage DMS – Relationship of Units (Sheet 1 of 2).

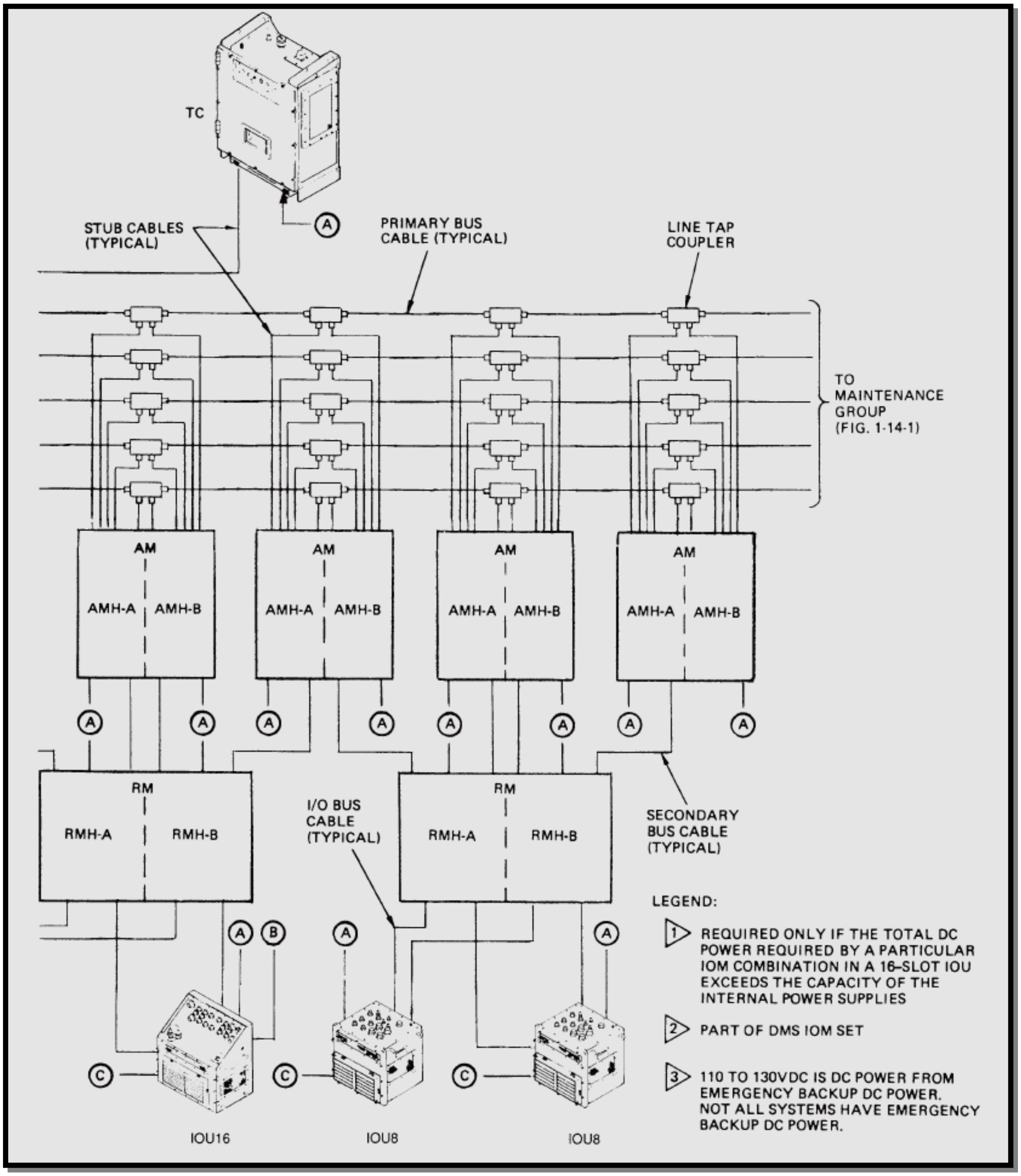


Figure 8-10. Typical Dual–Stage DMS – Relationship of Units (Sheet 2 of 2).

8.1.6 Dual-Stage System Overview

A dual-stage DMS (Figure 8-10) is suited to large or medium-sized installations. The maximum throughput of this system is the highest of the three basic configuration types (i.e., dual-stage, single-stage, and hybrid).

The dual-stage DMS also has the highest maximum user interface efficiency (user interfaces per unit of equipment). A fully redundant dual-stage system with full interconnectivity has a maximum of five primary buses (Table 8-2).

8.1.7 Special DMS Configuration Classes

Shipboard user equipments, subsystems, and systems can interface with DMS either at the input/output (IOU) level (level 1 interfaces) or at the area multiplexer (AM) level (level 2 interfaces).

Level 1 Interfaces

Level 1 interfaces are classified as the standard interfaces. Standard interfaces were described previously. Special level 1 interfaces are a variation of the standard level 1 interfaces.

Level 2 Interfaces

Level 2 interfaces are also classified as special interfaces. These interfaces are reserved for user equipments whose data loads are comparable to that of a remote multiplexer (RM). As do the RMs, level 2 interfaces employ baseband signaling at a 1.2 MHz rate using biphase Manchester-coded data transmission biphase-level, split-phase, in accordance with MIL-STD-1572. Balanced differential line drivers and receivers are also employed for this interface.

8.1.8 Special Level 1 Configurations and Overview

Special level 1 configurations exploit DMS modular design.

System Packaging

After configuration planning is complete and all standard items planned for the configuration have been identified, the building blocks are packaged into units. The exact configuration along with special instructions for supply and maintenance are detailed in the Ship Specific Database (SSD) applicable to the configuration.

Functional Description of One-of-Many Possible DMS Special Configurations

Figure 8-11 illustrates one of many possible, special, level 1, interface configurations that are structurable with DMS building blocks. The configuration shown employs a redundant ARM (LHD only) pair and two IOU16s. The IOU16s and ARM (LHD only) pair are populated with a buyer-selected set of IOMs. The IOMs interface with ship signals (some input, some output), as specified by the buyer. The ARM (LHD only) pair operates in the turnaround mode, multiplexing signals from IOU16 input ports to output ports, again as specified by the buyer. In the configuration shown, traffic controllers and a primary bus structure are not used: the ARM (LHD only) pair operates in the turn-around mode. Also, in this configuration the MG is not used.

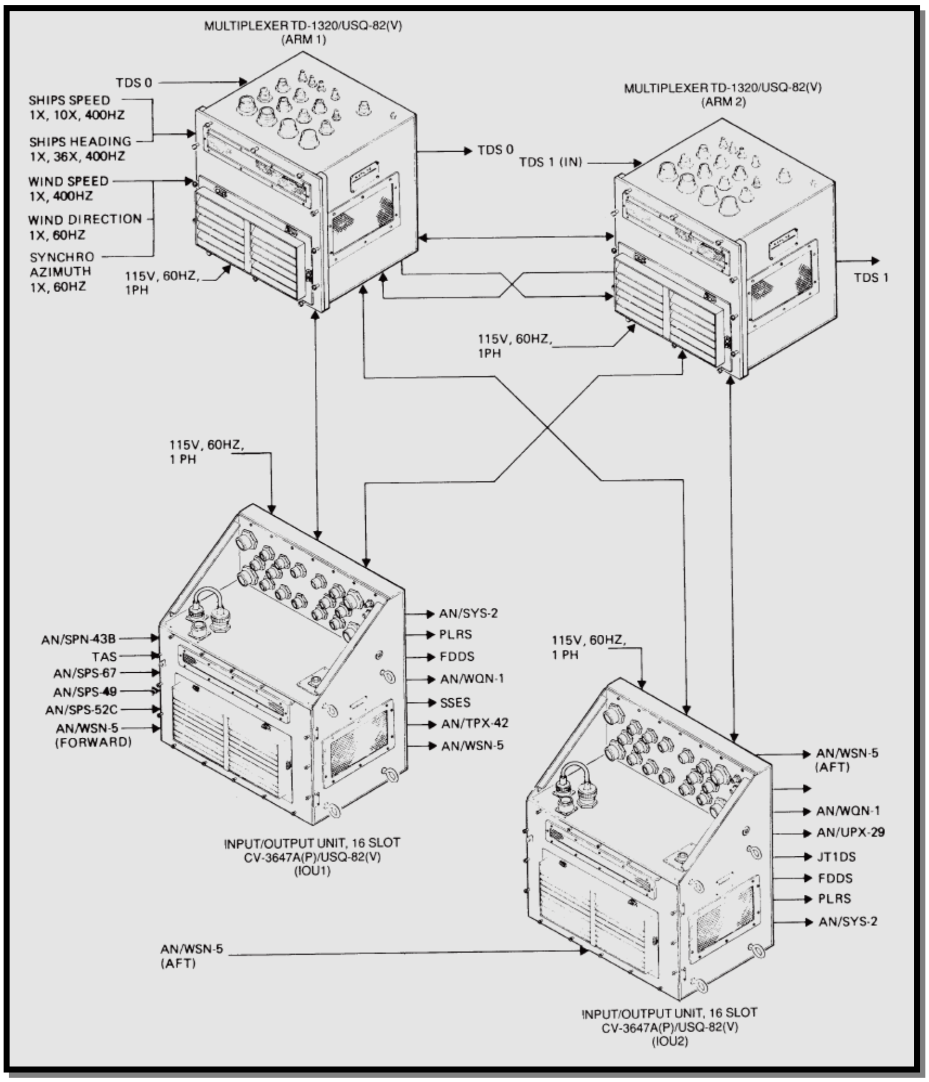
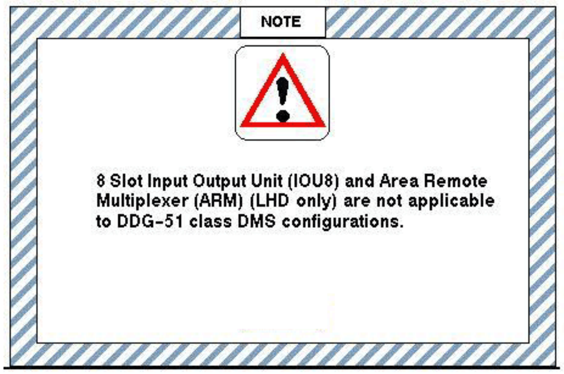


Figure 8-11. One of Many Possible DMS Special Level–1 Interface Configurations.

Processing BITE Data

BITE data is processed as specified by the buyer. In the configuration shown in Figure 8-11, BITE data from the ARM (LHD only) pair are multiplexed to buyer-supplied equipment located elsewhere in the ship. The buyer specifies procedures for calling up BITE data and how the data is to be used by maintenance personnel. Maintenance procedures applicable to a particular configuration are covered in Ship Specific Database (SSD) applicable to the configuration.



8.1.9 8 Slot Input/Output Overview

A 8 slot input/output unit PN 10830-514-X (hereinafter referred to as IOU8) interfaces with user devices and a local RM and/or ARM (LHD only) to provide user-to-user communication paths. The function of the IOU8 is to convert the format of input user signals to the DMS digital NRZ signal format and to convert the DMS working signal format (DMS output) to the format of the original user signal(). The IOU8 houses from one to eight IOMs.

Input/Output Communications

An IOU cannot communicate with an RM or ARM (LHD only) unless the local RM or ARM (LHD only) provides the IOU with enable discretes and/or EMR enable discretes. From the standpoint of the local RMs or ARMs (LHD only), the IOUs are basically passive, functioning as random access memories (RAMs) from which digitized data from source user devices are fetched or to which demultiplexed data are forwarded for storage before being converted to sink user device format. IOUs do have two active circuits, however, which allow the IOUs to transmit to the RM or ARM (LHD only) on an as-needed basis if enabled. These two circuits are the I/O SUM ERROR circuit (part of the BITE circuitry in the TIBs) and the EMR circuit. From the standpoint of the user devices and/or human observer, the IOMs of the IOUs are (for all practical purposes) continuously receiving/transmitting data because the data sampling/update rates are high enough to offset normal multiplexing transport delays that may occur. However in the case of the ABO IOM, a transport delay of 2.5 seconds is realized due to the filter processing of received signals.

Dual Redundancy and Interfaces

Each IOU8 has dual-redundant input/output ports that interface with the local RM or ARM (LHD only) pair. An IOU8 contains from one to eight IOMs; each IOM has an A channel and a B channel that interface with TIB A and TIB B, respectively. The two TIBs are electrically and functionally identical but independent of each other except for their coordinated servicing of data transfers and cross-reporting of BITE data. TIB A is the primary TIB, transmitting/receiving data via the local RMH A (Figure 8-12) or ARM A (LHD only). TIB B is the alternate TIB, transmitting/receiving data via the local RMH B or ARM B (LHD only) . The terms primary (or A) and alternate (or B) refer to internal timing and control characteristics of the TIBs, and other units of the DMS which provide coordination between paired units necessary to avoid data servicing conflicts. The terms A and B are also used in the programming to refer to the respective hardware units and ports; they are also used to identify interfacing halves or units such as RMH A and RMH B or ARM A (LHD only) and ARM B (LHD only). These terms are not intended to imply that an alternate or B unit is a backup unit used only if the primary unit fails. In the case of the TIBs, the TIB A timing network generates the internal clocks for both TIBs unless the timing network in TIB A fails; otherwise, both TIBs are nominally equally active in data transfers.

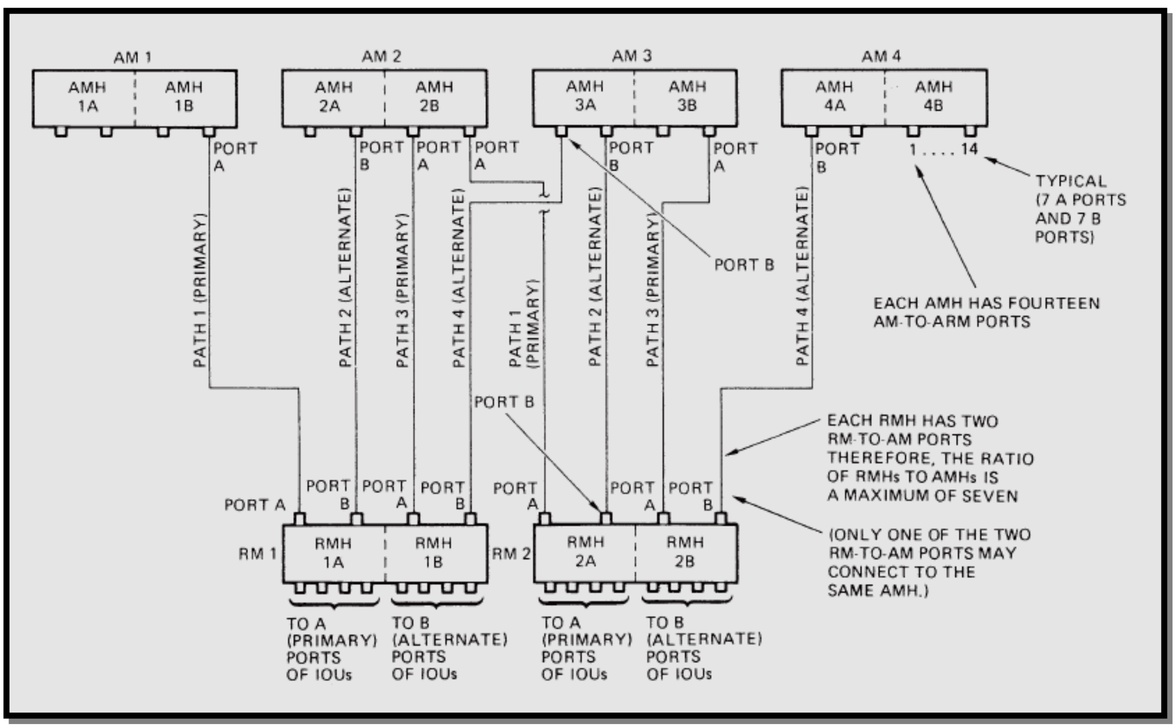


Figure 8-12. Redundant RM–to–AM Secondary Bus Connectivity – Block Diagram.

Input/Output Mechanization

In response to inputs received from either an RMH or ARM (LHD only) or from an IOM, each TIB transfers incoming data immediately at the TIB clock rate. The timing networks in the two TIBs are interconnected so that their respective 2.4 megahertz internal clocks are maintained 180 degrees out of phase with each other. This prevents conflicts in an IOM that would result if both TIBs were to address the same IOM on the same clock edge. If properly addressed, however, each IOM can receive or send data on both A channel and B channel at the same time except for EMR data. Only one of the two TIBs can receive EMR data from an IOM at any one time because when one TIB provides an EMR enable to an IOM, the EMR enable from the other TIB is locked out by the IOM. An IOU may contain any combination of input IOMs, output IOMs, IOMs that are both input and output, or message processing IOMs, depending on its interfacing role. Input signals are received from a user device by an input IOM and are converted by the IOM to the DMS 17-bit word (16 data bits and one parity bit) digital format for multiplexing within the DMS. After being demultiplexed, the output signals are converted by output IOMs to the interface format required by the user device before being sent to the device. Message processing IOMs have no direct interface with user devices. Instead, they provide special internal message processing or data manipulation for certain applications in accordance with inputs determined by switch positions on user switchboards or other user inputs.

8.1.10 Functional Summary

IOU8 include: two TIBs and a maximum of eight IOMs.

Source and Sink Functions

Source user devices provide signals to input IOMs or to an input channel of an IOM that handles both input and output. Sink user devices receive signals from output IOMs. It is possible for one user device to function as both a datasource and a data sink, but such a device must have a different port for each function and each port must interface with the correct type of IOM. For any given data transfer, however, one device functions only as the source and the other device functions only as the sink.

Transfer Control Functions

User devices vary in their degree of simplicity and sophistication. Sophisticated devices, in addition to being able to initiate Aperiodic data transfers, can provide control words for outgoing message headers and can check control words in incoming message headers, simple devices cannot. However, simple devices vary in their transfer initiation capabilities. Some simple devices can initiate their own aperiodic transfers, some cannot and must rely on the interfacing IOMs to detect a need for an aperiodic transfer and to initiate the transfer.

IOU and IOM Functions

Buffering and Conversion Functions. Each IOU-IOM combination is basically a multi channel input-output buffer. Each input IOM converts user input data into the DMS 17-bit-word NRZ serial format, stores it in memory, and reads it out to a local RMH or ARM (LHD only) when addressed. These data words are transferred by the DMS to the IOU that is connected to the sink user device. This data becomes the user device input signal. The data is received by the sink IOU along with addressing bits that steer the data to the proper memory locations in the output IOM(s). The data is then read from memory, converted to user format, and driven to the user devices. Typically, the memory device used is the RAM in the LSI IC on the IOM.

EMR Functions

Certain IOMs include EMR circuitry for aperiodically generating external message requests (EMRs) which are relayed by a TIB to the local RM or ARM (LHD only). Receipt of an EMR causes the RM and ARM (LHD only) to initiate an aperiodic transmit request or receive request message. The IOM EMR circuitry includes logic and a PROM that issue an EMR word (Figure 8-8) when a specific type of input is received from a user device and when EMR is enabled by the local RM or ARM (LHD only). The user device may be either a data source or a data sink. The input conditions that can initiate an EMR include a change of state on a certain input channel or a handshaking signal (discrete) from a user device. Sophisticated devices can supply a receive request or transmit request header word in addition to the handshaking signal. This header word is fetched from such a device by the local RMH or ARM (LHD only) after EMR acknowledgement and is transmitted as a receive request or transmit request message to the sink terminal.

IOU8 Physical Construction

The IOU8 is an enclosure for IOMs and terminal interface buffer modules. The IOU8 provides power, cooling, and environmental protection for the modules. The IOU8 houses up to eight input/output modules, two terminal interface buffer (TIB) modules, a power supply, an EMI AC line filter, a fan assembly, a control panel, and a module master interconnect board (MIB). The operating and monitoring controls consist of a circuit breaker which acts as an AC power on/off switch, an AC power on indicator, a DC power on/off switch, a DC power on indicator, an elapsed time meter to record the total AC operating time, and test switches.

MIB

Interconnection within the assembly is made with a MIB and with flexible cable assemblies or hardwired cables. The MIB interconnects the modules, power supply, and fan assembly. The flexible ribbon cables or hardwired cables interconnect the MIB to the external interface connector panel. The interfacing connector panel, located on the top section of the enclosure, contains 15 external interface connectors. Intermodule pathways of 16 and 10 wires provide for data transfer between IOMs.

Module Keying

A variable keying device is located on each MIB module connector to prevent insertion of the wrong module. The mating keying device on each IOM is fixed and unique for each IOM type. When it has been determined which module will be inserted in a particular MIB connector, the MIB connector keying device is coded to match the module keying device. Sixty-four keying codes are available. When the IOU8 slot keying device is set for a particular IOM type, the keying arrangement prevents inserting the wrong IOM type sufficiently to make electrical contact. Once coded the connector keying device can be later changed to accommodate a different IOM. The IOU8 provides for secure locking of fully inserted modules. Self-contained cams, for inserting and extracting IOMs, are part of the modules.

Mounting

The IOU8 is packaged in an aluminum housing which is designed to be mounted in a standard 19 inch electronic equipment rack, bulk-head mounted, or mounted from its bottom side. The housing size, weight, power requirements, and general information are shown similar to the IOU16.

Cooling

Cooling is accomplished by internal AC fans. The inlet air enters the housing through a louvered opening, an air filter, and an EMI/RFI screen mounted on the front door. The air is directed over the modules by means of a plenum system. The air is exhausted through another EMI/RFI screen and opening in the right side of the housing as viewed from the front.

Security Provisions

The front door is capable of being locked with a standard padlock. If the IOU is padlocked, the padlock must be removed prior to opening the door to shut off power.

8.1.11 16 Slot Input/Output Unit Overview

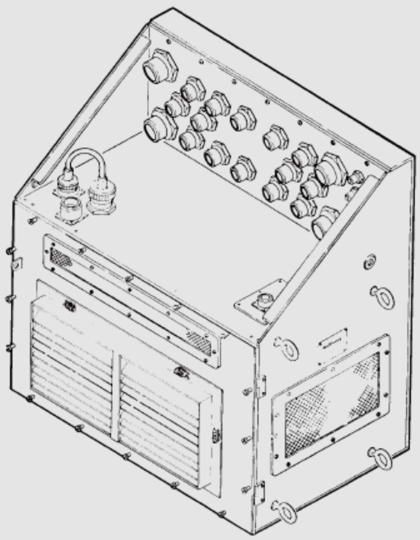
16 Slot Input/Output Unit PN 10477-514-1 (hereinafter referred to as IOU16) interfaces with user devices and a local RM and/or ARM (LHD only) to provide user-to-user communication paths. The function of the IOU16 is to convert the format of input user signals to the DMS NRZ digital format and convert the DMS working signal format (DMS output) to the format of the original user signal. This unit is interfaced in a variety of configurations in accordance with the ships requirements. An IOU16 performs the same functions as an IOU8.

Functional Summary

The functional summary of the IOU8 also applies to the IOU16 except for the circuit card count. An IOU16 contains two TIBs and up to 16 IOMs.

IOU 16 Common Construction Features

The IOU16 is packaged in a single enclosure. See Figure 8-13.



IOU16

EQUIPMENT CONFIGURATION

INPUT POWER:

PRIMARY: 115V, 1 PH, 60 Hz, 120 WATTS MAX WITHOUT IOMS (INCLUDING FANS); 600 WATTS MAX WITH IOMS (INCLUDING FANS)

EMERGENCY: 110 TO 130 VDC, 544 WATTS MAX WITH IOMS

ADDITIONAL POWER IF REQUIRED AT J39:
+5 VDC, 17 WATTS; -5 VDC, 9 WATTS;
+15 VDC, 9 WATTS

COOLING:

AC-POWERED INTERNAL FANS: FOUR FANS 14 WATTS EACH

ENVIRONMENT:

	OPERATING	STORAGE
TEMPERATURE	0 TO 65°C	-62 TO 71°C
RELATIVE HUMIDITY	0 TO 95%	0 TO 95%

MOUNTING PROVISIONS: BULKHEAD OR BASE.

REDUNDANT CONSTRUCTION: TWO OUTPUT PATHS PROVIDED FOR EACH USER SIGNAL.

DESCRIPTION DATA:

OFFICIAL NOMENCLATURE: INPUT-OUTPUT UNIT, 16 SLOT CV-3647A(P)/USQ-82(V)

MANUFACTURER'S NOMENCLATURE
INPUT/OUTPUT UNIT (16-SLOT)
PART NUMBER 10477-514-1
MANUFACTURER'S CODE 94756

DIMENSIONS (INCHES), WEIGHT (LBS):

	UNCRATED	CRATED
HEIGHT	26.19	36.75
WIDTH	25.19	37.25
DEPTH	17.66	24.75
WEIGHT	188.00	220.00

SECURITY PROVISION: CAPABILITY OF PADLOCKING IOU16 FRONT DOOR

Figure 8-13. I0U16 and Variant Configuration.

IOU 16 Physical Construction

The IOU16 is an enclosure for IOMs and terminal interface buffer modules. The IOU16 provides power, cooling, and environmental protection for the modules. The IOU16 houses up to 16 input/output modules, two TIB modules, a power supply, an EMI AC line filter, a fan assembly, a control panel, and a module MIB. The operating and monitoring controls consist of a circuit breaker which acts as an AC power on/off switch, an AC power on indicator, a DC power on/off switch, a DC power on indicator, an elapsed time meter to record the total AC operating time, and test switches.

MIB

Interconnection within the assembly is made with a MIB. The MIB interconnects the modules, power supply, and fan assembly. The interfacing connector panel located on the top section of the enclosure contains 28 external interface connectors and one dummy connector. Intermodule pathways provide for data transfer between IOMs. Flexible ribbon cables interconnect the MIB to the external interface connectors.

Module Keying

A variable keying device is located on each MIB module connector to prevent insertion of the wrong module. The mating keying device on each IOM is fixed and unique for each IOM type. When it has been determined which module will be inserted in a particular MIB connector, the MIB connector keying device is coded to match the module keying device. Sixty four keying codes are available. When the IOU16 slot keying device is set for a particular IOM type, the keying arrangement prevents inserting the wrong IOM type sufficiently to make electrical contact. Once coded, the connector keying device can be later changed to accommodate a different IOM. The IOU16 provides for secure locking of fully inserted modules. Self-contained cams, for inserting and extracting IOMs, are part of the module.

Mounting

The IOU16 is packaged in an aluminum housing which is designed to be mounted on the bulk-head or mounted from its bottom side. The housing size, weight, power requirements, and general information are shown in Figure 8-13.

Cooling

Cooling is accomplished by internal AC fans. The inlet air enters the housing through a louvered opening, an air filter, and an EMI/RFI screen mounted on the front door. The air is directed over the modules by means of a plenum system. The air is exhausted through another EMI/RFI screen and opening in the right side of the housing as viewed from the front.

Security Provisions

The front door is capable of being locked with a standard padlock. If the IOU is padlocked, the padlock must be removed prior to opening the door to shut off power.

8.1.12 IOM Set Overview

An IOM set consists of all of the IOMs (Figure 8-14) installed in a particular DMS configuration. To avoid complicating the configuration control documentation of the IOUs and ARMs (LHD only), all of the IOMs in a given installation are identified as parts of an IOM set. The types and quantities of IOMs in an IOM set are in accordance with the requirements of the DMS installation configuration for which the IOMs are intended.

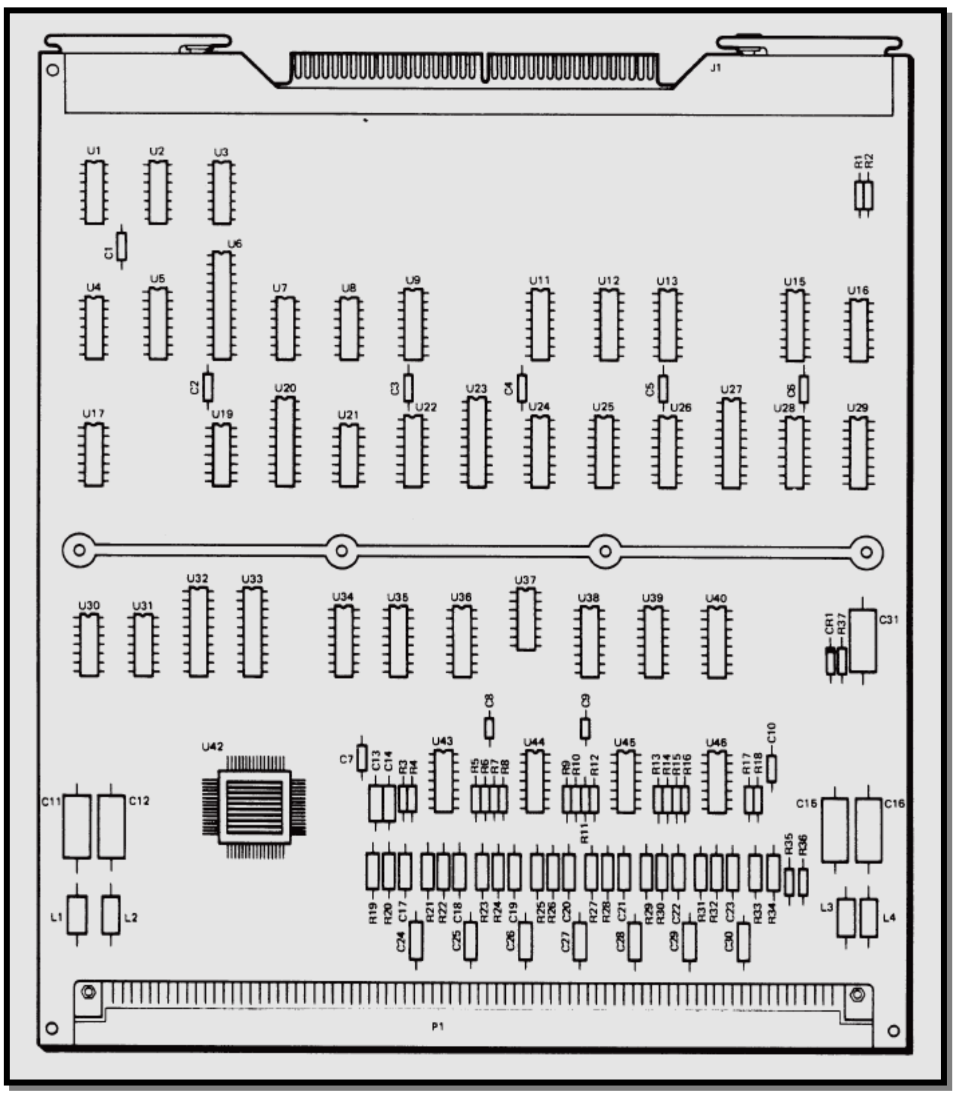


Figure 8-14. Typical Input/Output Module (IOM).

Current Part Number Data
The upgrade status of IOMs is indicated by the "dash number", i.e., the "-1" in IOM part number "19450-501-1". As IOMs are modified to improve performance or because of other design requirement changes, the dash number is changed from "-1" to "-11" to "-21", etc… Throughout this manual modules are referred to by the basic part number, IOM type letter designator, and/or noun name. To determine the current part number for a particular module, note the basic part number, IOM type letter designator, and/or noun name and look up the complete part number in the site/ship specific configuration manual Ship Specific Database (SSD) as described below.

8.1.13 Functional Summary

IOM Types and Applications
In a specific application, each IOM performs one of four general system functions: input, output, input plus output, and message processing.

Input Functions
An input IOM receives source user device signals, digitizes these signals, stores the signals in memory, and transmits the digital signals to DMS circuitry when requested.

Output Functions
An output IOM receives digital signals from DMS circuitry, stores them in memory, coverts the digitized signal into the format required by the sink user device(s), and outputs the converted signal to the sink user device(s).

Special Functions
Message processor modules are a special type of IOM that provide only internal switching control or messages for other IOMs and do not have direct interfaces with any user device.

Message Processing
A Message Processor module (MPM) has the ability to provide switching control as well as other functions. The switching control function is controlled by a switchboard, computer, or other device, via source circuitry in the DMS. This function allows the control of other IOMs either remotely, by means of remote control messages (RCMs), or locally, by means of External Message Requests (EMRs). Because the MPM may be used either with local source circuits or with local sink circuits, for sourcing or sinking user-supplied data, the module functions either as a special input IOM or as a special output IOM, depending on where the IOM is installed. The MPM is also capable of gathering data from users, operating on the data and generating new data for output to users, all without outside intervention.

Dual Capability

An NRZ serial data IOM functions as (1) an input module, (2) an output module, or (3) both an input and an output module, depending on the interfacing firmware (message PROM programming) and the types of user device channels that are serviced.

Features Common To All IOMs

All IOMs include the same dual-channel DMS interface and contain BITE circuitry. An IOM may contain BITE circuitry only in the DMS interface IC (LSI) common to all IOMs or an IOM may also include BITE circuitry in addition to that contained in the LSI (part U42 in Figure 8-14). A brief functional description of each of the various IOMs is contained in Table 8-4.

IOM Type	IOM Name	Compatibility			Purpose
		42 Pin	92 Pin	TRIAX	
1 (AI)	Discrete Input Switch Closure	Yes	Yes	No	Allows DMS to interface with up to 16 single-pole, single-throw user switched circuits. Detects if each circuit is opened or closed. Converts each connected state into a logic state of a corresponding bit. Stores the 16 bits in a RAM for access by interfacing DMS equipment and transfers the stored data as a 16-bit output word. Four of the 16 channels are independently for aperiodic update via EMR process.
2 (AAO)	Discrete Output, Isolated Switch Closure, DC	Yes	Yes	No	Controls (opens and closes) up to 16 users DC load circuits by means of solid state relays. Each relay is controlled by one the bits in the 16-bit serial word received by this IOM. Only the outputs defined by sub-addresses are updated after each data transfer. Each of the 16 DC load circuits has a current rating 1 to 1000 milliamp at 3 to 150 vdc.
3 (ABO)	Discrete Output, Isolated Switch Closure, AC	Yes	Yes	No	Controls (opens and closes) up to 16 user AC load circuits by means of 16 solid state relays. Each relay is controlled by one of the bits in the 16-bit serial data word received by this IOM. Only the outputs defined by sub-addresses which remain constant for 2.5 seconds are updated after each datum transfer. Each of the 16 AC load circuits has a current rating of 50 to 1000 milliamp to 144 rms, 60 or 400 Hz.
4 (SM)	Storage Module	Yes	Yes	No	Provides additional storage space for access by the DMS for reading and writing of data, independently of one another. Seven storage registers on the SM provide the temporary storage capacity as required by the DMS. An eighth storage register is dedicated to the Loop Test write-read mechanism.
5 (E)	Ethernet Module	Yes	No	Yes	Provides communication between users on an Ethernet network and DMS users. The EIOM provides the protocol conversion from TCP/

					IP/Ethernet on output. The EIOM interfaces to the DMS via the existing Input/Output Channel (IOC) backplane bus. The EIOM fits in any DMS IOU slot, which is serviced by a 42-pin and a triaxial connector. Each EIOM supports one Ethernet or IEEE 802.3 network. The EIOM also contains two serial I/O ports, which support RS422/232 for DMS and non-DMS users.
6 (JXI) (JI)	Synchro Input, Four Channel	Yes	Yes	No	There are two versions of this IOM. One version converts four channels of 90 Vrms, 60 Hz or 400 Hz synchro signals to 10-bit digital information in the DMS format. This IOM converts synchro signals having rotational values from zero to 2700 degrees per second. The other version has four channels and converts to 14 bits of digital information in the DMS format. Channels 0 and 2 convert 60 Hz or 400 Hz synchro signals having rotational values from zero to 500 degrees per second. Channels 1 and 3 convert 400 Hz signals having rotational values from zero to 4000 degrees per second. These IOMs are capable of interfacing with all 115 volt synchro transmitter type devices listed in MIL-STD-710.
7 (JBO)	Synchro Output, Four Channel, 400 Hz	Yes	Yes	No	Converts serially-formatted and multiplexed digital data into four 90-Vrms, 400-Hz, 3-wire synchro signal outputs. Outputs are capable of driving 115-vac, 400-Hz synchro control transformer- type devices.
8 (ABO)	Synchro Output, Four Channel, 60 Hz	Yes	Yes	No	Same as item 7 but operates at 60 Hz.
9	Deleted				
10	Deleted				
11 (BBO)	Tri-Level Discrete Output	Yes	Yes	No	Provides eight channel of simulated sensor (variable resistance) circuits to interface with user switchboard and/or alarm panel circuits. The 16-bit input words are converted into eight channel of tri-level impedances; viz., 7 kilohms (Normal), shorted (Alarm), or open (supervisory fault) in accordance with the eight channel states encoded in the input word.
12 (BI)	Tri-level Input	Yes	Yes	No	Provides eight identical active channels for communications between users and will interface with passive (two wire) or active (three wire) users. The module monitors these user interface lines and reports their state, normal, open, or shorted.
13 (DI)	Discrete Input Isolated Voltage level	Yes	Yes	No	Interfaces with up to 16 channels of AC, DC, or interrupted DC discrete signals. Converts the state of each signal to a logic state of the corresponding bit. Stores the 16 bits in a RAM for access by

					interfacing equipment and transfer as a 16-bit output word. Each channel can be individually programmed to be compatible with the selected input signal type. Four of the 16 channels are programmable for aperiodic update via the EMR process.
14 (DCO)	Discrete Output Voltage Level	Yes	Yes	No	Provides a 16-channel bi-level discrete output interface to sink user devices. Each channel is controlled by the state of the corresponding bit in the input word from the DMS. Each channel is independently programmable for the normal (positive logic) or inverted (negative logic) sense. This IOM provides a lamp test input which may be controlled by the user.
15 (N)	NRZ Serial Data Input/Output (STANAG 4156)	No	Yes	No	Adapts DMS to interface up to four channels of NATO STANAG 4156 NRZ words from user devices or to transmit up to four channels of NRZ words to user devices. Each of the four channels is programmable with a DIP shunt for one of two message transfer protocols (type A or type B) depending on the user device capability. The type A protocol must be used when the device cannot generate a control word. This IOM has the capability of operating in a total of nine different message transfer modes, four in the type A protocol and five in the type B protocol. Handshaking signals are used in all nine modes. The types and complexities of message transfers that this IOM handles in a given application varies with the type of user devices serviced and the message transfer requirements of these user devices. EMR generation capability is available on all four channels. Only one channel and one direction (in or out) can be active at a time.
16 (P1I)	Parallel Data input NTDS fast (LHD only)	No	Yes	No	Adapts DMS to interface with a user source device that has an NTDS fast, category I (computer to peripheral) interface. The source device may use either computer or peripheral protocol. The IOM is programmable to function in the complementary role with the device (i.e., peripheral if the device has a computer role and computer if the device has a peripheral role).
17 (P3O)	Parallel Data output NTDS fast 16-bits (LHD only)	No	Yes	No	Adapts DMS to interface with a user sink device that has an NTDS fast, category I (computer to peripheral) interface. This IOM is capable of receiving messages, via the DMS, from IOMs of any type, buffering and delivering them to the device in words of a programmable length in accordance with the word format requirements of the device. This IOM is programmable to function in the complementary role to the user sink device (i.e., peripheral if the device is a computer and computer

					if the device is peripheral).
18 (P2I)	Parallel Data input NTDS slow	No	Yes	No	Adapts DMS to interface with a user source device that has an NTDS slow, category I (computer/peripheral) interface. The source device may use either computer or peripheral protocol. The IOM is programmable to function in the complementary role with the device (i.e., peripheral if the device has a computer role and computer if the device has a peripheral role).
19 (P2O)	Parallel Data output NTDS fast 32-bits	No	Yes	No	Adapts DMS to interface with a user sink device that has an NTDS slow, category I (computer to peripheral) interface. This IOM is capable of receiving messages, via the DMS, from input modules of any type, buffering and delivering them to the device in words of programmable length in accordance with the word format requirements of the device. This IOM is programmable to function in the complementary role to the user sink device (i.e., peripheral if the device has a computer role and computer if the device has a peripheral role).
20 (P1O)	Parallel Data output NTDS fast, 32 bits	No	Yes	No	Adapts DMS to interface with a user sink device that has an NTDS fast, category I (computer to peripheral) interface. The sink device may use either computer or peripheral protocol. The IOM is programmable to function in the complementary role with the device (i.e., peripheral if the device has a computer role and computer if the device has a peripheral role).
21 (Y)	Message Processor	Functional No User's	Functional No User's	Functional No User's	Does not interface directly with user. Has same capability as a message processing IOM (item 20) plus additional features. Used to control transfer of data between RM/ARM (LHD only) IOUs and ultimately from user to user. May provide selective distribution of data message. (May act as a through wired switchboard. In addition, may perform operations on data based on algorithms stored in PROMs).
22 (RI)	Low-level serial input	No	No	Yes	Enables DMS to communicate with user through MIL-STD-1397 Type E (low-level serial interface) protocol. The low-level serial input (LLSI) and low-level serial output (LLSO) IOMs exchange data directly through Intermodule pathways. Both modules detect and report communications errors between users.
23 (RO)	Low-level Serial output	No	No	Yes	Enables DMS to communicate with user through MIL-STD-1397 Type E (low-level serial interface) protocol. The low-level serial input (LLSO) and low-level serial output (LLSI) IOMs exchange data directly through Intermodule pathways. Both modules detect and report communications errors between users.
24	Parallel Data	Yes	Yes	No	Enables DMS to provide an isolated interface

(API)	Input, 12-Bit				between a user with up to 12 data channels and DMS. The 12 channels of data inputted to the IOM are controlled by the user. BITE circuits on the IOM provide warnings to DMS when the IOM is not functioning within specified parameters.
25 (PCO)	Clock Data Output	Yes	Yes	No	Enables DMS to provide a real time clock output, Greenwich Mean Time (GMT), to an external computer via an NTDS fast interface. The clock is updated at a 1024 Hz rate on the IOM. Each time the clock is updated it is offered to the external computer via the NTDS fast interface, but may not be 8pted by the computer unless needed. GMT data furnished by a remote navigation system initially sets the clock and continually re-syncs it to the GMT data approximately once per second. The clock automatically resets to zero every 24 hours. A BITE error signal is generated when the 1024 Hz signal becomes absent.

Table 8-4. Input/Output Modules (IOMs) - Summary Descriptions.

8.1.14 IOM Physical Description

Figure 8-14 illustrates a typical input/output module. The connectors have two rows of male pins, 80 pins per row. The size of most IOMs is approximately 11.5 by 9.5 by 1.0 inches. However, some IOMs are wider than 1 inch and thus occupy two adjacent IOU slots.

Module Keying

A variable keying device is located on each side of the module connector. The keying device is coded to match the mating keying device on the MIB connector to prevent insertion of the module into the wrong connector. Sixty-four keying codes are available. The codes can be changed at any time to accommodate IOU slots to different IOMs.

Module Insertion and Extraction

The modules have two cam arms that are permanently attached to the corners of the module that are opposite the connector end. These cams aid in the insertion and extraction of the module in addition to locking the module in its slot. The cams are secured in the locked position with a screw.

IOM Mating Peculiarities

All IOU8, IOU16, and ARM (LHD only) IOM slot connectors are not compatible with all IOMs. Table 8-4 lists which IOM types are compatible with each of the IOM slots. Figures 8-15, and 8-16 illustrate IOM slot peculiarities.

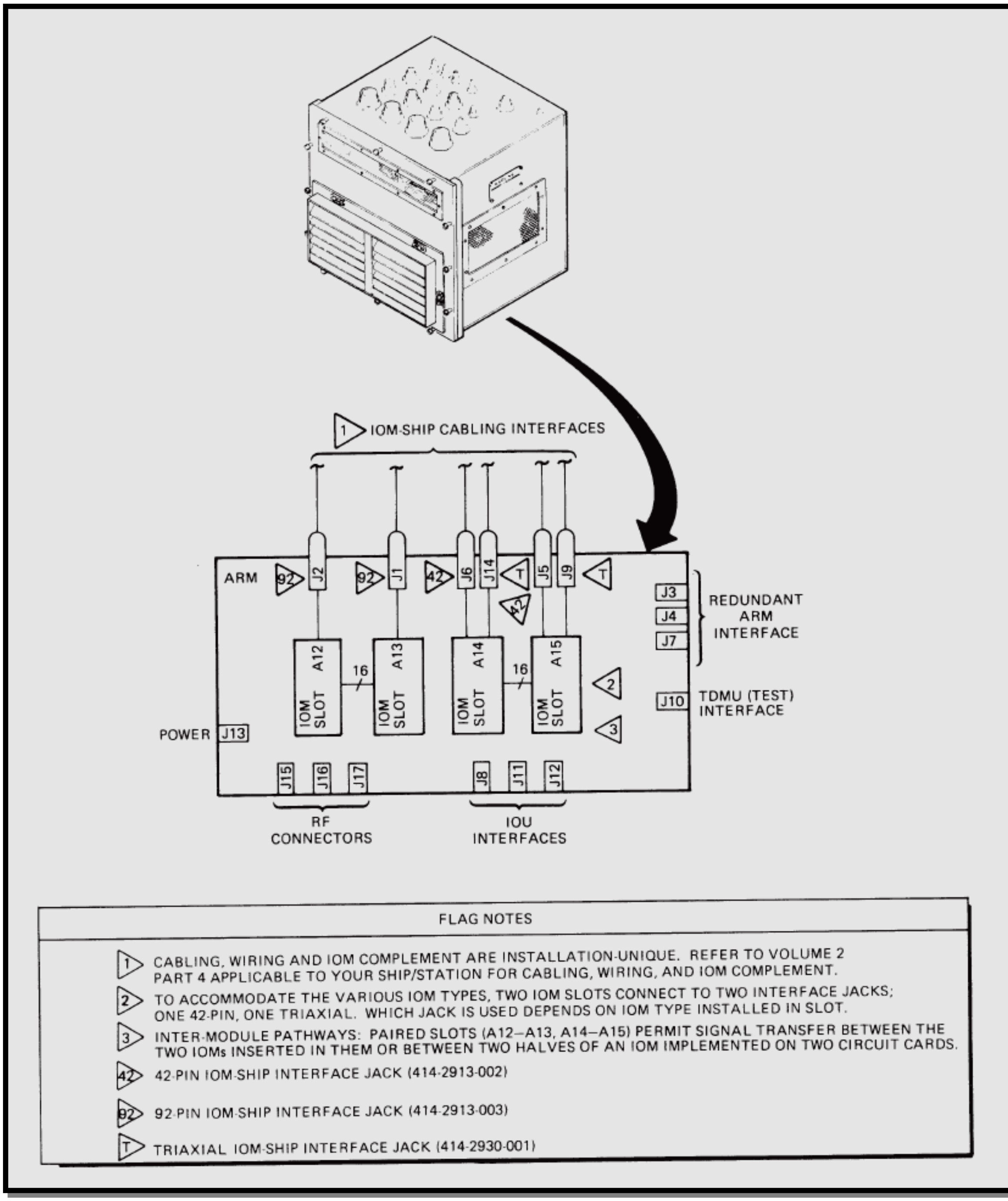


Figure 8-15. IOM–Ship Interface Jacks vs. IOM Slots in ARMs.

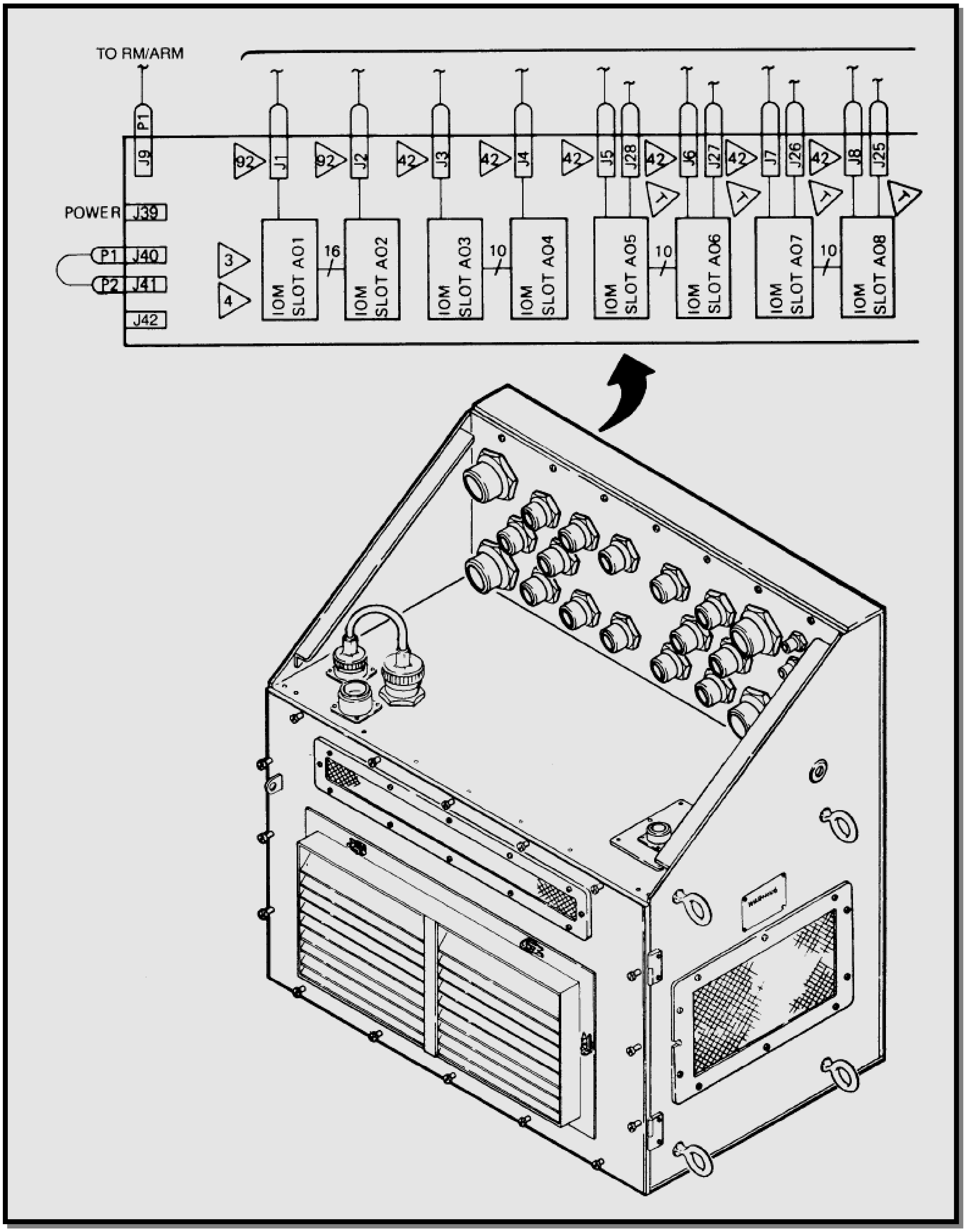


Figure 8-16. IOM–Ship Interface Jacks vs. IOM Slots in IOU16s (Sheet 1 of 2).

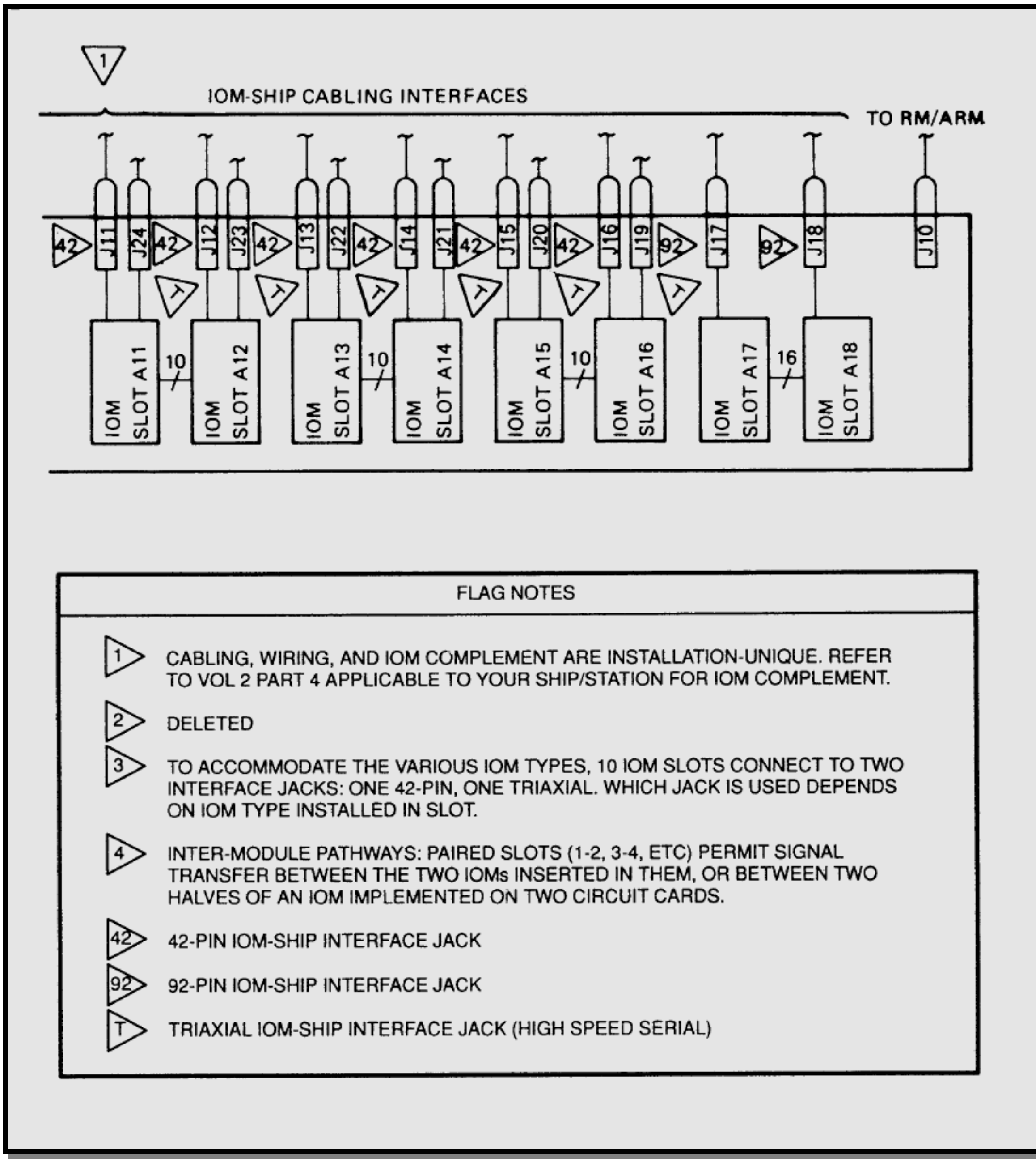
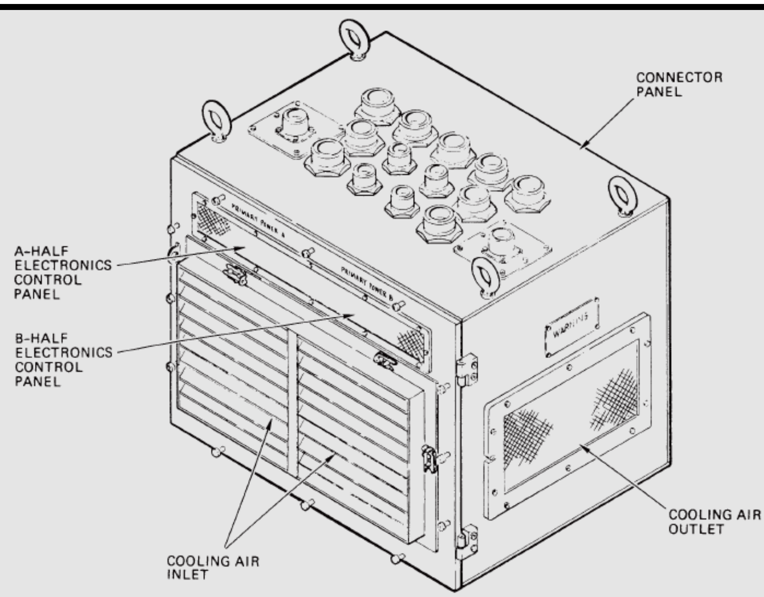


Figure 8-16. IOM–Ship Interface Jacks vs. IOM Slots in IOU16s (Sheet 2 of 2).

8.1.15 Remote Multiplexer (RM) Overview

(See Figure 8-17). An RM, PN 10700-514-X, interfaces with IOUs and AMs and communicates with other RMs and/or ARMs via AMs to provide user-to-user communication paths. Users can also communicate with other users (located in the same area) that share the same RM. The function of an RM is to perform the primary control functions associated with initiating message transfers, responding to requests for messages, packing IOM words into messages, unpacking words from messages, and routing of data to and from IOMs for each data word.



EQUIPMENT CONFIGURATION

INPUT POWER A-HALF AND B-HALF EACH:
PRIMARY: 115V, 1 PH, 60 Hz, 325 WATTS MAX (INCLUDING FANS)
EMERGENCY: 110 TO 130 VDC, 297 WATTS MAX

COOLING:

AC-POWERED INTERNAL FANS: FOUR FANS, TWO FOR A-HALF, TWO FOR B-HALF 14 WATTS EACH

ENVIRONMENT:

	OPERATING	STORAGE
TEMPERATURE	0 TO 50°C	-62 TO 71°C
RELATIVE HUMIDITY	0 TO 95%	0 TO 95%

MOUNTING PROVISIONS:
BASE AND BULKHEAD

REDUNDANT CONSTRUCTION:

TWO IDENTICAL FUNCTIONAL UNITS PACKAGED IN A SINGLE ENCLOSURE

DIMENSIONS (INCHES), WEIGHT (LBS):

	UNCRATED	CRATED
HEIGHT	18.18	28.50
WIDTH	21.99	30.25
DEPTH	17.47	24.75
WEIGHT	150.00	221.00

SECURITY PROVISION: CAPABILITY OF PADLOCKING FRONT DOOR AND LOCKING MESSAGE PROM MODULES

DESCRIPTION DATA:
OFFICIAL NOMENCLATURE: MULTIPLEXER, REMOTE TD-1318A/USQ-82(V)
MANUFACTURER'S NOMENCLATURE: REMOTE MULTIPLEXER
PART NUMBER 10700-514-21
MANUFACTURER'S CODE 94756

Figure 8-17. Remote Multiplexer (RM).

Redundant Features

Each RM is dual redundant, consisting of two halves (RMHs) with identical logic and firmware. Both halves are electrically and functionally identical. Each half is independent of the other except for their cross-reporting of BITE data and interactive servicing of messages.

Communication Paths

In a given RM one RMH is designated RMH A and the other is designated RMH B. Each RMH has a primary and an alternate AM interface port. Therefore, each RM has four paths of communication to AMs for any message.

IOU Interfaces

Because each RMH has four IOU ports and each IOU port can interface with up to 16 IOMs, a maximum of 64 IOMs can be interfaced by each RMH. The opposite/ redundant RMH interfaces with the opposite/redundant ports of these same IOMs. Hence, each RM has two communication paths to the interfacing IOMs for any message that it handles.

Service Offers

In addition to RMH controller interaction between both halves, path select logic of both halves allows only one RMH to accept a simultaneous service offer (SO) for the same message or a simultaneous relayed request for any message.

Turnaround Mode

Any RMH is also capable of providing a communication link between two users connected to the IOUs of the same RMH in a unique mode of data transfer (turnaround mode) without any interaction with the AMH, except to appear busy to the AM for the duration of the message.

Functional Summary

Each RMH (Figures 8-18 and 8-3) houses five circuit cards: an interface no. l card (IF1), an interface no. 2 circuit card (IF2), two circuit cards (CU1 and CU2) comprising a controller unit (CU), and an encoder/decoder (E/D).

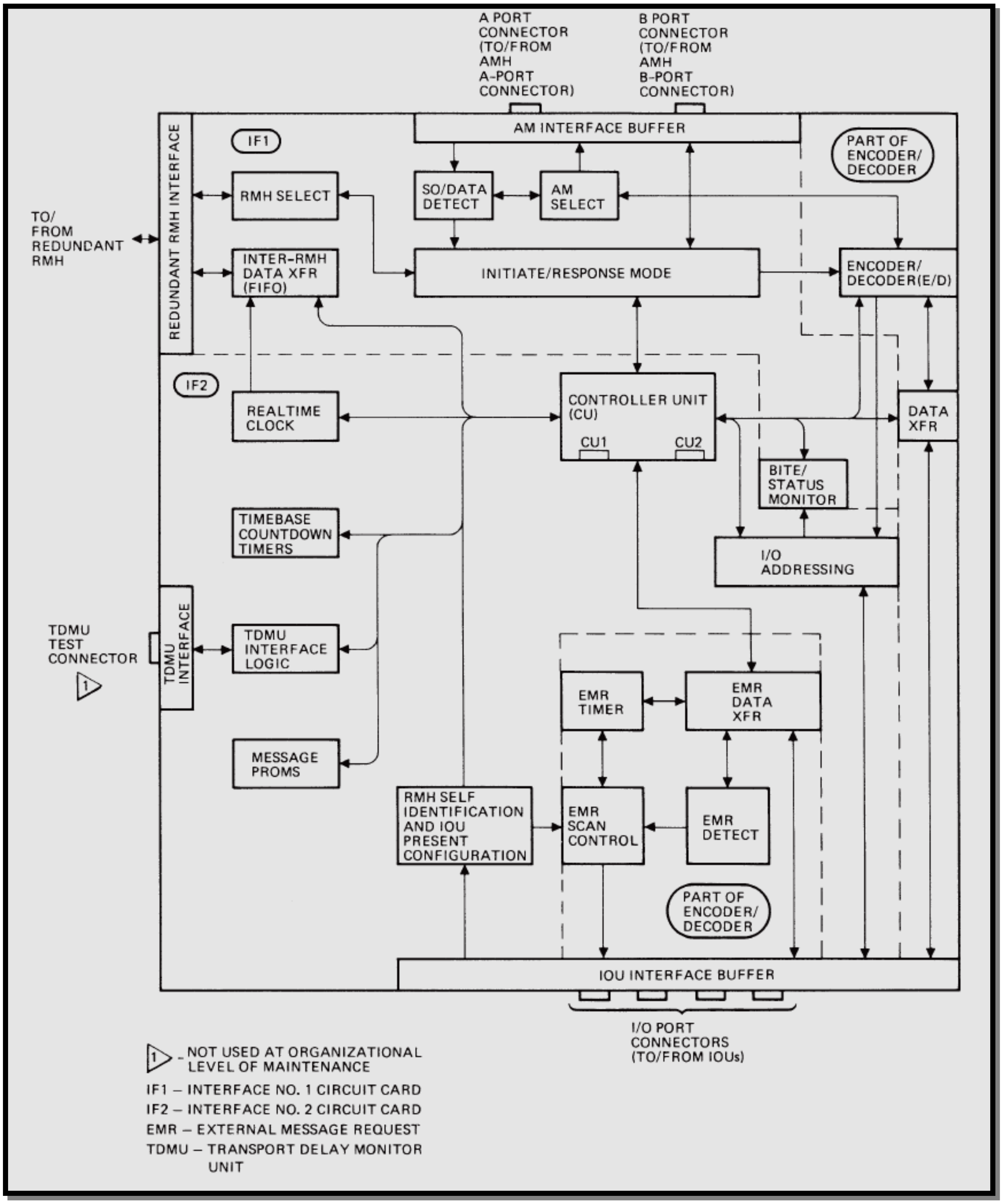


Figure 8-18. RMH Simplified Block Diagram.

8.1.16 External RM Interfaces

IOU Interfaces
The dual RM interfaces with 1, 2, 3 or 4 IOUs each of which can be 8-slot (IOU8) or 16-slot (IOU16). The RM performs all control and timing functions needed to multiplex outgoing data from the IOUs and to demultiplex incoming data to the IOUs.

AM Interfaces
The dual RM interfaces via four secondary bus connections to four AM halves. The RM sends service requests (SRs) to the AMHs and transmits data when an AMH responds with a service offer (SO). The RM also accepts data from the AMHs which are coming from the primary buses.

RM Functions/Multiplexing and Demultiplexing
An RMH operating in the source mode multiplexes incoming NRZ encoded 17-bit serial data words from the IOUs and transmits baseband Manchester-encoded serial data messages containing 20-bit words to the AMHs. The header data are provided by message PROMs or by hardware in the source RMH or by the source user, as applicable.

Sink Mode
An RMH operating in the sink mode decodes the incoming Manchester-encoded messages from AMHs into NRZ-encoded data words, demultiplexes the message, and forwards these words to the applicable IOUs and IOMs using the IOM addresses and subaddresses provided by its message PROMs. Addressing and subaddressing bits, issued in parallel format by the RMH to the IOUs: (1) address the source IOMs for input data from the IOUs during the multiplexing process and (2) address the sink IOMs for steering the output data to the IOMs during the Demultiplexing process.

IOM Enabled
Each set of address bits is converted by a TIB, in the IOU, into an IOM enable discrete to enable the addressed IOM.

Sub-Addressing
Each set of subaddress bits, transmitted after the address bits on the same lines, functions as a set of channel select or function-select bits for the IOM logic. For messages which are PROM-programmed to operate in the turnaround mode, an RMH gathers a serial data word from a source IOM and forwards the serial data word to a sink IOM in the same IOU or in another IOU connected to this RMH.

Multiword Message

For multiword messages, the words are alternately gathered and forwarded on a word-by-word basis. Conversion from NRZ to Manchester code does not take place for turnaround messages.

Message Initiations and Controls

The RMH always interrogates its message PROMs in order to control message transfers through the DMS. All information on handshaking, transfer type, update rate, retries, and I/O addressing is found in the message PROMs. Periodic messages are initiated by internal timers driven by a real time clock and a controller in the RMHs. Aperiodic messages are initiated by EMRs from an IOU or by RCMs from another RMH. The order in which the various messages are processed is controlled by the RMH controller using priority and first-in first-out logic without allowing any message lockout.

Message PROMs

Each RMH has four 512 x 8-bit message PROMs that contain a total of 128 message control segments.

PROM Program

The PROMs are programmed to characterize and control the messages processed by the RMH, providing a capacity to control the processing of up to 128 unique messages, each identifiable by 6-bit message ID (MSGIDs).

Message Identification

The number of messages implemented in a given RMH depends on the application. The MSGID identifies a unique 16 x 8 bit segment (containing 16 8-bit words, 0 through 15) of a message PROM. MSGID 0-63 are used for initiate mode messages. MSGID 64 through 126 are used for response mode messages. MSGID 127 is for IOM self-test tables. Each segment can provide at least 7 IOM address/subaddress words to fetch or forward message data words.

Linking Messages

The relation between message PROM IOM addresses and physical IOU slots is given in Table 8-5. Where additional message control capacity is required, the next 16 word segment can be linked to provide an additional 16 words of IOM addresses/subaddresses. If an end of message (EOM) word, consisting of all ones, is not present in a PROM segment, this segment is linked to the next segment for extended I/O addressing; the EOM will be present in the last segment linked.

Message PROM IOM Address*	IOU8 Slot Ref Des	IOU16 Slot Ref Des
0	XA03	XA1
1	XA04	XA2
2	XA05	XA3
3	XA06	XA4
4	XA07	XA5
5	XA08	XA6
6	XA09	XA7
7	XA10	XA8
8	-----	XA11
9	-----	XA12
10	-----	XA13
11	-----	XA14
12	-----	XA15
13	-----	XA16
14	-----	XA17
15	-----	XA18
* Module address, bits 0 through 3 of word 7.		

Table 8-5. PROM IOM Address Relationship to IOU Slots.

Block Transfers

The EOM word marks the end of IOU/IOM addressing/subaddressing for the message, unless a block transfer of data is programmed. A block transfer is indicated if the block transfer (BLK) bit of word 0 in the message PROM segment is set to 0. In block transfer, all data words in a message are transferred to the same address/ subaddress. There is no EOM word in the message PROM for this type of transfer; EOM is determined by the controller when data words stop coming in. Block transfer may be used at the source RMH and/or the sink RMH.

Message PROM Format

The format for one message sector of a message PROM is given in Figure 8-19. The message PROM format description is provided in Table 8-5.

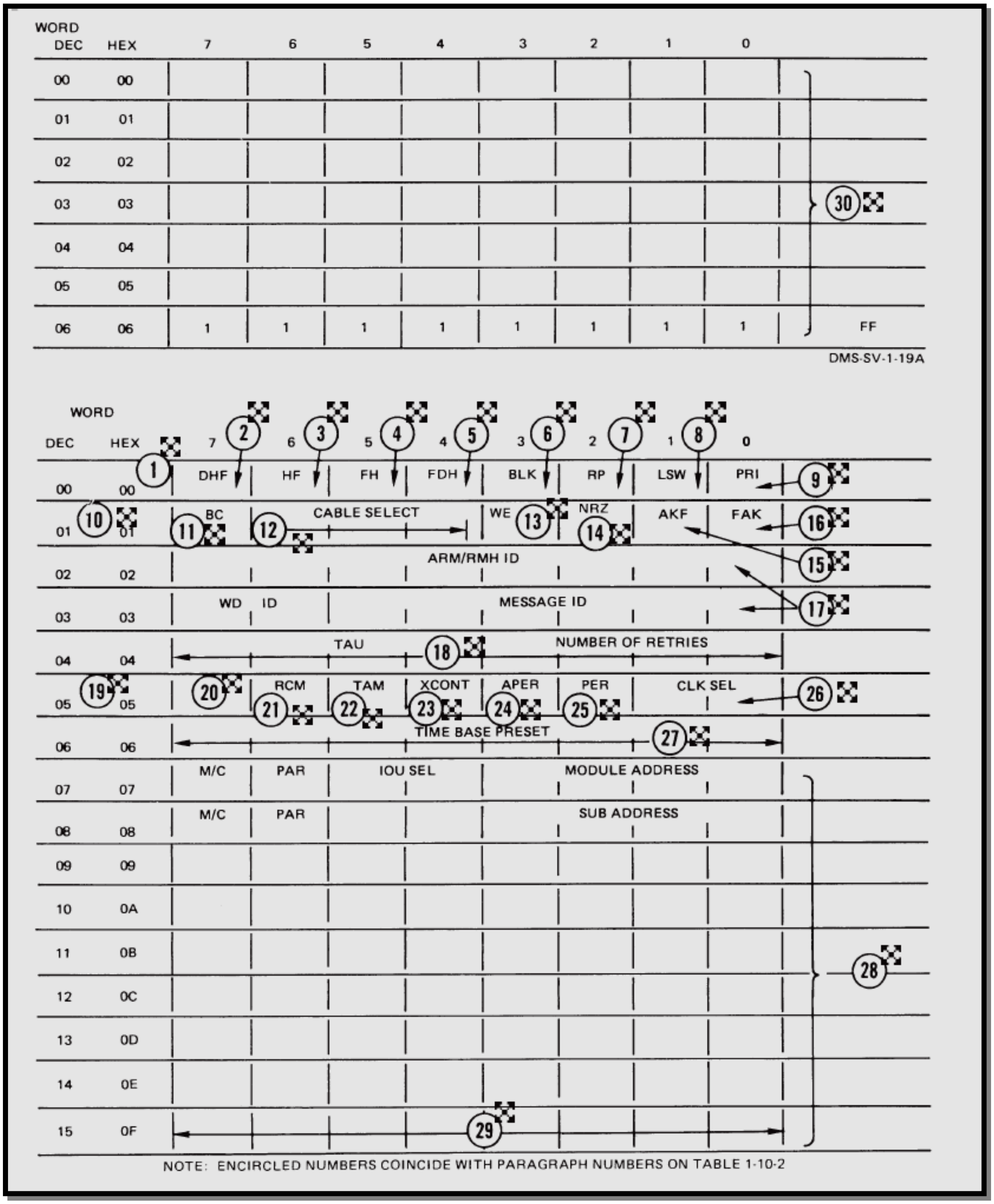


Figure 8-19. Message PROM Format.

Message Sink-RMH-Initiated Periodic Message Transfers

Each sink-RMH-initiated periodic message transfer (Figure 8-9) begins with a receive request message generated by an RMH that will sink the requested data. A receive request message is a one-word control message consisting of a receive request word (Figure 8-8). A receive request word consists of a request header (bits 1 through 16) and a parity bit (bit 17). A receive request word requests a data message from a source RMH.

Periodicity Control

The CU in the sink RMH uses a time base countdown timer and the real time clock on IF2 (interface No. 2 module) to trigger clock interrupts that cause the CU to (1) determine the next periodic receive request MSGID to be placed in its service queue and (2) place this MSGID into the queue. For each periodic message initiated by this RMH, one of the two time-base countdown timers is loaded (set) by the CU to countdown to zero and trigger a clock interrupt in accordance with time constants obtained from the message PROM segment for the associated message. These time constants determine (1) the update interval (periodicity) of the message, (2) the number of retries to be attempted if the transfer is unsuccessful, and (3) the delay time between retries. The controller maintains a service queue for messages that require updating and determines the servicing sequence based on a combination of priority and first- in first-out (FIFO) considerations and added logic that does not allow low priority messages to be ignored during heavy traffic periods.

See Figure 8-19 where circled numbers correspond to the numbers listed below.

Table 8-6 (Below). Message PROM Format Descriptions.

1-Word 0. Word 0 in the message PROM consists of eight bit which describe fundamental control characteristics for a given message related to the DMS control words (headers), type of transfer, and message priority. The header fetch and HF functions provide programmable digital devices (e.g., computers) with increased flexibility for control of transfer or receipt of data. Use of these functions will conserve message PROM storage as well as minimize I/O requirements. Details of each bit in a word 0 are provided in 2 through 9 as follows:

2 - Data Header Fetch (DHF). Bit 7 of word 0 in the message PROM signifies whether or not the data header for the message is to be obtained from the user device or is to be constructed from data in the message PROM. Some digital devices have the capability to formulate and provide the data header, whereas analog and discrete devices do not. The DHF function enables the source user device to retain control of the MSGID. This allows the source device to uniquely identify up to 128 different messages having the control characteristics defined in one PROM segment. 0= DHF; 1 = not DHF.

3 - Header Fetch (HF). Bit 6 of Word 0 in the message PROM signifies whether or not the Receive Request or Transmit Request is to be obtained from the user device or is to be constructed from data in the message PROM. Most digital devices have the capability to formulate and provide these control words; most analog and discrete devices do not. The HF function enables the user device to retain control of both the RMID and the MSGID. If the header to be obtained is a receive request, the sink device can identify the source RMID and source MSGID from which the data are requested. If the header to be obtained is a Transmit Request, the source device can identify the Sink RMID and Sink MSGID to which the data are to be transmitted. 0= HF; 1 = not HF.

4 - Forward Header (FH). Bit 5 of word 0 in the message PROM indicates whether or not the transmit request and receive request control words are to be forwarded to the user device. If the user device is capable of interpreting these control words, it may be desirable to forward the control words to the user. The FH function, when selected, allows the recipient of the header to identify what MSGID is being requested or transmitted. The RMID in the control word is the RMID of the recipient; the recipient is not able to identify the sender of the control word. For this reason, MSGIDs must be assigned on a global basis in order for the recipient to identify what data to send (if the control word is a transmit request), or what data to send (if the control word is a receive request). The MSGID in the control word which is forwarded must identify a message which is identical for all devices communicating with the recipient, or the MSGID must identify a message which is unique to the two communicating devices. 0 = FH; 1 = not FH.

5 - Data Header Forward (FDH). Bit 4 of word 0 signifies whether or not the data header is to be forwarded to the user device with the data. If the user device is capable of interpreting the data header, it may be desirable to forward this control word to the user. When the data header is forwarded to the sink user device, the FD function enables the sink device to confirm that the message received is the message that was requested. 0 = FD; 1 = not FD.

6 - Block Transfer (BLK). Bit 3 of Word 0 indicates whether or not the message is a block transfer. If a block transfer is indicated, the message is limited to a single module address. BLK is used to send/receive all words of a message to/from the same I/O interface. Nonblock transfer is used to multiplex words of a message from/to different I/O interfaces. 0 = BLK; 1 = not BLK. The maximum message length in BLK is 4096 words.

7 - Responding PROM (RP). Bit 2 of Word 0 in the message PROM identifies the RMH or ARM (LHD only) in which the message PROM is located as the sender (Initiator) or receiver (responder) of the initial DMS control word. Since the initial control word may be either a transmit request or receive request, this bit does not identify the source or sink of the message. 0 = Responder; 1 = Initiator.

8 - Long or Short Wait Time (LSW). Bit 1 of Word 0 signifies whether the sink RMH or ARM (LHD only) should wait a long (2ms) or short (50 us) period for the data header (or first data word). If the NRZ control bit is asserted, the short wait time is 50 ms. The long wait time is specifically provided for smart user devices which may be unable to receive, interpret, and respond to an DMS control word within the 50 us period. Message PROMs which service dumb IOMs such as discrete, analog or synchro should be programmed for the short wait time. 0 = long; 1 = short.

9 - Priority (PRI). Bit 0 of Word 0 indicates the intended PRI for a given message. PRI is a measure of time sensitivity for the message. The FIFO queues are provided, one high priority and one low priority. The high priority queue is normally serviced first, thus reducing access delay for those messages. The low priority queue is mechanized so that it can never be completely blocked out; messages assigned a low priority are eventually serviced once they are placed in queue. It is recommended that no more than about 20 percent of the messages originating at a given RM or ARM (LHD only) be assigned a high priority; otherwise the time advantage tends to be defeated. 0 = Low; 1 = High.

10 - Word 1. Word 1 in the message PROM consists of eight bits as defined in 11 through 16 as follows:

11 - Broadcast (BC). Bit 7 of Word 1 is used only when the message PROM resides in an ARM (LHD only), and indicates whether or not the message is a broadcast message. (Note that RM terminals do not handle broadcast messages.) 0 = BC; 1 = not BC.

12 - Cable Selection Bits. Bit 4, 5, and 6 of word 1 in the message PROM are used only when the message PROM resides in an ARM (LHD only) and indicates which primary bus cables the ARM (LHD only) can use to transfer this particular message. One or more bits can be set. These bits provide the selected cable access feature of the ARM (LHD only) by which the user can direct that transmissions be initiated on a particular primary bus (or buses). This capability can be used to dedicate specific bus cables to specific functions; e.g., broadcast of the track file, or specially compartmented information (SCI). 0 = illegal cable; 1 = legal cable.

13 - Wait Enable (WE). When a source device is sending data and the WE bit is "0", the device waits to send the data header until after the first data word is fetched. If the WE bit is "1" the source device sends the data header first then fetches the first data word.

14 - Non Return to Zero (NRZ). The NRZ is "0" if the first sink IOM addressed by the PROM is an NRZ input/output module (IOM). Reserve address information is programmed on the Message PROM at the location where the first data subaddress would be for other IOMs. The first data subaddress follows the reserve address.

15 - Acknowledge Fetch (AKF). Bit 1 of Word 1 in the message PROM signifies whether or not the acknowledge control word for the message is to be obtained from the user device or is to be constructed from data in the message PROM. The AKF function is used in conjunction with the FH (4) when the header is a transmit request. When the Acknowledge is to be obtained from the sink user device, the sink device can accept or refuse receipt of the message by transmitting or withholding the acknowledge. 0 = AKF; 1 = not AKF.

16 - Forward Acknowledge (FAK). Bit 0 of word 1 indicates whether or not the acknowledge control word is to be forwarded to the user device. When the acknowledge control word is to be forwarded to the source user device, it signifies to the source device that a path is retained in a connected status for the time programmed in bit 1 of Word 0 (8). This function would be implemented for FIFO buffered data transfers in order to minimize data staleness. 0 = FAK; 1 = not FAK.

17 - Words 2 and 3. Words 2 and 3 contain RMID (eight bits), MSGID (six bits), and Word ID (two bits) fields used for assembling the DMS control words. When ARMs are used in the system, the RMID field is the ARMID. These are only required when they are not fetched from the user device.

18 - Word 4. Word 4 contains N and T which are used to specify 256 combinations of number of retries (N) and delay between retries (T). N may be any number between 0 and 15. T is used in conjunction with N to specify delays covering a range of approximately 50 msec to 750 msec in 50 msec increments. The N and T parameters are programmable in order to resolve temporary conflicts and in case of source or sink device failure.

Typically, N will be set to approximately 10 unless the system is heavily loaded. It indicates the number of times a message should be attempted if no response or an error condition exists for a particular update. If N is set too low, a blocking condition may not have time to clear and data will not be transmitted until the next regular update.

Normally TAU is made commensurate with the average message length. If it is essential to minimize transport delay, TAU should be assigned a small value (0 or 1).

19 - Word 5. Word 5 of the message PROM consists of eight bits divided into six fields which describe mode control and timing characteristics for a given message. Details of each bit in word 5 are provided in the following items, 20 through 26.

20 - Spare Bit 7 of Word 5 is an unused spare bit.

21 - Remote Control Message (RCM). Bit 6 of Word 5 in the message PROM signifies that data transmitted following a transmit request will be used for message

control (i.e., an RCM data word), and the I/O is not enabled. This function is used in DMS switching. 0 = RCM; 1 = not RCM.

22 - Turnaround Mode (TAM). Bit 5 of Word 5 in the message PROM is used to signify that a message originating at one I/O port served by this RM or ARM (LHD only) is to be received at another I/O port served by the same RM or ARM (LHD only) without being transmitted over the primary bus. Use of the TAM reduces throughput to approximately one-half capacity for block transfer 6 since the source and sink device must be sequentially addressed for each transfer. Circuit reliability/availability should be considered when making a decision whether or not to use the TAM. When it is used, reliability/availability are increased because dual RMH or ARM (LHD only) paths are available (just like for normal message transfer).

If the TAM bit is "1" and the UNITED field of the Request Header matches the SLFID word, the Smart User Turnaround Mode (SUTAM) is entered. This mode allows a fixed EMR word to initiate transfers which may be either bus or TAM transfers. It also allows the responding IOMs to be varied for different transfers. The program utilizes two Message PROMs, an initiating PROM and a responding PROM. The initiating PROM provides message control and address information for initiation of the message. The responding PROM provides message control and address information for the responding IOM(s). 0 = TAM; 1 = not TAM.

23 - Externally Controlled (XCONT). Bit 4 of word 5 in the message PROM indicates whether or not this message is protected from external disablement by EMRs or RCMs. All messages except those associated with DMS switching should be protected to avoid the possibility of inadvertent disablement. 0 = XCONT; 1 = not XCONT (i.e., protected).

24 - Aperiodic (APER). Bit 3 of word 5 indicates whether or not this message is to be aperiodically initiated by an EMR or RCM. 0 = Aperiodic; 1 = not Aperiodic. APER = 1 should be used for periodically initiated messages and for response messages.

25 - Periodic (PER). Bit 2 of word 5 indicates whether or not this message is to be periodically initiated by DMS clock timers. 0 = periodic; 1 = not periodic. The following table indicates how the RM or ARM (LHD only) firmware uses the APER and PER bits in word 5:

APER	PER	Update by Clock	Except EMR/RCM One-Shot
0	0;	Yes	Yes
0	1	No	Yes
1	0	Yes	No
1	1	No	No

26 - Clock Select Group (CKL-SEL). Bit 0 and 1 of word 5 in the message PROM allows the selection of one of four different clock select groups as follows:

CLK	SEL	Clock Select Group	Update Rate Change
0	0;	53.33 µs	73 µps to 300 µps
0	1	3.413 ms	1.1 µps to 293 µps
1	0	218.453 ms	1.1 µpm to 4.6 µps
1	1	13.98 seconds	1.0 µph to 4.3 µpm

27 - Word 6. Word 6 contains an eight bit Time Base Preset (TBPRESET) used in conjunction with the CKL-Sel (26), to specify the update interval for this message. This word is a count value that determines how many clock pulses of the appropriate clock are to be counted to establish the update interval.

28 - Words 7 through 15. Words 7 through 15 are used for IOM addressing. The IOM will be addressed for the Request Header if the Header Fetch Bit is set. If the Data Header Fetch bit is set, the IOM will be addressed to obtain the Data Header. If the Forward Header bit is set, the IOM will be addressed and the Header sent to the IOM. In all the above cases, the IOM address will be obtained sequentially from words 7 through 15 of the message PROM. Words 7 through 15 content abbreviations are as follows:

M/C	= module (IOM) or channel address (1 = IOM, 0 = channel)
PAR	= odd parity bit
IOU SEL	= Which of four IOUs is being addressed
IOM ADDRESS	= 0 through 15 (which of 16 IOM slots)

29 - Word 15. If this word is all 1's then this word or any word after word 9 containing all 1's constitutes the EOM for this PROM segment. If word 15 is not all 1's, then this message is extended into the next 15 words of the PROM. If there are linking PROMs, the EOM is contained in the last PROM linked.

30 - Word 32 through XX. If any given message is 32 words or longer, a continuation PROM is required. The last word of a message must be all 1's; this constitutes the EOM (End Of Message) for this PROM segment.

Receive Request Header Generation

When the MSGID is read out of the service queue, the receive request header is developed. The request header contains the source RMH identification (SR RMID), the source MSGID, and word identification (WID) code. The header data are obtained from either a message PROM or from the sink IOU in accordance with a bit in the message PROM called header fetch (HF). Usually, the header data are obtained from the message PROM. Fetching the header from the IOU is done in special cases where a sophisticated type of user device, capable of supplying a header word, is the sink for the data being requested. The header is saved in memory, loaded into a data output register, and sent out to an AMH when this RMH responds an SO.

SO Acquisition

To obtain an SO, the CU loads its service request register (SRR) with a SR bit set high, the MSGID, and the message priority (PR) bit (either l or 0). SR and PR are forwarded to both interfacing AMHs in parallel. The two RMHs of an RM coordinate with each other to avoid simultaneous servicing of the same message by both RMHs.

Receive Request Header Transmittal

Upon receipt of an SO from an AMH in response to the SR, the RMH (1) transmits the header as a receive request message to the source RM, (2) prepares to receive the requested data message from the source RM, (3) drops its ready state, and (4) remains busy (ARDY and BRDY discretes in the false state) for the duration of the message transfer. In the busy state, the RMH will accept only the data message that was requested. When the header is transmitted, the CU receives an encoder transmitting interrupt (ENCI) from the encoder/decoder. An error will be flagged if the CU does not receive this interrupt within 20 microseconds.

Source RMH Initial Responses

Upon receipt of the relayed request, the IF1 (interface no. 1) card in a source RMH identified in the request for data (receive request message) generates a relayed request interrupt (RRI) for its CU and E/D. The RRI causes this source RMH to drop its ready state, start modulating the data line with pre-data (front porch) modulation, and prepare to send the requested data to the sink RMH. When requests are received simultaneously from more than one AM port, selection logic allows a source response on only one AM port. The source RMH determines, by means of the MSGID and WDID in the request message, which message PROM segment to interrogate. The message PROM provides control information needed by the RMH to obtain and sequence the requested data.

Data Header Generation

The source RMH logic automatically starts front porch modulation on the data line in order to hold a path for the forthcoming data message transmittal. The forward header (FH) bit, in word O of the message PROM segment, indicates whether the request message header is to be forwarded to the user device. If FH equals 0, the header is forwarded. The data header fetch (DHF) bit in the message PROM determines whether the data header is supplied by the message PROM (DHF = 1) or by the source user via an IOU (DHF = 0). The addressing required to obtain the header from the user (IQM address and subaddress), if applicable, is also contained in the message PROM. The data header bits are loaded into an output register, encoded by the E/D, and transmitted to the sink RMH.

Generation of Data Words

The source RMH obtains the requested data words one at a time by consecutively reading the various module address and subaddress words, stored in the message PROM, to select the specific data source(s). The IOUs specified by the IOU select bits in the module address words responds with the data. Each data word received from an IOU is encoded and transmitted to the sink RMH. This sequence continues until an EOM is detected in the message PROM. An EOM is a word consisting of all ones. In certain cases, a block transfer may be programmed in the message PROM and used instead of this multiple address/subaddress type of transfer.

Sink RMH Responses To Data Messages

When the sink RMH receives the data header from the source RMH, the RMH compares the data header against the request header itself. The sink will check the data header forward (FDH) bit in the sink message PROM. If the FDH bit is set (FDH = 0) in the message PROM, the header is forwarded to the user via the sink IOU, specified in the message PROM. If the headers are not equal, an error is flagged and the transfer is aborted; i.e., the RMH continues to accept the message transmission but does not forward the data words to the IOU. If the message PROM programmed for a retry, a retry is initiated for the same message after the faulty transfer is completed. If the headers are equal, the data words are forwarded to the IOU along with their applicable addressing obtained in consecutive order from the message PROM. When the EOM word in the PROM is reached, no additional data words should be received. If data words continue to arrive, an error flag is set to indicate a long message transfer error. If applicable, block transfer may be used at the sink RM instead of this multiple address/subaddress type of transfer, whether or not block transfer was used at the source RM.

Source-RMH-Initiated Periodic Message Transfers

Each source-RMH-initiated periodic message transfer (Figure 8-9) requires that a transmit request message be generated by an RMH that will source the data message. A transmit request message is a one-word control message consisting of a transmit request word (Figure 8-8). A transmit request word consists of a request header (bits 1 through 16) and a parity bit (bit 17). A transmit request word requests the sink RMH to accept a data transmission from the source RMH.

Periodicity Control

Periodicity control of source-RMH-initiated periodic message transfers is performed as previously described except the next transmit request MSGID is placed in the service queue instead of the next receive request MSGID.

Transmit Request Header Generation

The transmit request header is generated in the same way that a receive request header is generated except the IOU and user device involved are sources instead of sinks.

SO Acquisition

An SO is acquired from an AMH as previously described.

Transmit Request Header Transmittal

The source RMH transmits the transmit request header as a transmit request message in the same way that a receive request message is transmitted except the RMH will wait for a one-word acknowledge message from a sink RMH instead of a data message.

Sink RMH Initial Responses

Upon receipt of the relayed transmit request, the IF1 card in a sink RMH identified in the transmit request message generates a relayed request interrupt (RRI) for its CU and E/D. The RRI causes this sink RMH to drop its ready state, start modulating the data line with predata modulation, and prepare to send an acknowledge message to the source RMH. When requests are received simultaneously from more than one AM port, selection logic allows a source response on only one AM port. The sink RMH determines, by means of the MSGID specified in the transmit request message, the applicable message PROM segment to use. If the forward header (FH) bit in the message PROM equals 0, the request header is forwarded to the user device.

Generation Of Acknowledge Message

The acknowledge fetch (AKF) bit in the message PROM determines whether the acknowledge word is supplied by sink RMH hardware (AKF = 1) or by the sink user via the IOU (AKF = O). Addressing required to fetch the acknowledge word from the sink user, if applicable, is also contained in the message PROM. In either case, the sink IOM is addressed by the sink RMH to determine its readiness to accept data. If the IOM is ready to receive data, an acknowledge discrete (IOMACK) is sent to the TIB in the IOU, acknowledging receipt of the addressing. If the IOM does not send an IOMACK, the TIB will issue an error discrete (IO SUM ERROR) to the sink RMH. If an IOU SUM ERROR is not found in the BITE monitor, the RMH enables the appropriate encoder to transmit the acknowledge message to the initiating RM. An acknowledge message includes an RMID (= self ID), an MSGID (= sink MSGID), and a WID (= 2). After transmittal of the acknowledge message, the sink RMH waits for the source RMH to transmit the data message (data header followed by the data words). If the header does not arrive, a no response error is flagged for this message and a receive request is generated to obtain the missing data if the message PROM is programmed for re-request.

Generation Of Data Words

When the source RMH receives the acknowledge message, it begins front porch modulation and starts processing the data header. If the DHF bit is set in the message PROM, an IOU is addressed to obtain the header. If DHF is not set, the header bits are constructed by source RMH hardware. The source RMH checks the acknowledge word, sends the word to an IOU if the forward acknowledge (FAK) bit is set (FAK = 0) and then transmits the data header to the sink RMH. The header contains RMID (= self ID), MSGID (= source MSGID), and WID (= 0). The source RMH then addresses the source IOU(s) to fetch the data words that will complete the data message. The addressing bits are obtained by the CU from the message PROM. The data words are transmitted to the sink RMH as they are received from the IOU(s). When the CU detects an EOM in the message PROM, there are no additional addresses/subaddresses to be sent to the IOU(s) and the data transmission terminates. If applicable, block transfer may be used instead of this multiple address/subaddress transfer.

Sink RMH Responses To Data Message

The sink RMH processes the data message received as previously described.

Sink-Initiated Aperiodic Message Transfers
Each sink-initiated aperiodic message transfer is executed on an as required basis in response to an EMR or an RCM. An EMR is generated locally by a user device serviced by an IOU which is connected to the RM which contains the message PROM to be controlled. An RCM functions like an EMR but originates remotely. Both an EMR and an RCM each includes an MSGID code and a control action (CA) code. The MSGID code identifies a message by its message PROM segment. The CA code specifies the action to be taken on the message by the addressed RMH. If CA specifies that the message be enabled, the MSGID is enabled to be placed in the service queue and the sink-RMH-initiated periodic message transfer procedure is performed when the MSGID for this message is read out of the service queue.

Source-Initiated Aperiodic Message Transfers
Each source-initiated aperiodic message transfer (Figure 8-9) is initiated and executed in the same manner as sink-initiated transfers however; the source-RMH-initiated periodic message transfer procedure is performed when the MSGID for this message is read out of the service queue instead of the sink-RMH-initiated periodic procedure.

8.1.17 RM Physical Construction
The RM assembly is packaged in a single enclosure. See Figure 8-17. The enclosure contains two RM halves (RMH) that are electrically and functionally identical but independent of each other except for their cross-reporting of BITE data and interactive servicing of messages. One RMH is designated RMH A and the other half is designated RMH B.

Subassemblies
The enclosure houses 10 logic modules, two power supplies, two EMI AC line filters, one fan assembly, one module MIB, and two control panels. Each RMH has five logic modules, one power supply, one EMI AC line filter, one control panel and shares the fan assembly and module MIB with the other RMH.

Control Panel
Two identical control panels for RMH A and RMH B are located on the enclosure front panel. The controls for operating and monitoring each RMH consist of a circuit breaker which acts as an AC power on/off switch, an AC power on indicator, a DC power on/off switch and indicator, an elapsed time meter to record the total AC power operating time, and test controls.

MIB

Interconnection within the enclosure is made with an MIB and hard-wired interconnections. The MIB interconnects the RMH A and RMH B modules, power supply, and fan assembly. There are 15 external interface connectors located on the interface connector panel.

Model Keying

Two variable index keys are located on each MIB module connector and on each module connector with matched coding to prevent insertion of the wrong type of module. The matched coding on the keying devices are coded for only one type of module. The keying arrangement prevents inserting the wrong module type sufficiently to make electrical contact. Sixty-four keying codes are possible.

Mounting

The RM is packaged in an aluminum housing that is designed for bulkhead or base mounting. The housing size, weight, power requirements and general information are shown in Figure 8-17.

Cooling

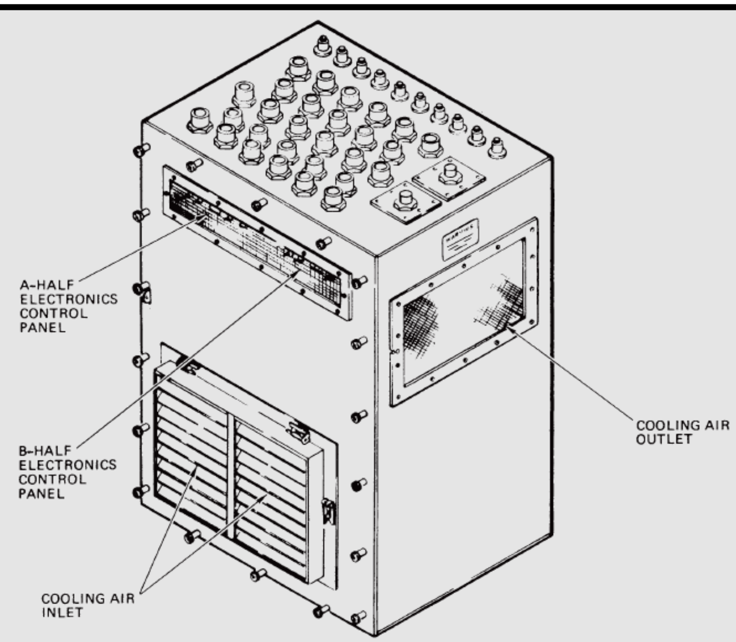
Cooling is accomplished by internal AC fans. The inlet air enters the housing through a louvered opening, an EMI/RFI screen, and an air filter, mounted on the front door. The air is directed over the modules by means of a plenum system. The air is exhausted through an EMI/RFI screen and opening in the right side of the housing as viewed from the front.

Security Provision

The RM enclosure is provided with a built-in locking device to prevent access to the PROM modules by unauthorized personnel. A seven pin tumbler cylinder in a conventional key operated locking cam engages a notch on the module, securing the module in the housing. The lock assembly is permanently mounted in the bottom flange of the module housing. This seven tumbler lock has seven different biting locations on each key with seven different depths available on each location. This allows over 80,000 key changes. A special code-changer key allows fast, accurate, no disassembly changing of tumbler combinations within the equipment while the equipment is in service. The memory PROM module boards contain covers that secure the memory PROMs. This cover is secured to the module with tamper proof screws. The head on the screws is hexagonal requiring a special tool for removal. This PROM cover prevents tampering with or removing a plug-in PROM while the module is in place in the housing. This tamper proof screw head and a special tool restricts changing of PROM's to those technicians having a key for module removal and a special tool for removal of the PROM cover assembly. For further security, the front door is capable of being locked with a standard padlock.

8.1.18 Area Multiplexers (AM) Overview

(See Figure 8-20). The purpose of the AM (PN 10740-514-X) is to interface groups of remote multiplexers (RMs) to the primary buses. Each AM is dual-redundant, consisting of two halves (AMHs). The AMHs of an AM are functionally and electrically independent of each other except for their cross-reporting of BITE data. Each AMH provides 14 RMH connections so that a dual AM can service up to seven dual RMs on a quad-redundant interconnection basis.



EQUIPMENT CONFIGURATION	
INPUT POWER A-HALF AND B-HALF EACH: PRIMARY: 115V, 1 PH, 60 Hz, 375 WATTS MAX (INCLUDES FANS) EMERGENCY: 110 TO 130 VDC, 347 WATTS MAX	DIMENSIONS (INCHES), WEIGHT (LBS): UNCRATED* / CRATED HEIGHT 29.41 / 43.50 WIDTH 21.50 / 28.50 DEPTH 17.68 / 24.75 WEIGHT 240.00 / 342.00
COOLING: AC-POWERED INTERNAL FANS: FOUR FANS TWO FOR A-HALF, TWO FOR B-HALF 14 WATTS EACH	SECURITY PROVISION: CAPABILITY OF PADLOCKING FRONT DOOR
ENVIRONMENT: OPERATING / STORAGE TEMPERATURE 0 TO 50°C / -62 TO 71°C RELATIVE HUMIDITY 0 TO 95% / 0 TO 95%	DESCRIPTION DATA: OFFICIAL NOMENCLATURE: MULTIPLEXER, AREA TD-1319A/USQ-82(V) MANUFACTURER'S NOMENCLATURE: AREA MULTIPLEXER PART NUMBER 10740-514-11 MANUFACTURER'S CODE 94756
MOUNTING PROVISIONS: BULKHEAD ONLY	
REDUNDANT CONSTRUCTION: TWO IDENTICAL FUNCTIONAL UNITS PACKAGED IN A SINGLE ENCLOSURE	*DIMENSION WITH LIFTING EYES REMOVED

Figure 8-20. Area Multiplexer (AM).

Functional Summary

Each AMH (Figures 8-21 and 8-3) houses 14 circuit cards: five RF transceivers, five cable controllers, one queue, two remote interface units (RIUs), and a BITE monitor. In order to simplify the description of AM operation, the interaction of AMHs and ARMs is not covered in this functional summary but is covered in the summary for the ARM (LHD only) later.

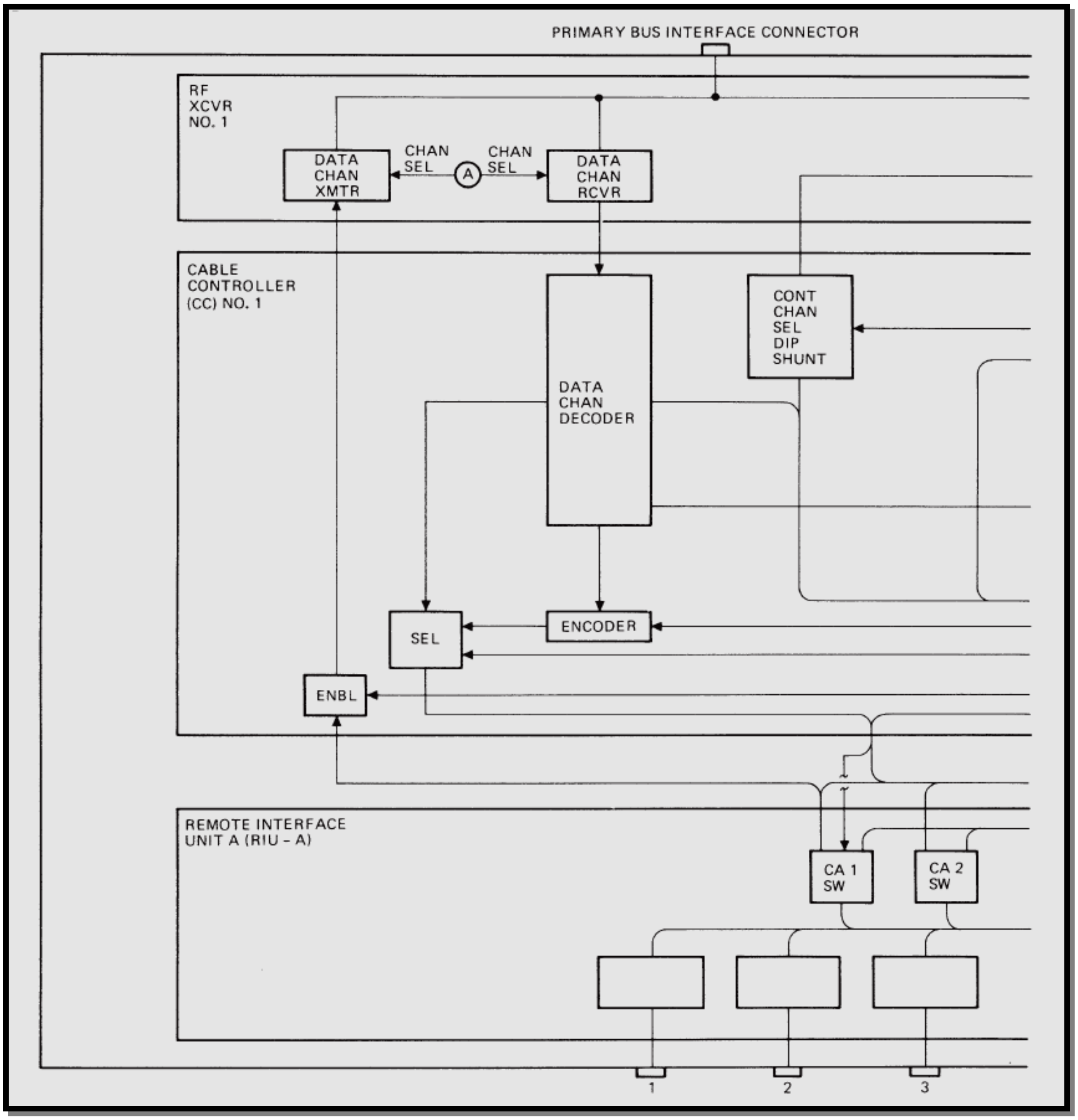


Figure 8-21. AMH Block Diagram (Sheet 1 of 2).

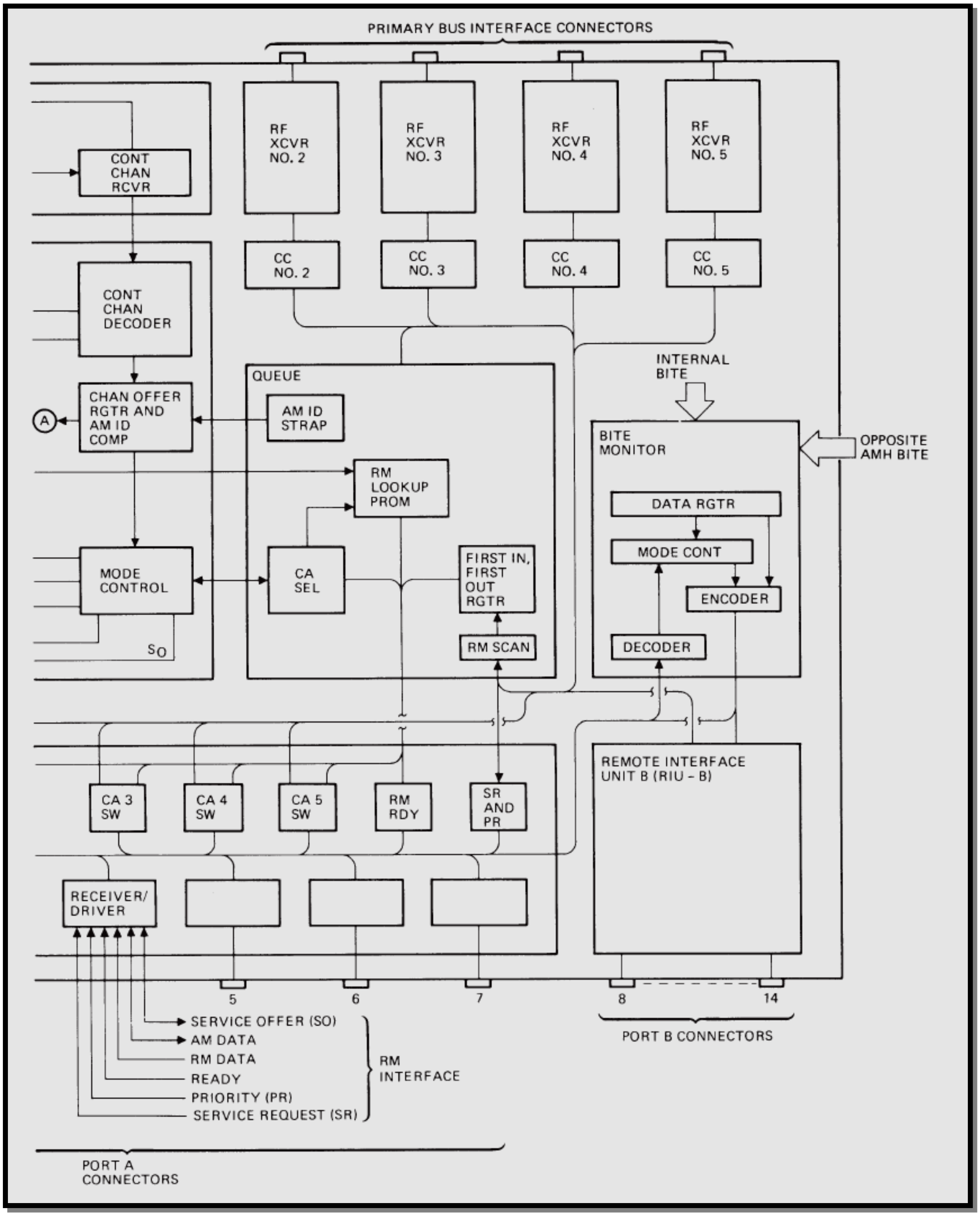


Figure 8-21. AMH Block Diagram (Sheet 2 of 2).

External AM Interfaces/RM Interfaces
Message transmittal is initiated when an RM issues an SR discrete and a priority (PR) discrete to the four connected AMHs. The message request is be transmitted by one of the RMHs to the first AMH to respond with a SO. In case of a tie, the RMH transmits the message through its primary port. When a message request is transmitted from one RM to another, each RMH of the responding RM may attempt to service the message but logic contained in each RMH permits only one of the two to respond with the requested data.

Primary Bus Interfaces
Via primary bus interfaces, the AMHs receive channel offers from the TCs and message data from other DMS units which are to be relayed to RMs. Channel offers are matched with service requests from RMHs and result in service offers to the RMHs so that they can initiate message transfer. Relayed message requests are forwarded to RMHs so that they can respond to message transfers which were initiated by other DMS units.

8.1.19 AM Functions

SR Buffering
The AMH encodes and stores the SR received from the RMH into a RAM and either a high-priority FIFO register or a low-priority FIFO register, depending on the priority indicated by the PR discrete. In response to TC channel offers (COs) addressed to the AMH, the AMH issues SOs to the applicable RMHs that have SRs, in accordance with the SR priorities and the sequence in which the SRs are received. If an RMH stops issuing an SR or if the RMH is busy (not ready) when an SO can be provided, or if an SO is issued to the RMH, the SR is deleted from the RAM and from the applicable FIFO register. In order to avoid ignoring low-priority SRs when the AMH becomes busy with high-priority SRs, a counter counts the SOs issued and causes a low-priority SR to be serviced after 15 consecutive high-priority SRs are serviced.

SO Generation and Transceiver Tuning
The SO issued by the AMH to the service requesting RMH is only a discrete signal and therefore does not specify the channel and primary bus that is offered. However, the logic in the AMH is switched to a configuration that allows the message from the RMH to be transmitted through a path that places the message onto the vacant channel specified in the CO message that was received through a primary bus from a TC. The CO is decoded by the decoder of the cable controller connected to this primary bus. A channel offer available (COA) signal, issued by the mode control to the cable selector on the queue module, indicates that a CO addressed to this AMH has been received on this bus. In addition, the mode control issues an SO to the RIUs. The RIU connected to the requesting RMH will route the SO to the RMH in accordance with control provided by the queue module.

At the same time, the channel select signals are issued by the CO register to the data channel receiver and transmitter to provide vacant channel tuning control, in order to establish a two-way communications path for the control message(s) and data message. This tuning is also accomplished by all other AMHs on this primary bus that are not busy in order to be able to respond to the forthcoming message from the initiating RMH.

RMH Linkup

The COA received by the queue module is converted into cable select signals to activate the applicable cable switch in the RIU module. This cable switch establishes a path from the RMH to the data channel transmitter. The SO from the mode control is routed through the cable switch to the RMH under control of RMH address bits provided by the FIFO register on the queue module. The message that the RMH transmits, in response to receipt of the SO, is routed through this path that has been established and is sent over the offered bus data channel.

Message Transmittal From AM To AM

The message request received from the RMH is transmitted by the transmitter in the AMH to all other AMHs connected to the primary bus. Each of these AMHs receives and decodes the message request, unless busy, and determines whether the RMID contained in the message is in the lookup PROM. If the RMID is in the lookup PROM, this means that the addressed RMH is connected to the AMH. Each AMH (four each in a redundant system) that finds the RMID in the lookup PROM attempts to forward the message to the addressed RMH. The RMH address bits are provided to the cable switch by the lookup PROM on the queue module. Successful forwarding of the message by one of these AMHs causes a not ready (busy) signal to be received from the RMH by the other AMHs. The RMH port that successfully receives the request message immediately responds with modulations followed by the requested data message. The AMs that do not receive an RMH response reset to process the next channel offer and request message.

BITE Functions

The BITE monitor card of each AMH receives and records BITE data from the other cards of the AMH and also certain critical BITE data from its opposite AMH. The recorded BITE information is forwarded to the MU in response to periodic MU time meter data requests from the MU. The communication process between the MU and the AMH is similar to that between RMHs except that the MU is always the initiator, functioning like an AMH addressing another AMH. The addressed AMH routes the MU data request, through the RIU specified in the request, to the BITE card monitor. If the primary/ alternate (P/A) bit is a 1, RIU-A is specified. If the P/A bit is a 0, RIU-B is specified. The BITE monitor card responds by sending the type of data specified in the request and waits for additional requests before reinitializing its registers. The BITE monitor data messages to the MU are routed through the same cable switch through which the data request was routed.

8.1.20 AM Physical Construction

The AM assembly is packaged in a single enclosure. The enclosure contains two AM halves (RMH) that are electrically and functionally identical but independent of each other except for their cross-reporting of BITE data and interactive servicing of messages. One AMH is designated AMH A and the other half is designated AMH-B.

Subassemblies

The enclosure houses 18 logic modules, 10 RF modules, two power supplies, two EMI AC line filters, one fan assembly (4 fans), three master interconnection boards (MIBs) and two control panels. Each AMH has nine logic modules, five RF modules, one power supply, one EMI AC line filter, one control panel, two fans, and shares the three MIBs.

Control Panel

Two identical control panels, for independent control of AMH A and AMH B, are located on the enclosure front panel. The controls for operating and monitoring each AMH consist of a circuit breaker which acts as an AC power on/off switch, an AC power on indicator, a DC power on/off switch and indicator, an elapsed time meter to record the total AC power operating time, and test controls.

MIB

Interconnection within the enclosure is made with three MIB's and ribbon cables which are part of the MIBs. The logic MIB assembly electrically interconnects the logic modules and the fan. The RF MIB assembly electrically interconnects the RF CCAs and power supplies. Ten coaxial primary bus stub connectors on the back of the RF MIB interface the RF modules with the 10 external coaxial connectors. The interface board assembly MIB interconnects the RMs to the logic MIB. There are 28 external RM interface connectors located on the interface connector panel. The 28 interface board assembly connectors, 10 RF coaxial connectors, and 2 AC power connectors are all mounted on the topside of the enclosure.

Module Keying

Two variable index keys are located on each logic MIB module connector and two on each module connector with matched coding to prevent insertion of the wrong type of module. The matched coding on the keying devices are coded for only one type of module. The keying arrangement prevents inserting the wrong module type sufficiently to make electrical contact. Sixty-four keying codes are possible.

Mounting

The AM is packaged in an aluminum housing that is designed for bulkhead or base mounting.

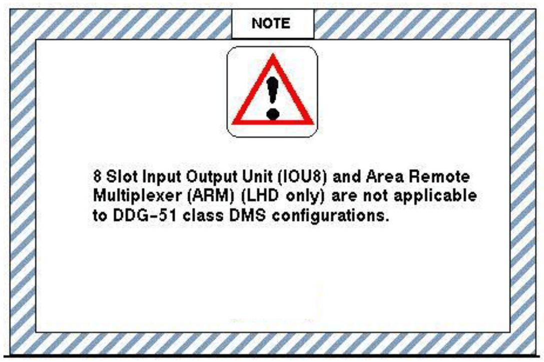
Cooling

Cooling is accomplished by internal AC fans. The inlet air enters the housing through a louvered opening, an air filter, and an EMI/RFI screen mounted on the front door. The air is directed over the modules by means of a plenum system. The air is exhausted through an EMI/ RFI screen and opening in the right side of the housing as viewed from the front.

Security Provision

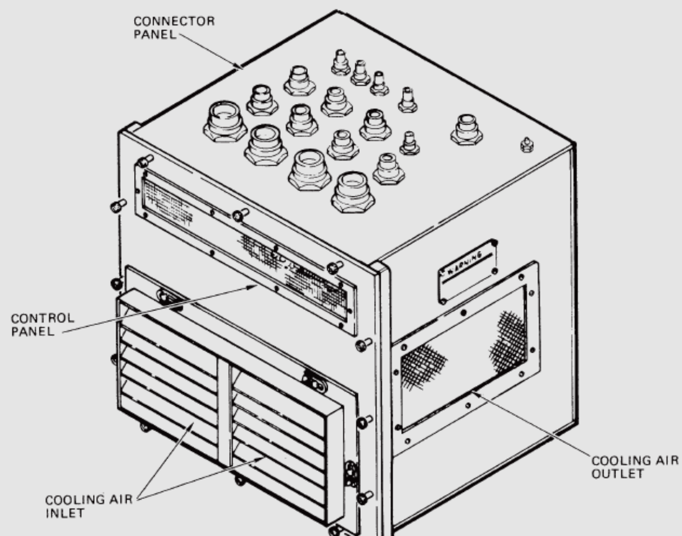
The AM front door is capable of being locked with a standard padlock.

8.1.21 Area Remote Multiplex (ARM) (LHD Only) Overview



See Figure 8-22. The purpose of the ARM (LHD only) is to interface IOUs and IOMs internal to the ARM (LHD only) IOU8s, and with each other. Each ARM (LHD only) IOU8 may house a maximum of four IOMs enabling the ARM (LHD only) to interface directly with user devices. To form a redundant system, two ARMs (LHD only) are cross-connected and function as a pair to provide dual-redundant communications terminals. Functionally, ARMs (LHD only) are composites of IOUs and RMHs operating in the turnaround mode. Paired ARMs (LHD only) are electrically and functionally identical but independent of each other except for their coordinated message servicing and cross-coupled BITE data reporting efforts. In a given redundant ARM (LHD only) pair, one ARM (LHD only) is designated ARM A (LHD only) and the other is designated ARM B (LHD only). ARM A (LHD only) interfaces with the A-ports of up to three IOUs. ARM B (LHD only) interfaces with the B-ports of up to three IOUs. In addition, ARM A (LHD only) and ARM B (LHD only) may each contain up to four internal IOMs and interface with user devices.

Each ARM (LHD only) attempts to transfer incoming data, received from a IOU or a user, as quickly as possible, but coordinates with the redundant ARM (LHD only) to avoid duplicating the efforts of the redundant ARM (LHD only) if the redundant ARM (LHD only) responds more quickly. In addition to monitoring IDs of each other to avoid servicing the same message, the ARMs (LHD only) of an ARM (LHD only) pair synchronize their operation by using opposite phases of the same clock. This allows time for one ARM to inhibit the other's transfer of the same message if both are attempting to process the message simultaneously. At present, ARMs (LHD only) only serve as a turnaround loop for linking two IOMs together. The associated message PROMs are programmed for this local turnaround service.



EQUIPMENT CONFIGURATION

INPUT POWER:
PRIMARY: 115V, 1 PH, 60 Hz, 650 WATTS MAX (INCLUDES FANS)
EMERGENCY: 110 TO 130 VDC, 622 WATTS MAX

COOLING:
AC-POWERED INTERNAL FANS: TWO FANS 14 WATTS EACH

ENVIRONMENT:

	OPERATING	STORAGE
TEMPERATURE	0 TO 50°C	-62 TO 71°C
RELATIVE HUMIDITY	0 TO 95%	0 TO 95%

MOUNTING PROVISIONS:
RACK, BASE, AND BULKHEAD

REDUNDANT CONSTRUCTION:
TWO ARMS INTERCONNECTED FORM A REDUNDANT FUNCTION

DIMENSIONS (INCHES), WEIGHT (LBS):

*10950-514-61	UNCRATED	CRATED
HEIGHT	18.73	28.50
WIDTH	19.00	29.25
DEPTH	17.71	24.78
WEIGHT	135.00	204.00

**10950-514-61	UNCRATED	CRATED
HEIGHT	17.48	26.50
WIDTH	19.00	28.25
DEPTH	18.96	28.50
WEIGHT	135.00	210.00

SECURITY PROVISION: CAPABILITY OF PADLOCKING FRONT DOOR

DESCRIPTION DATA:
OFFICIAL NOMENCLATURE: MULTIPLEXER, TD-1320(V)1/(USQ-82(V)
MANUFACTURER'S NOMENCLATURE: AREA-REMOTE MULTIPLEXER
PART NUMBER 10950-514-61
MANUFACTURER'S CODE 94756

* CONNECTOR PANEL MOUNTED ON TOP SIDE
** CONNECTOR PANEL MOUNTED ON REAR SIDE

Figure 8-22. Area Remote Multiplexer (ARM).

8.1.22 Functional Summary

An ARM (Figure 8-23) (LHD only) houses a minimum of 6 circuit cards (no optional circuit cards installed) and a maximum of 14 circuit cards (all optional circuit cards installed). The 8 optional circuit cards allow for expansion of the ARM (LHD only). The 6 required circuit cards consist of 2 cable controller cards, a control unit (CU) comprised of CU1 and CU2 controller unit cards, and 2 interface cards (1F1 and 1F2). The 8 optional circuit cards consist of 3 RF transceivers, one cable controller, and 4 IOMs. Four of the optional cards (exclusive of the IOM cards) would be used as necessary in a DMS configuration that requires the ARM to interface with the RF Bus(es).

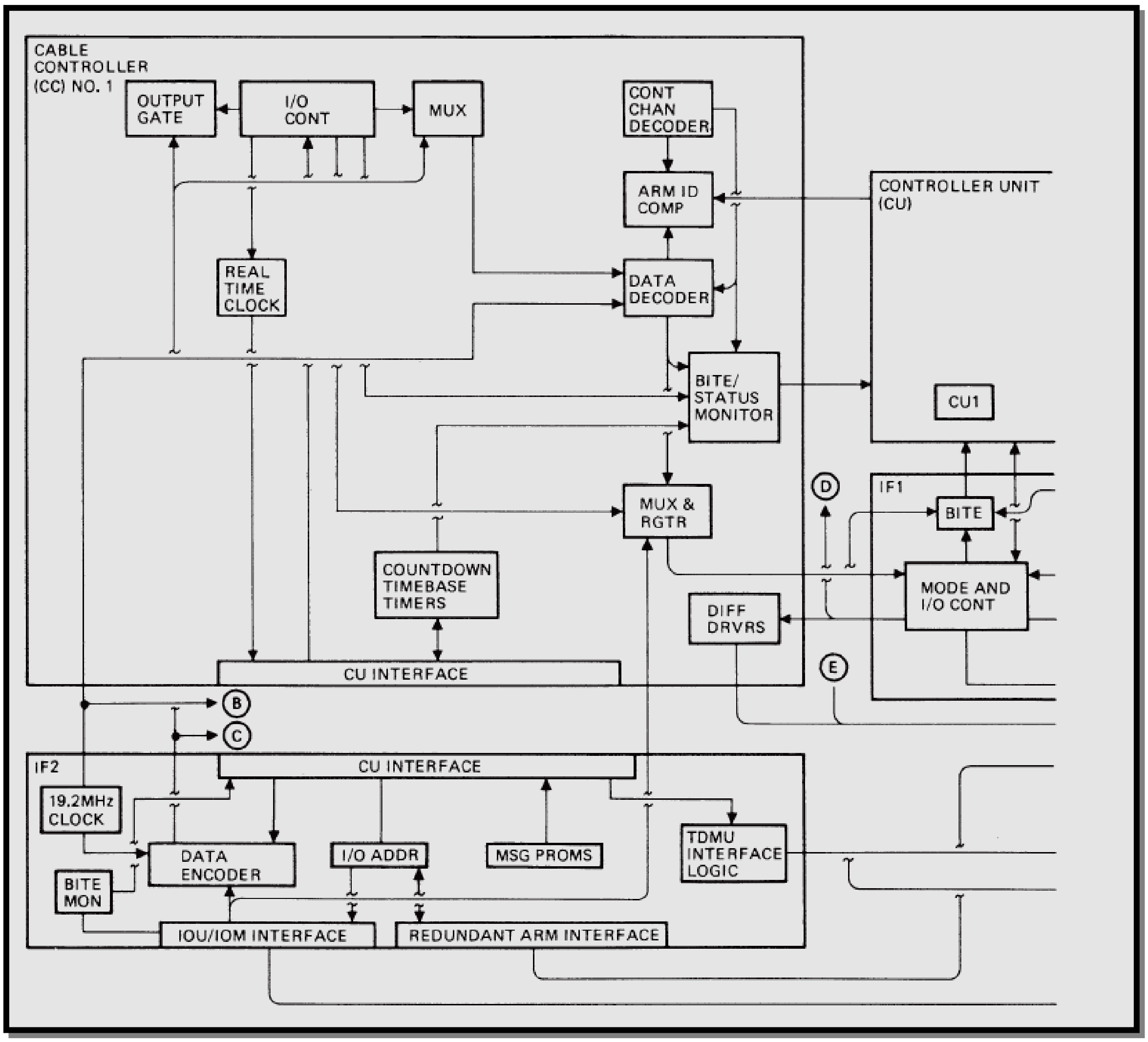


Figure 8-23. ARM Block Diagram (Sheet 1 of 2).

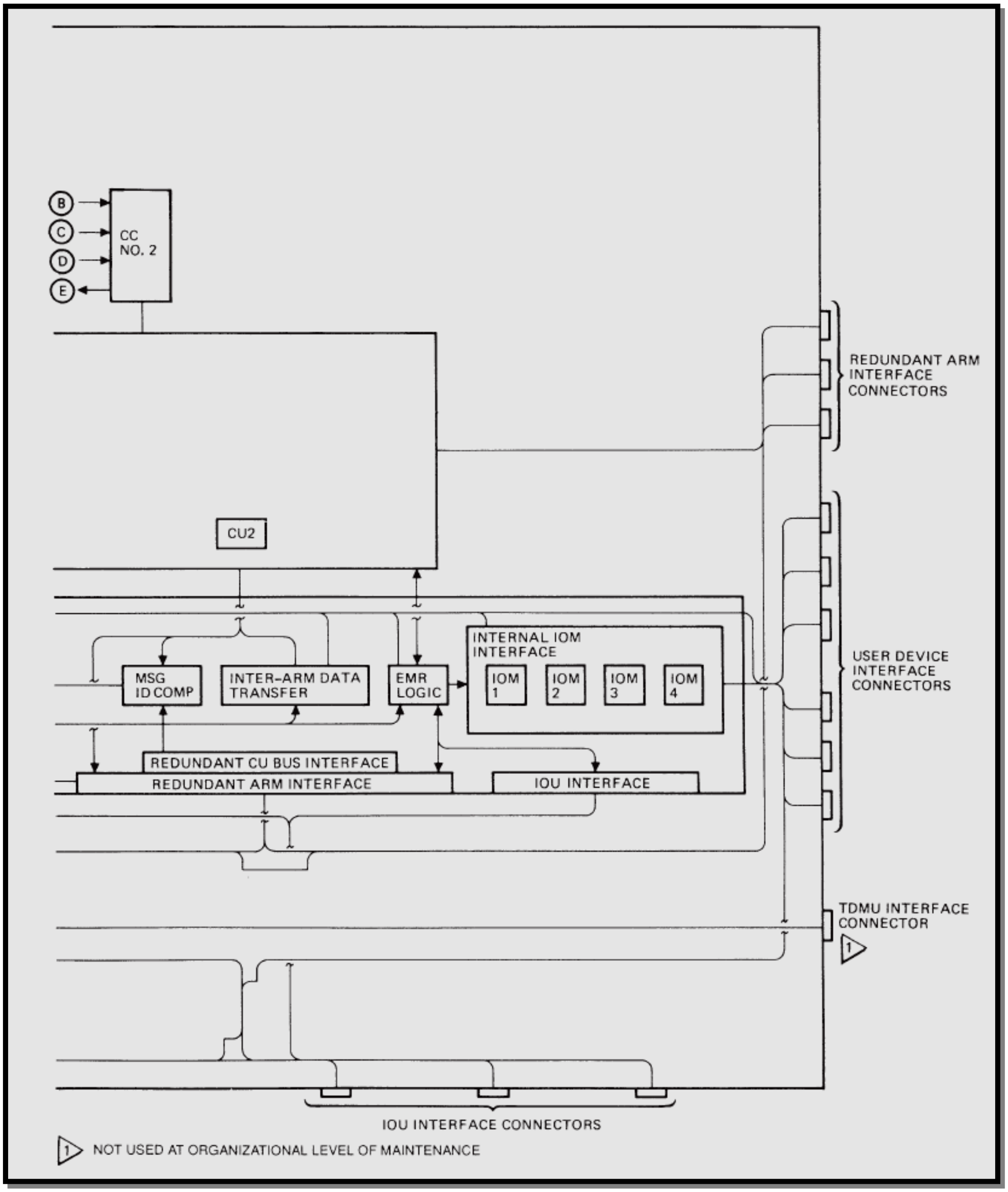


Figure 8-23. ARM Block Diagram (Sheet 2 of 2).

IOU Functions

IOUs function with ARMs (LHD only) as they do with RMHs as previously described.

ARM Function/Multiplexing and Demultiplexing

A source ARM multiplexes incoming data words from IOUs and/or from internal IOMs into data messages. Conversely, a sink ARM (LHD only) demultiplexes incoming data messages and forwards the data words of these messages to the applicable IOUs/IOMs, using the module addresses and subaddresses provided by its message PROMs. The relation between PROM IOM addresses and physical IOU IOM slots is given in Table 8-7. (In the message PROMs, IOMs internal to the ARM (LHD only) are considered to be in IOU number 0.) A given ARM (LHD only) may function at times as a source terminal and at times as a sink terminal, depending on application and firmware and the specific message transfers in which the ARM (LHD only) becomes involved.

Message PROM IOM Address *	ARM (LHD only) Slot REF DES.	IOU8 Slot REF DES.	IOU16 Slot REF DES.
0	XA12**	XA03	XA01
1	XA13**	XA04	XA02
2	XA14**	XA05	XA03
3	XA15**	XA06	XA04
4	XA12***	XA07	XA05
5	XA13***	XA08	XA06
6	XA14***	XA09	XA07
7	XA15***	XA10	XA08
8			XA11
9			XA12
10			XA13
11			XA14
12			XA15
13			XA16
14			XA17
15			XA18

* IOM address, bits 0 through 3 of word 7.
** IOM slots for primary ARM.
*** IOM slots for alternate ARM (LHD only).

Table 8-7. Message PROM IOM Address Relationship to ARM (LHD only) and IOU Slots

Message Initiation and Controls

ARM (LHD only) message initiations and controls are the same as those for RMHs.

Message PROMs

The quantity and general functions of the ARM message PROMs are the same as described for the RMH message PROMs.

Sink-ARM Initiated Periodic Message Transfers

Each sink-ARM (LHD only) initiated periodic message transfer begins with a receive request message generated by an ARM that will sink the requested data. A receive request message is a one-word control message consisting only of a request header (bits 1 through 16 and a parity bit, bit 17). A receive request message requests a data message from a source ARM (LHD only).

Periodicity Control

The CU in the sink ARM (LHD only) uses a time base countdown timer and the real time clock, contained on cable controllers no. l and no. 2, to generate interrupts that cause the CU to (1.) determine the next periodic receive request MSGID to be placed in the service queue and (2) place this MSGID into the queue. The timer and the real time clock on the cable controller no. 3 (when installed) are not used. For each message initiated by this ARM(LHD only), one of the two time-based countdown timers is loaded (set) by the CU to count down to zero and generate an interrupt in accordance with time bits obtained from the message PROM segment for the associated message. These time bits determine (1) the update interval (periodicity) of the message, (2) the number of retries to be attempted if the transfer is unsuccessful, and (3) the delay time between retries. The service queue consists of portions of the CU firmware and hardware, including the data RAM, and determines the servicing sequence for messages whose MSGIDs are placed into the queue. The sequence, in which the messages are serviced, based on a combination of priority and FIFO consideration, is determined by the CU program. Controller logic does not allow low-priority messages to be totally ignored during heavy traffic periods.

Source ARM (LHD only) Initial Responses

A sink ARM (LHD only) can request data from a source ARM (LHD only). The pulse used for request interrupt (RI) is generated in the data decoder section of the cable controller module. This pulse goes to logic in IF2. If successful, the 1F1 card in a source ARM (LHD only) identified for data (receive request message) generates a RI for the CU. The RI causes this source ARM (LHD only) to drop the ready state and prepare to send the requested data to the sink ARM (LHD only). In addition, this source ARM inhibits the redundant ARM from servicing this request. The source ARM (LHD only) determines, by means of the MSGID and WID in the request message, which message PROM segment to interrogate. The message PROM provides control information needed by the ARM (LHD only) to obtain and sequence the requested data.

Generation Of Data Words

The source ARM (LHD only) obtains the requested data words one at a time by consecutively reading the various module address and subaddress words stored in the message PROM, and addressing the appropriate source IOUs/IOMs. The IOUs/IOMs specified by the IOU select bits in the module address words respond with the data. As each data word is received from an IOU/IOM, the word is encoded and forwarded to the sink ARM (LHD only). This sequence continues until an end of message EOM is detected in the message PROM. An EOM is a word consisting of all ones. In certain cases, a block transfer may be programmed in the message PROM and used instead of this multiple address/subaddress type of transfer.

Sink ARM (LHD only) Responses To The Data Messages

When the sink ARM receives the data header from the source ARM (LHD only), the sink ARM (LHD only) checks the header by comparing the header against the request header and forwards the header to the user via the sink IOU/IOM if the FDH bit is set (FDH = 0) in the message PROM. The latter operation is implemented by sending the header out to the IOU/IOM along with the data header forwarding address specified in the message PROM. If the headers are not equal, an error is flagged and the transfer is aborted; i.e., the ARM (LHD only) continues to accept the message transmission but does not forward the data words to the IOU/IOM. A retry is initiated for the same message after the faulty transfer is completed if programmed for retry. If the headers are equal, the data words are forwarded to the IOU/IOM along with their applicable addressing obtained in consecutive order from the message PROM. When the EOM word in the PROM is reached, no additional data words should be received. If data words continue to arrive, an error flag is set to indicate a long message transfer. If applicable, block transfer may be used instead of this multiple address/subaddress type of transfer.

Source ARM (LHD only) Initiated periodic Message Transfers

Each source-ARM (LHD only)-initiated periodic message transfer requires that a transmit request message be generated by an ARM (LHD only) that sources the data message. A transmit request message is a one-word control message consisting of a request header (bits 1 through 16 and a parity bit, bit 17). A transmit message word requests the sink ARM (LHD only) to accept a data transmission from the source ARM (LHD only).

Periodicity Control

Periodicity control of source-ARM(LHD only)-initiated periodic message transfers is performed as described previously, except the next transmit request MSGID is placed in the service queue instead of the next receive request MSGID.

Transmit Request Header Generation

The transmit request header is generated in the same way that a receive request header is generated except the IOU/IOM and user device involved are sources instead of sinks.

Transmit Request Header Transmittal

The source ARM (LHD only) transmits the transmit request header as a transmit request message in the same way that a receive request message is transmitted except the ARM (LHD only) waits for an acknowledge message from a sink terminal instead of a data message.

Sink ARM (LHD only) Initial Responses

The pulse used for RI is generated in the data decoder section of the cable controller module. This pulse goes to logic in IF2. If successful, the IF1 card in a sink ARM (LHD only) identified in the transmit request message generates an RI for the CU. The RI causes this sink ARM (LHD only) to drop the ready state and prepare to send an acknowledge message (the WID in the request message flags this as a transmit request) to the source ARM (LHD only). In addition, this sink ARM (LHD only) inhibits the redundant ARM (LHD only) from servicing this request. The sink ARM (LHD only) determines, by means of the MSGID in the transmit request message, the applicable message PROM segment to use. If the FH bit in the message PROM equals 0, the request header is forwarded to the user device.

Generation Of Acknowledge Message

The AKF bit in the message PROM determines whether the acknowledge word is supplied by the sink ARM (LHD only) (AKF=1) or by the sink user via the IOU/IOM (AKF=0). Addressing required to fetch the acknowledge word from the sink user, if applicable, is also contained in the message PROM. In either case, the sink IOU/IOM is addressed by the sink ARM (LHD only) to determine ready/busy status. If the IOM in an IOU can communicate, the IOM sends an acknowledge discrete (IOMACK) to the TIB in the IOU, acknowledging receipt of the addressing. If the IOM does not send an IOMACK, the TIB issues an error discrete (IOUERR(n)) to the sink ARM (LHD only). If an internal IOM fails to send an IOMACK after being addressed, BITE logic in IF2 issues an IOUERR0 to the IF1 BITE monitor to flag this condition. If an IOUERR(n) is not found in the BITE monitor, the ARM (LHD only) loads the acknowledge word bits into an output register for encoding and transmittal to the source ARM (LHD only) as an acknowledge message. An acknowledge message includes an ARMID (= self ID), a MSGID (= sink MSGID), and a WID (= 2). After transmittal of the acknowledge message, the sink ARM (LHD only) waits for the source ARM (LHD only) to transmit the data message (data header followed by the data words). If the header does not arrive, a no response error is flagged for this message, and a receive request is generated if the message PROM is programmed for re-request.

Generation Of Data Words

When the source ARM (LHD only) receives the acknowledge message, the ARM (LHD only) starts processing the data header. If the DHF bit is set in the message PROM, an IOU/IOM is addressed to obtain the header. If the DHF is not set, the header bits are constructed by the source ARM (LHD only). The source ARM (LHD only) checks the acknowledge word, sends the word to an IOU/IOM if required, and then transmits the data header to the sink ARM (LHD only). The header contains ARMID (= self ID), MSGID (= source MSGID), and WID (= 0). The source ARM (LHD only) then addresses the source IOU(s)/IOM(s) to fetch the data words that will complete the data message. The addressing bits are obtained by the CU from the message PROM. The data words are transmitted to the sink ARM (LHD only) as they are received from the IOU(s)/IOM(s). When the CU detects an EOM in the message PROM, there are no additional addresses/subaddresses to be sent to the IOU(s)/IOM(s) and the data transmission terminates. If applicable, block transfer may be used instead of this multiple address/subaddress transfer.

Sink ARM (LHD only) Responses To Data Message

The sink ARM (LHD only) processes the data message that is received as described previously.

Initiated Aperiodic Message Transfers

Each sink-initiated aperiodic message transfer is executed on an as required basis in response to an EMR or a RCM. An EMR is obtained locally from an IOM serviced by this ARM (LHD only). An RCM is transmitted by another ARM to a sink ARM by means of a source-initiated message transfer. Both an EMR and an RCM includes an MSGID code and a control action (CA) code. The MSGID code identifies a message and the applicable message PROM segment. The CA code specifies the action to be taken on the message by the addressed ARM. If CA specifies that the message be enabled, the MSGID is placed in the service queue and the sink-ARM (LHD only)-initiated periodic message transfer procedure is performed when the MSGID for this message is read out of the service queue.

Source Initiated Aperiodic Message Transfers

Each source-initiated aperiodic message transfer is initiated and executed in the same manner as sink initiated transfers except the source-ARM (LHD only)-initiated periodic message transfer procedure is performed when the MSGID for this message is read out of the service queue instead of the sink-ARM (LHD only)-initiated periodic procedure.

8.1.23 ARM (LHD only) Physical Construction

The ARM (LHD only) assembly is packaged in a single enclosure that is designed for bulkhead, rack, or base mounting. When configured for bulkhead mounting, the interface connector panel is assembled as the top panel of the enclosure. When the ARM (LHD only) is configured for mounting in a standard 19-inch electronic rack, the interface connector panel is assembled as the rear panel of the enclosure. When the ARM (LHD only) is required to be base mounted, the interfacing connector panel may be optionally assembled as either the top or rear enclosure panel.

Subassemblies

The enclosure houses seven logic modules, three RF modules, four input/output modules, a power supply, an EMI AC line filter, a fan assembly, two MIBs and a control panel.

Control Panel

The controls for operating and monitoring the ARM (LHD only) consist of a circuit breaker that acts as an AC on/off switch, an AC power indicator, a DC power on/off switch and indicator, an elapsed time meter to record the total AC power operating time, and test controls.

MIB

Interconnection within the enclosure is made with two MIBs and with flexible ribbon cables or hardwired cables which are part of one of the MIBs. The module MIB assembly electrically interconnects the modules, the power supply, and the fan. The interface MIB interconnects the IOUs, users, TDMU, and a redundant ARM (LHD only) to the module MIB. There are 17 external interface connectors located on the interface MIB panel. Inter-module pathways provide for data transfer between IOMs.

Module Keying

Two variable index keys are located on each MIB module connector and two on each module connector with matched coding to prevent insertion of the wrong type of module. The matched coding on the keying devices are coded for only one type of module. The keying arrangement prevents inserting the wrong module type sufficiently to make electrical contact. Sixty-four keying codes are possible.

Mounting

The ARM (LHD only) is packaged in an aluminum housing that is designed for rack, base, or bulkhead mounting.

Cooling

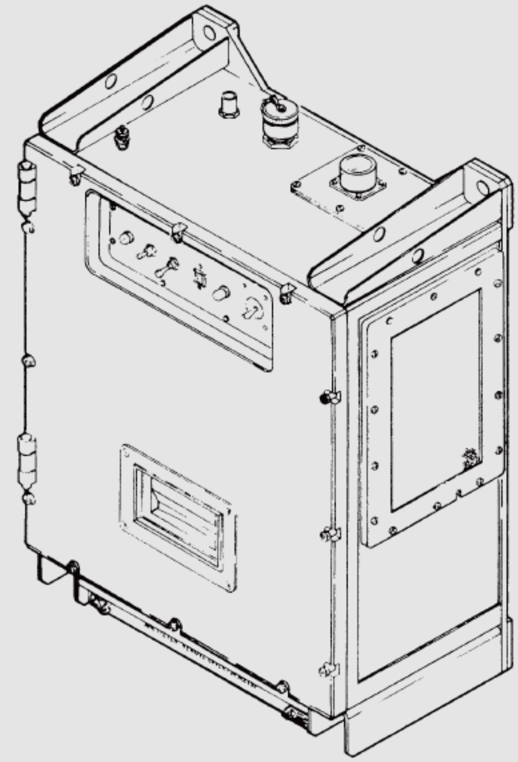
Cooling is accomplished by internal AC fans. The inlet air enters the housing through a louvered opening, an air filter and an EMI/RFI screen mounted on the front door. The air is directed over the modules and power supply by means of a plenum system. The air is exhausted through an EMI/RFI screen and opening in the right side of the housing as viewed from the front.

Security Provision

The ARM (LHD only) enclosure is provided with a built-in locking device to prevent access by unauthorized personnel to the message PROMs on Interface No. 2 CCA. This lock assembly is compatible with early versions of the Interface No. 2 CCA; later versions of this CCA are not compatible with the lock assembly. The Interface No. 2 CCA contains a cover that prevents tampering with or removing a plug-in PROM. This cover is secured to the module with tamper-proof screws that require a special tool for removal. This restricts changing of PROMs to those technicians having a special tool for removal of the PROM cover assembly. The ARM (LHD only) front door is capable of being locked with a standard padlock.

8.1.24 Traffic Controller (TC) Overview

(See Figure 8-24) One TC PN 10800-514-11is required for each primary bus. Each TC operates independently of the other TCs. The purpose of a TC is to provide orderly control of primary bus access to the AMs, ARMs and MEs connected to the bus, so that all four data channels of each bus are loaded uniformly. The TC controls access to the bus by polled offerings of vacant (idle) data channels on the bus. The polled offerings are transmitted in the form of CO messages. Each CO message contains the address of only one of the units connected to the bus and is therefore valid only for the addressed unit. The polling/offering sequence is determined by a polling PROM from which each address is obtained for each CO message. Each polling PROM has the capacity for storing 256 addresses and therefore has a 256-address polling cycle. This allows each polling PROM to be programmed to address those units required to handle heavier and/or higher-priority data transfer loads more often than units with lighter or lower priority transfer loads. A TC will offer channels (poll) at a rate up to 30,000 offers per second.



EQUIPMENT CONFIGURATION

INPUT:
PRIMARY: 115V, 1 PH, 60 Hz, 75 WATTS MAX
(INCLUDES FANS)
EMERGENCY: 110 TO 130 VDC, 61 WATTS MAX

COOLING:
AC-POWERED INTERNAL FAN: ONE FAN
14 WATTS

ENVIRONMENT:

	OPERATING	STORAGE
TEMPERATURE	0 TO 50°C	-62 TO 71°C
RELATIVE HUMIDITY	0 TO 95%	0 TO 95%

MOUNTING PROVISIONS:
BULKHEAD ONLY

REDUNDANT CONSTRUCTION: NONE

DIMENSIONS (INCHES), WEIGHT (LBS):

	UNCRATED	CRATED
HEIGHT	22.12	32.50
WIDTH	16.50	23.25
DEPTH	9.12	16.50
WEIGHT	72.00	135.00

SECURITY PROVISION: NONE

DESCRIPTION DATA:
OFFICIAL NOMENCLATURE: CONTROLLER, TRAFFIC
C-10810A/USQ-82(V)
MANUFACTURER'S NOMENCLATURE:
TRAFFIC CONTROLLER
PART NUMBER 10800-514
MANUFACTURER'S CODE 94756

Figure 8-24. Traffic Controller (TC).

Functional Summary

The transmitter of the RF transceiver (Figure 8-25) transmits the CO messages on the control channel; the two receivers operate together as a pair, alternately tuning to two of the four data channels at a time to scan for and detect vacant channels. In addition to detecting vacant channels, the vacant channel detector issues channel select discretes in order to control receiver tuning via the configuration DIP strap and the voltage-controlled oscillator (VCO) of each receiver. If the vacant channel detector detects a vacancy on two successive scans of the same channel, an IDLE signal is issued to the mode control. The mode control then increments the PROM address counter by one, causing the counter to issue the next address to the polling sequence PROM. The PROM then transmits the next AMH/ARM (LHD only) or MU address to the message register. At the same time, the vacant channel detector provides the vacant channel identification to the message register. The message register shifts the parallel inputs to a serial output for the encoder that in turn encodes the TTL data into the Manchester-formatted. CO message and drives the encoded message to the RF transmitter. The transmitter frequency-modulates the message on the control channel of the primary bus. Each primary bus is assigned a total of five channels. The RF carrier frequencies for the five channels are 46.2, 54.6, 63.0, 71.4, and 79.8 megahertz. For any primary bus, any one channel is used as the control channel and the remaining four are used as the data channels. Determination of the control and data channel assignments for a given primary bus is accomplished by installing a pre-wired DIP strap on the logic control card in the TC.

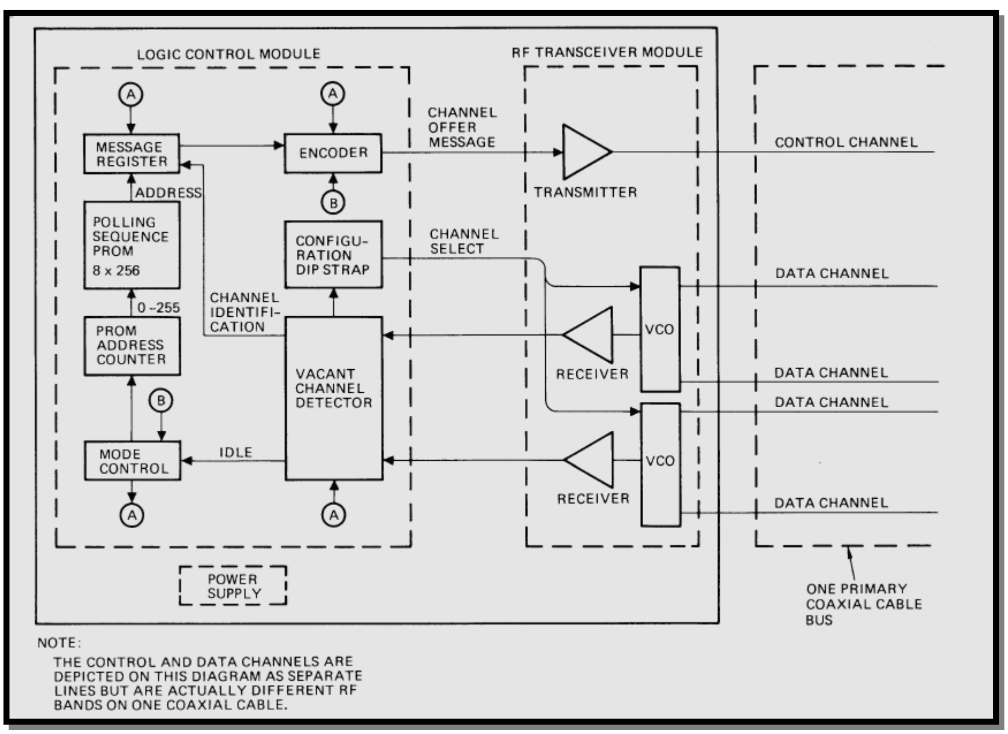


Figure 8-25. Traffic Controller (TC) – Block Diagram.

TC Physical Construction
The TC assembly is packaged in a single enclosure that is designed only for bulkhead mounting.

Subassemblies
The enclosure houses two circuit card assemblies CCAs a power supply, an EMI AC line filter, a fan assembly, a module MIB, and a control panel.

Control Panel
The control panel is located on the enclosure front panel and is accessible without opening the front door. The controls for operating and monitoring the TC consist of a circuit breaker that acts as an AC power on/off switch, an AC power on indicator, a DC power on/off switch and indicator, an elapsed time meter to record the total AC power operating time, and a lamp test switch.

MIB
Interconnection within the enclosure is made with an MIB and with hardwire cables. The MIB assembly electrically interconnects the CCA and power supply to the control panel components.

Module Keying
Two variable index keys are located on the MIB module connector XA03 and two on the module connector with matched coding to prevent insertion of the wrong type of module. The matched coding on the keying devices are coded for only one type of module. The keying arrangement prevents inserting the wrong module type sufficiently to make electrical contact. Sixty-four keying codes are possible.

Mounting
The TC is packaged in a dip brazed aluminum housing that is designed only for bulkhead mounting. The housing size, weight, power requirements, and general information are shown in Figure 8-24.

Cooling
Cooling is accomplished by an internal AC fan. The inlet air enters the housing through an opening, an air filter, and an EMI/RFI screen located on the bottom side of the enclosure. The air is directed over the modules and power supply. The air is exhausted through two EMI/RFI screen and openings located on both sides of the housing.

Security Provision
There is no provision for security. Since the entire DMS system can be disabled by turning off the power to all of the TCs, the TCs should be located in restricted access areas to prevent unauthorized turn-off of TC power.

8.1.25 TC Maintenance Group (MG) Overview

The MG units and their relationships to each other and to the rest of the DMS are illustrated in Figure 8-26 and Figure 8-27. Table 8-8 identifies and describes the major functions of the MG for the three basic DMS configuration types. Figure 8-28 shows the MG data flow. The MG program consists of two parts: a software program and a firmware program. The MG software program is resident in the Data Processing Set AN/UYK-44(V) memory. The MG firmware program is resident in the maintenance electronic (ME) units. Failure of the MG does not affect DMS data transfer functions.

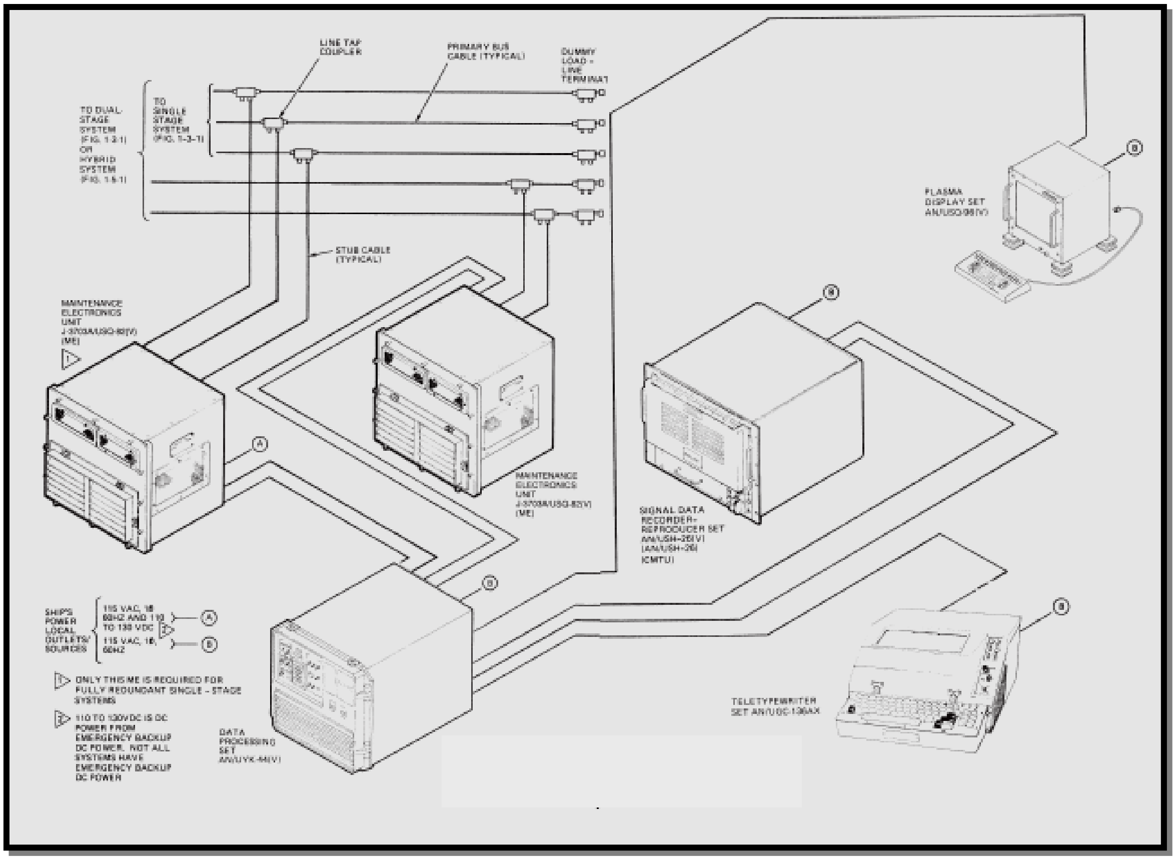


Figure 8-26. Maintenance Group OQ–228A/USQ–82 (V) Relationship of Units.

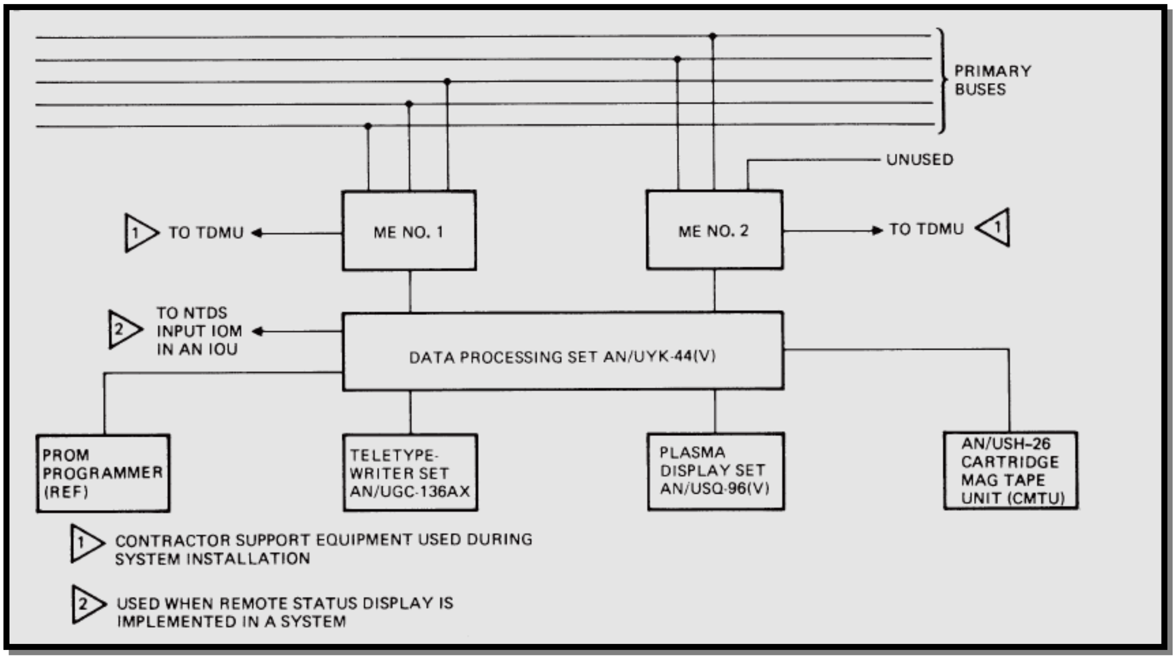


Figure 8-27. MG Hardware – Simplified Interface Diagram.

FUNCTION	PURPOSE	MG PROGRAM MODE*
Performance monitoring and fault localization (PM/FL)	Automatic, on-line PM/FL	PV, CM
Status monitoring and fault localization	Status determination and fault localization	PV
Message PROM configuration monitoring and fault localization	Message PROM contents determination and fault localization	CM
Operator request (OR) interface	Initiation of non-PM/FL operations	OR
Real-time integration support (display/printout) of desired source signal(s)	To verify correct installation and performance of units during and at completion of system installation	IS
CM data (message PROM contents) printout/display	Auditing of message PROM contents	CM
Fault summary list display/printout	To display/printout a detailed listing of all faults/fault localization data reflecting present system status	OR
BITE data display/printout	To display/printout BITE data on a specific AMH, ARM (LHD only) RMH, or ME	OR
Remote status display	To provide the latest DMS status information to a sink device that is requesting this information.	OR
*CM - Configuration management PV - Performance Verification	IS - Integration Support OR - Operator Request	

Table 8-8. MG Major Function Summaries

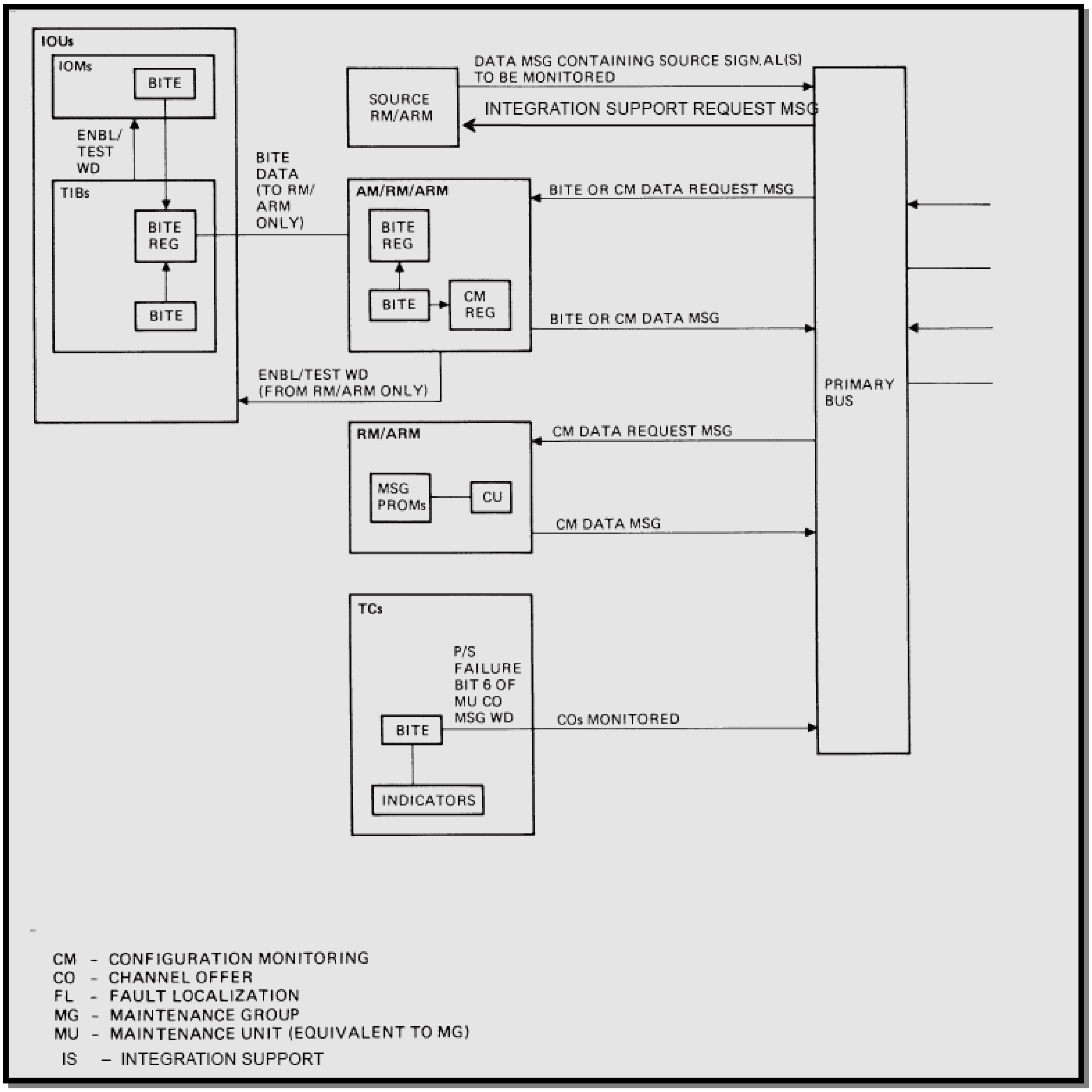


Figure 8-28. MG (MU) Data Flow–Simplified Block Diagram (Sheet 1 of 2).

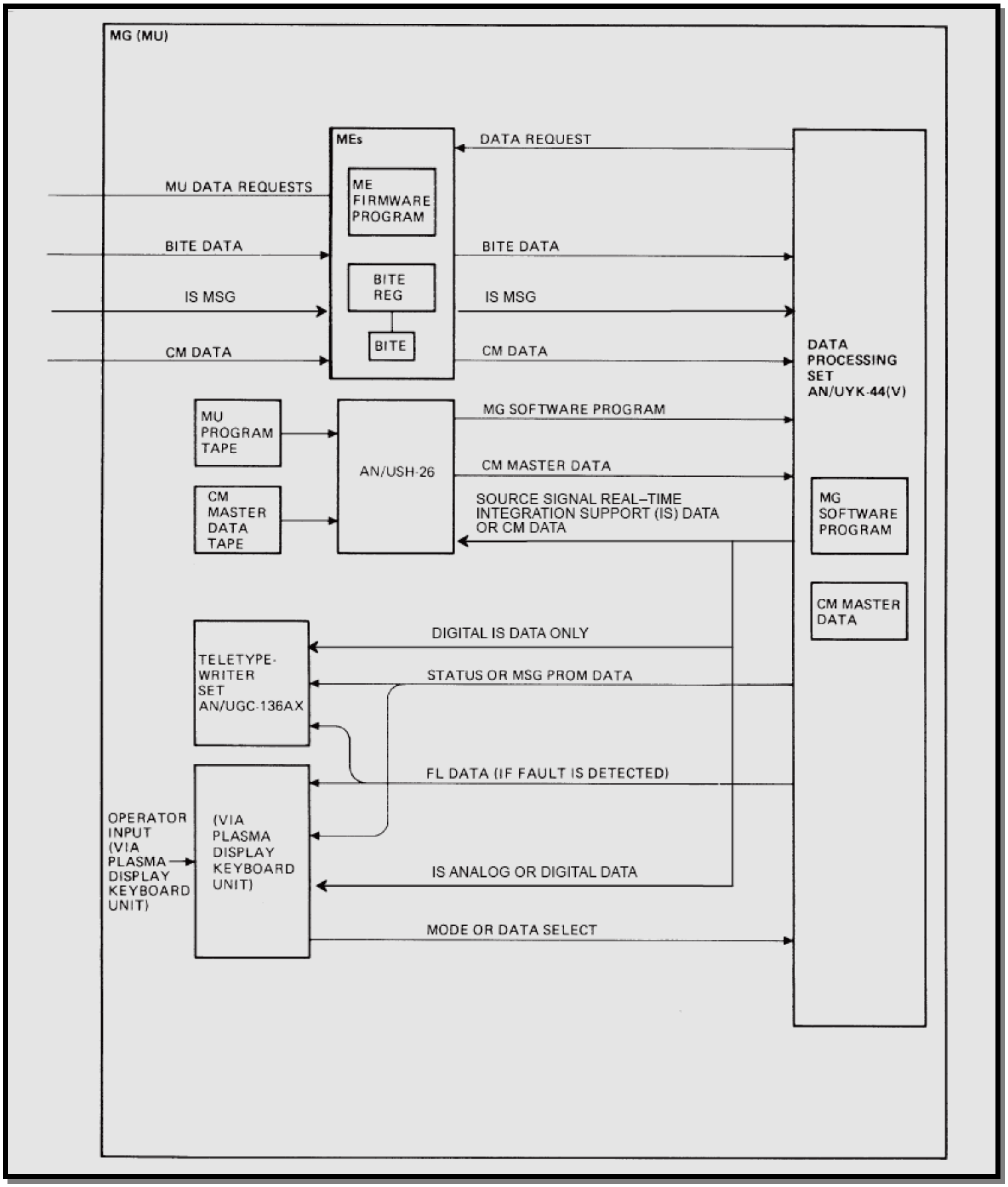


Figure 8-28. MG (MU) Data Flow–Simplified Block Diagram (Sheet 2 of 2).

Relationship Between BITE and MG Program Functions

System status monitoring is performed by BITE circuits located in most of the circuits whose performance/configuration is monitored/tested. The non-MG DMS BITE circuits operate autonomously relative to the MG firmware and software. The ME BITE operates autonomously relative to MG software. Any faults detected by BITE are latched into local BITE registers. In addition, certain equipment configuration data is latched into configuration monitoring (CM) registers. The MG software program periodically requests the data from these registers by means of BITE or CM data request messages. The requested data are transmitted to the MG in MU data message words derived from the registers. Using the data received from these registers, the program performs its status monitoring, fault localization, display, and printout functions. Operator-initiated special functions can be performed in parallel and/or on a computer time-shared basis with these automatic functions. No requests are made to the MG by non-MG equipment.

Data Acquisition By The MG

In the execution of PM/FL, the program requests data from the BITE and CM registers on a scheduled basis via the various primary and secondary bus paths in the system. BITE data obtained from a given AMH, RMH, or ARM (LHD only) include BITE data on the unit and critical BITE data on its redundant unit. BITE data obtained from an ME include hardware BITE and loop data and firmware BITE and loop data. AMH configuration monitoring data obtained from the CM registers in the AMHs consist of the RMIDs from the request messages, received via the primary buses, that have recently been processed by the AMHs. RMH and ARM (LHD only) configuration monitoring data are not latched into CM registers but is periodically obtained through the controller unit (CU) of each RMH or ARM (LHD only). RMH and ARM (LHD only) CM data consist of message PROM contents which are compared to that in memory derived from the CM master data type. Any differences are detected and annunciated.

Transmission Paths Monitoring

The TCs and the primary and secondary bus cables are checked by the program during the PV mode of PM/FL by statistical comparisons. The throughput on each cable is monitored and analyzed to determine the status of the buses.

Integrated Support (IS) Mode Data Requests

During real-time integration support which must be manually commanded by the operator, the program requests one (or all) of the data words from a real user source message. The requested data are transmitted from the source terminal in the RMH or ARM (LHD only) and is displayed/printed out by the MG. This capability enables maintenance personnel to rapidly verify the existence and status of any DMS input signal. The MG requests and sinks data at a relatively low rate and does not affect the data transfer capacity of the DMS.

Operator and MG Relationships (PM/FL)

PM/FL is the primary function of the MG and requires no operator inputs. Operator commands for data or an additional operating mode causes a very brief exit from PM/FL to perform the task, but the commands do not inhibit the PM/FL functions. The PM/FL mode generates displays and printouts to inform maintenance personnel that the DMS is either operating properly or that a failure has occurred.

Fault Priority Hierarchy And Annunciation

PM/FL operates on a fault priority basis such that only the highest priority fault of a major unit is fault localized and annunciated. If more than one fault exists in one major unit, the completeness of the diagnostic data inputs to the MG program varies directly with the priority rank of the fault. As soon as the highest priority fault is cleared (corrected) the next highest priority fault remaining is automatically localized by the program and annunciated. Detection of a failure causes the program to automatically (1) perform diagnostic testing, (2) display the results of the testing on the plasma display unit (PDU) in terms of a fault code, (3) print out the fault code on the printer, (4) sound an audible alarm, and (5) turn on the DMS visual alarm indicator on an ME. This indicator, controlled by the AN/UYK-44, indicates that one or more faults has been detected within the DMS. The audible alarm may be manually turned off with a reset switch. The resetting of the audible alarm also simultaneously changes the flashing state of the visual indicator to the steady state. Given the fault index number displayed on the plasma display unit and printed out on the teletypewriter set, the technician refers to volume II of this manual and performs the indicated corrective maintenance for this fault index number. The PM/FL functions and types of faults detected by PM/FL are described in Table 8-9. How the PM/FL workload is distributed is outlined in Table 8-10.

		INDICATED		
FUNCTION	FAULT(S) DETECTED	ON	WITHIN	FAULT(S)-LOCALIZED TO
Status Monitoring	1. 1. Any fault that renders inoperative an IOU, IOM, RMH, AMH, TC, or ME, when the failure is reported to MU by BITE data from the failed unit	*PDU and TTS	60 seconds of occurrence	1. Failed IOM 2. Not more than three non-IOM LRUs
	1. 2. Any short-circuit or open- circuit condition on any primary or secondary bus cable, or any TC failure	PDU and TTS	10 minutes of occurrence	1. Primary bus cable segment stub, or line tap
	1. 3. Any variation exceeding 25 percent of a periodic signal which has an update rate of from .05 to 300 updates per second	PDU and PRINTER	60 seconds of occurrence	Same as for 1 and 2
	1. 4. Any variation exceeding 25 percent of a periodic signal which has an update rate of less than .05 updates per second	PDU and TTS	3 update intervals	Same as for 1 and 2
	1. 5. Any failure that renders any unit inoperative in such a manner that error-free BITE data cannot be received from that unit	PDU and TTS	10 minutes of occurrence	Same as for 1 and 2
Message PROM configuration monitoring	1. 1. Any changes in message PROM coding since MG program initialization. (This can serve to verify desired PROM change	PDU and TTS	For maximum size** systems, 60 minutes of occurrence for RM PROMs and 20 minutes for ARM (LHD only PROMs. Proportionately less time for smaller	Same as for 2

		implementation as well as failures or unauthorized changes.)		systems.	

* PDU - Plasma Display Unit; TTS - Teletypewriter set
** 112 RMs in dual- stage system; 16 ARM (LHD only) pairs in single-stage system.

Table 8-9. PM/FL Functions and Faults Detected.

FUNCTION	PERFORMED BY
Performance Monitoring	BITE and MG Programs
Function Monitoring	Decentralize BITE on the individual modules (circuit cards) in the ME, AM, TC, RM, ARM (LHD only), and IOU units in the DMS.
Status monitoring and message PROM configuration monitoring	1. Software is AN/UYK-44 memory, which controls data acquisition and evaluation 2. ME firmware, which requests and acquires the data
Fault localization	Software in AN/UYK-44 memory
Status/fault annunciation	MG software and hardware
Display	Software and plasma display unit
Printout	Software and teletypewriter set
Fault status storage	Software and AN/UYK-44 memory

Table 8-10. PM/FL Workload Distribution.

Loss of AN/UYK-44 Communications

Loss of communication from the AN/UYK-44 is detected by ME circuitry which sounds the audible alarm and turns on the COMPUTER alarm indicator. Given this symptom, refer to volume II of this manual for fault localization instructions. This fault localization involves checking for a failure in ME circuitry interconnecting cabling or AN/UYK-44 primary power source before troubleshooting the AN/UYK-44 in accordance with the AN/UYK-44 technical manual.

Real Time Integration Support (IS)

In all DMS configuration except single-stage systems, the MG has the capability to provide real-time system integration checkout support to verify correct installation/modification of the DMS configuration. This integration support (IS) mode is operator initiated on the plasma display set keyboard and is performed during PM/FL. This IS mode permits the operator to request any RMH or ARM (LHD only) source message data word (signal) to be displayed.

The operator must specify (1) the source ARM (LHD only) or RMH ID, (2) the message ID, (3) the word number to be displayed, and (4) the analog plot or the digital display parameters. The operator can enable either the analog plot or the digital display capability but not both simultaneously. Digital data may be displayed on the plasma display unit and printed out on paper by the teletypewriter set. Analog data may be displayed on the plasma display in a plot format but is not printed out on the teletypewriter. Exit from the IS mode requires a termination command from the operator.

BITE Data Display/Printout

The BITE data from an AMH, RMH, ARM (LHD only), or ME may be requested by the operator on the plasma display set keyboard. The data is displayed/printed out as a hexadecimal number along with hardware identification, time, and date information. This function may be used to periodically monitor equipment status, in accordance with instructions contained in volume II of this manual, in the event that a fault was localized to a circuit card but the card was not replaced due to unavailability of a spare card. A change in the hexadecimal number will indicate a change in the equipment status, usually an additional but lower priority fault. Lower priority faults are masked (not fault localized and annunciated) by PM/FL. However, higher priority faults are fault localized and annunciated.

Loss Of TC Channel Offers

The MU program performs tests that monitor the TC for data channel offers. The collected data are processed by the MU software program to determine the operational status of the TC. The status of the TC is displayed on the plasma display unit indirectly as a BUS GO. If channel offers are not received on any control channel by the ME from the TC on a particular bus, the MG annunciates a fault. The fault is printed with a unique fault index number that indicates the TC has an over-temperature fault. The plasma display displays a BUS MG GO. If channel offers are not received by an AM then a unique fault index number is printed that indicates the fault is within the TC. The TC BITE circuitry tests the TC logic control circuit card assembly and TC power supply. The results of these tests are displayed by indicator lamps within the TC. The information displayed by the indicator lamps is used for corrective maintenance action. When the TC logic control circuit card assembly is malfunctioning, the LOGIC FAULT indicator comes on. When the TC power supply is malfunctioning, the PWR SPLY FAULT indicator will come on. This BITE information is not available to the MG.

CM Data (Message PROM Contents) Display/Printout

The operator may initiate display/printout of (1) the message PROM contents for a particular message PROM in an RMH/ARM (LHD only), (2) the contents of all message PROMs in an RMH/AMH, and (3) the contents of all message PROMs in all RMHs/ARMs. A comparison printout may also be obtained for the PROM contents for a particular message versus the PROM contents obtained from the CM master data tape. Differences are flagged by asterisks.

Fault Summary List Display Printout

The operator may initiate display/printout of a fault summary table on a page-by-page basis and a complete printout of the fault summary table. The output for the complete printout is available to the teletypewriter set only. The list includes the Julian date, time, major unit identification, and fault code for each malfunctioning major unit.

Remote Status Display

In this mode, the AN/UYK-44 provides DMS status information in response to requests from devices that are connected to the DMS. The sink user device can be either a remote status panel or a remote display terminal. The data are provided via DMS sink-initiated message transfers.

Types Of MG Operator Messages

MG Operator messages (Table 8-11) are generally displayed to inform the operator of system status (Type S), to prompt the operator (Type P), or to notify the operator of an unexpected system event (Type E). The display of Type E events are outside the normal MG fault detection and reporting capabilities and are reported to the operator to indicate an error condition within the MG. Should Type E messages be displayed on a regular basis, the ISEA should be notified for resolution.

MSG NO.	TYPE	MESSAGE	DESCRIPTION
1	S	NO CM TAPE	No CM tape mounted on selected tape drive.
2	S	CM TAPE LOADED	CM tape successfully loaded.
3	S	RESTART WITHOUT SI	Response message if 'NOSI/' entered at keyboard during initialization.
4	E	ME RAW DATA OVFL	The amount of raw data received from the ME exceeds the program buffer area.
5	E	HDR NOT EXP	The AM/RM Address in the Received Data Header does not match the Request AM/RM Address.
6	E	ANAL TYP BAD	Undefined Performance Verification Request.
7	E	NOT EXT INTR	Interrupt Received was not an External Interrupt.
8	E	I/O QUE OVFL	Received a new External Interrupt before Processing Completed from last Received External Interrupt.
9	E	ILL IS REQ	Illegal IS Command received by ME.
10	S	****UNABLE TO LOAD CM TAPE****	CM tape load error.
11	P	MOUNT CM TAPE-ENTER LDCM, NOCM OR NOSI	CM tape load operator Prompt.
12	S	LOADING CM TAPE	CM tape load in progress.
13	E	NO RESPONSE	No DMS response to a ME request for data.
14	E	MF35 BAD ID	Invalid AM/RM address received in data.
15	P	WITH PV ENTER 'GOPV/' WITHOUT PV ENTER 'NOPV/'	Initialization sequence operator prompt.
16	S	PV FAULT REPORTING INHIBITED	Performance verification mode not enabled.
17	S	PV FAULT REPORTING	Performance verification mode enabled.

		ENABLED	
18	S	REJECT OPER DATA REQ	Invalid operator request.
19	P	REJECT-ENTER 'INIT/' TO RESTART	Operator keyboard error, restart initialization sequence.
20	S	NO ME ON CHAN 1	No response from ME #1.
21	S	NO AVAILABLE ME	No available ME detected.
22	E	PROCEDURAL ERROR	Illegal program branch detected.

Table 8-11. MG Operator Messages.

ME Description and Functional Summary

The ME (Figure 8-29 and 8-30) functions as an interface buffer between the AM/UYK-44 and the primary buses. Functionally and physically similar to the ARM (LHD only) the ME includes 12 circuit cards: an output buffer, an input buffer, an interface No. 2 card (IF2), an interface No. 1 card (IF1), two cards (CU1 and CU2) comprising a controller unit (CU), three cable controllers, and three RF transceivers. In a five-primary bus DMS installation, one ME unit connects to three primary buses and the other ME connects to two buses.

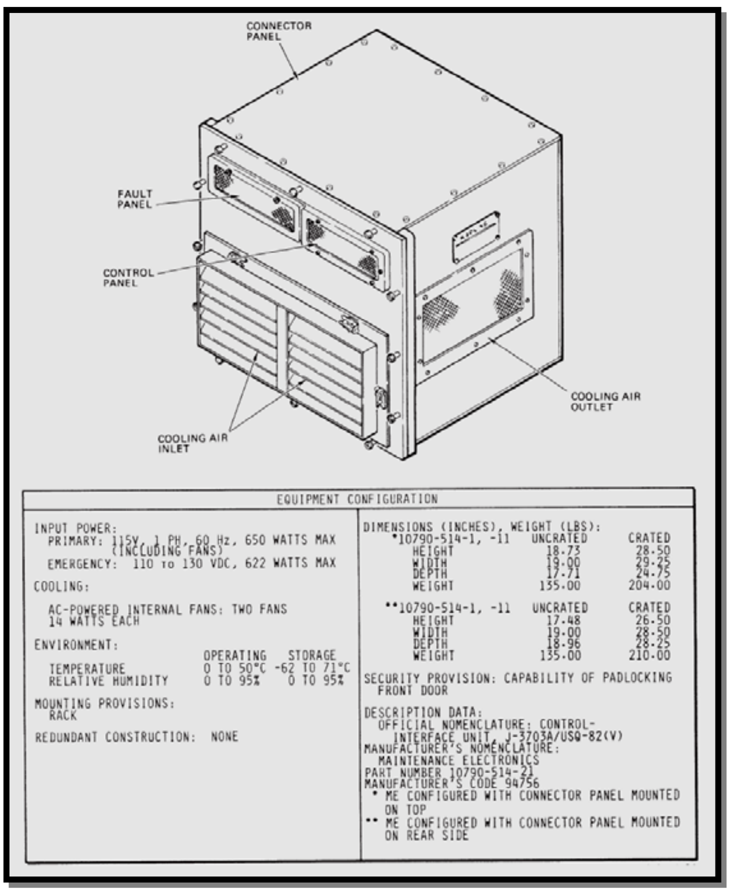


Figure 8-29. Maintenance Electronics (ME).

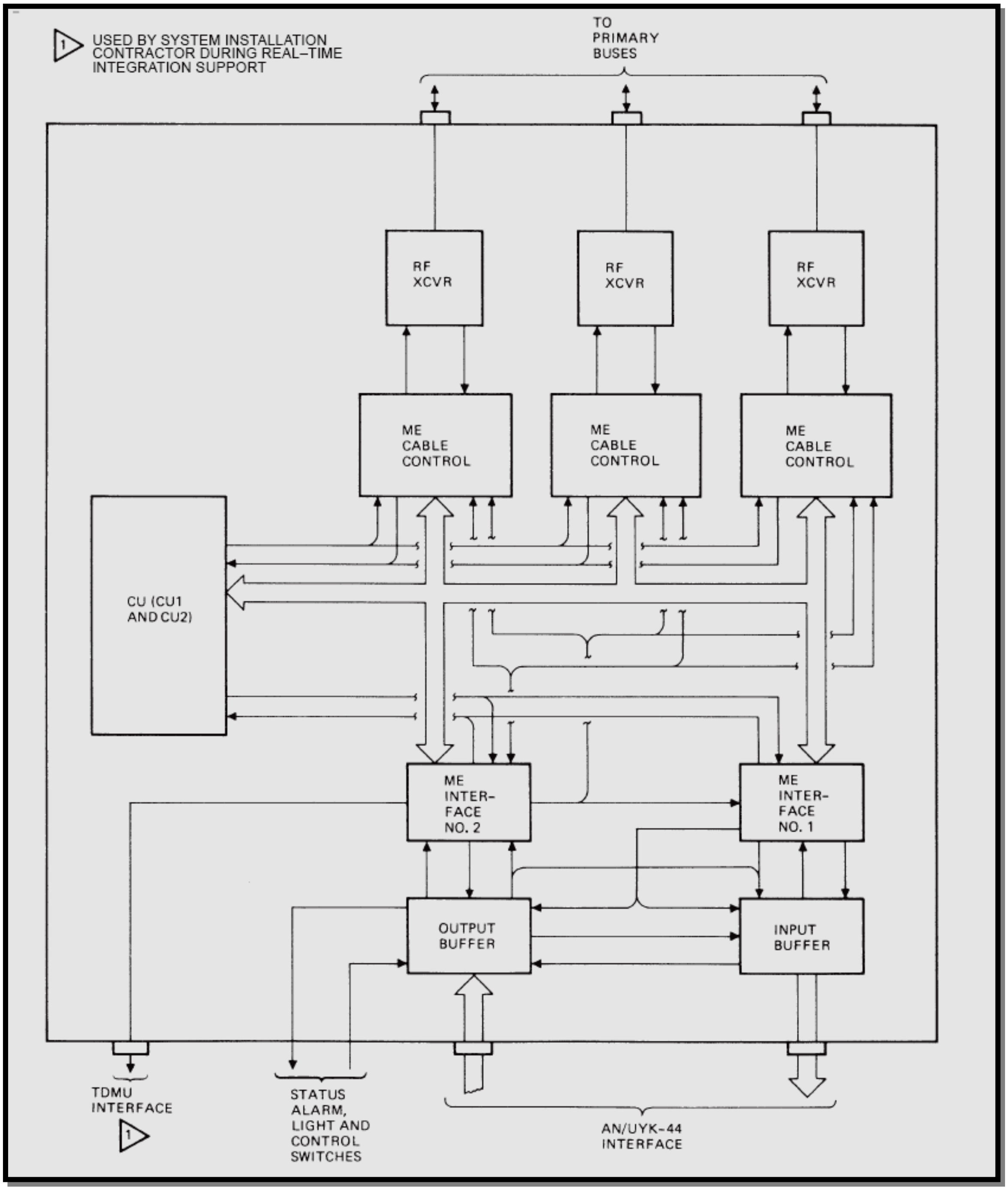


Figure 8-30. ME Block Diagram.

Primary Bus Interface

The primary bus interface and the basic message format and protocol for the ME are the same as those for the ARM (LHD only) and the AM. In the DMS interface buffering role, the ME receives commands from the AN/UYK-44, requests and receives BITE and CM data from the AMHs and RMHs/ARMs in response to these commands, and transmits these data to the AN/UYK-44. An ME interfaces with up to three primary buses. When there is more than one ME in a system, the MEs operate independently of each other and are not connected to the same buses.

8.1.26 AN/UYK-44 Interface

Data are transferred between the AN/UYK-44 and ME in NTDS-fast format. The quantity of data bits per word at this interface is the same as that used in the operational units of the DMS. However, transmission is in the parallel format instead of the serial, and a parity bit is not used. One channel is devoted to output data from the AN/UYK-44 to the ME. A second channel is devoted to input data to the AN/UYK-44 from the ME. Each channel has 16 parallel data lines, one line for each word bit, plus four control lines. The control lines for the output channel are defined in Table 8-12. Table 8-13 defines the control lines for the input channel. The terms output and input refer to the AN/UYK-44 output and input, respectively. The types of data transferred in the output and input channels described in Table 8-14. The ME is capable of handling up to two requests at a time, one for PM/FL and one for integration support (IS), message PROM contents display/printout; or BITE data display/printout. The AN/UYK-44 requests for ME BITE data and the ME responses are summarized in Table 8-15.

NAME OF LINE	DIRECTION OF SIGNAL	FUNCTION
EFR (external function request)	ME to AN/UYK-44	Set condition indicates readiness of ME to accept an EF code word on that channel.
EFA (external function acknowledge)	AN/UYK-44 to ME	Set condition indicates AN/UYK-44 has placed an EF code word on the OD lines of that channel.
ODR (output data request)	ME to AN/UYK-44	Set condition indicates readiness of ME to accept a word of data on that channel.
ODA (output data acknowledge)	AN/UYK-44 to ME	Set condition indicates AN/UYK-44 has placed a word of data on the OD lines of that channel.

Table 8-12. Output Channel Control Signals.

NAME OF LINE	DIRECTION OF SIGNAL	FUNCTION
EIE (external interrupt enable)	AN/UYK-44 to ME	Set condition indicates readiness of AN/UYK-44 to accept an EI code word on that channel.
EIR (external interrupt request)	ME to AN/UYK-44	Set condition indicates ME has placed an interrupt code word, available to computer, on ID lines of that channel.
IDR (input data request)	ME to AN/UYK-44	Set condition indicates that the ME has placed a word of data, available to computer, on ID lines of that channel.
IDA (input data acknowledge)	AN/UYK-44 to ME	Set condition indicates that AN/UYK-44 has sampled ID lines of that channel.

Table 8-13. Input Channel Control Signals.

OUTPUT FROM AN/UYK-44	RESULTING INPUT TO AN/UYK-44	PURPOSE
MU data requests	MU data	DMS PM/FL
ME BITE requests	ME BITE data	ME PM/FL
IS requests	IS data	IS

Table 8-14. ME to AN/UYK-44 Data Interfaces.

ME BITE DATA REQUESTS	ME RESPONSES
ME initialization (EFW followed by two loop test ODWs)	Initialize hardware and firmware. Also send hardware loop test data and hardware BITE data to AN/UYK-44.
Send hardware loop test data (EFW followed by two loop test ODWs)	Route the two ODWs through ME hardware and back out to AN/UYK-44 as an IDW and an EIW containing same bit patterns as the ODWs.
Send hardware BITE data (EFW only)	Output two 16-bit words of ME hardware BITE data read from 32-bit hardware BITE register.
Send firmware loop test data (EFW followed by two loop test ODWs)	Route two ODWs through ME hardware to ME CU and back out to AN/UYK-44 as an IDW and an EIW containing same bit patterns as ODWs.
Send firmware BITE data (EFW only)	Send firmware BITE data (EFW only)

Table 8-15. ME To ME BITE Data Requests From AN/UYK-44 Data

Firmware Program And Major Operating Modes

The ME contains the MG firmware program which is stored in PROMs. Although functionally similar to ARMs, MEs do not contain message PROMs. The type of information contained in the message PROMs, located in the ARMs and RMHs, is provided to the ME by the AN/UYK-44 as part of each MU data request command in accordance with the software program in the AN/UYK-44 memory. The ME firmware program consists of an initialization routine, a background loop, and three interrupt-initiated modes (Figure 8-31).

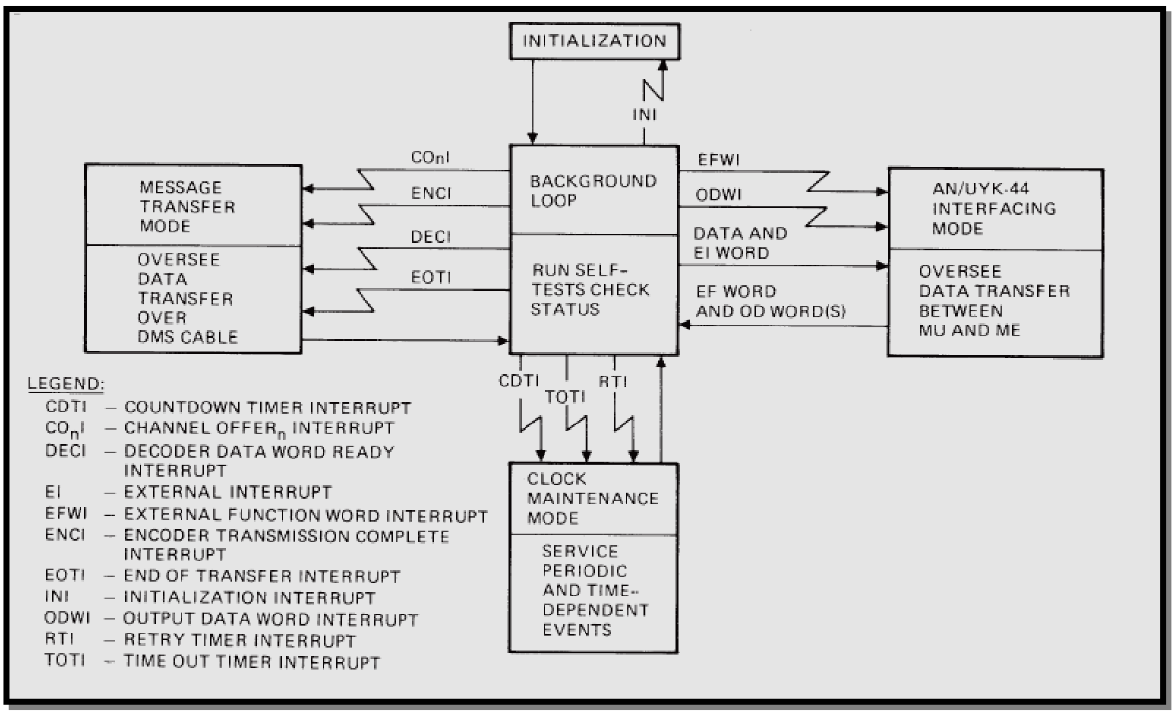


Figure 8-31. ME Firmware Program – Modular Organization.

Initialization Mode

At power application to the ME (or upon receipt of an initialize interrupt (INI) from the AN/UYK-44 program), the CU immediately undergoes an initialization process in which all latches, clocks, interrupts, flags, and data RAMs are cleared in preparation for normal operations. Upon completion of initialization, the ME program proceeds to the background loop. Initialization is reentered if an initialize interrupt (INI) is received from the AN/UYK-44 (Figure 8-31).

Background Loop Mode

In the background loop mode (Figure 8-31), the ME program performs self tests and times out responses. The program remains in the background loop until an interrupt is received and then jumps to the mode of operation indicated by the type of interrupt received. There are three main interrupt-initiated modes: message transfer, MU interfacing, and clock maintenance.

Message Transfer Mode

The message transfer mode (Figure 8-31) uses the channel offer interrupt (COI) and the encoder transmitting complete interrupt (ENCI) to send out receive requests on the primary buses. The decoder data word ready interrupt (DECI) and the end of transfer interrupt (EOTI) are used to receive the requested data.

AN/UYK-44 Interfacing Mode

In the AN/UYK-44 interfacing mode (Figure 8-31) the program oversees and coordinates the flow of data between the ME and the AN/UYK-44 in the NTDS fast format. Either an external function word interrupt (EFWI) or an output data word interrupt (ODWI) causes the ME CU to enter the AN/UYK-44 interfacing mode. An EFWI indicates that there is an EF word from the AN/UYK-44 available for input to the CU. Each ODWI indicates that an OD word is arriving from the AN/UYK-44. There will be a maximum of four OD words. After these words are received, the ME transmits the request on a primary bus. When the ME receives the requested data via the primary bus, the data are sent to the AN/UYK-44 while in the background mode. At completion of this data transfer to the AN/UYK-44, the CU sends an external interrupt (El) word to the AN/UYK-44 to identify the data sent and to advise that the transfer is complete.

Clock Maintenance Mode

An interrupt from the countdown timer, time-out timer, or retry timer causes the CU to enter the clock maintenance mode (Figure 8-31). If a countdown timer interrupt (CDTI) or a retry timer interrupt (RTI) is received, the CU performs time-dependent actions required to service a message whose MSGID is in the service queue. If a time-out timer interrupt (TOTI) is received, this indicates that an anticipated interrupt (such as a COI or a DECI) has not been received. The CU flags the error and then proceeds in accordance with the firmware program instructions for the error encountered.

ME Self-Tests/Checks

The ME performs self-tests and hardware/firmware mode checks while in the background mode. The results of these tests/checks are stored and provided to the AN/UYK44 when requested. The ME self-tests/checks, controlled by the CU firmware, are the (1) countdown timer test, (2) retry timer test, (3) time-out timer test, (4) encoder/decoder loop test, (5) data RAM test, (6) interrupt mask register test, and (7) checks to determine if the hardware and firmware are operating together in the same modes.

ME Physical Description

The ME assembly is packaged in a single enclosure that is designed for rack, base, or bulkhead mounting. When configured for bulkhead mounting, the internal connector panel is assembled to the top of the enclosure. When the ME is configured for mounting in a standard 19-inch electronic equipment rack, the interface connector panel is attached to the rear side of the enclosure. When the ME is base-mounted, the interfacing connector panel may be attached to the top or rear of the enclosure.

Subassemblies

The ME enclosure houses 14 modules, a power supply, a EMI AC line filter, a fan assembly, a control panel, and a fault panel. The controls for operating and mounting the ME consist of a circuit breaker which acts as an AC on/off switch, an AC power on indicator, a DC power on/off switch, a DC power on indicator, an elapsed time meter to record the total AC operating time, an audible alarm for fault annunciation, and testing controls and indicators.

MIB

Interconnection within the assembly is made with a MIB and with hard wired cables. The module MIB interconnects all modules, the power supply, and the fan assembly. The hard-wired cables interconnect the module MIB to the interface MIB.

Module Keying

A coded keying devise is located on each MIB module connector to prevent insertion of the wrong module. The mating keying device on modules of the same type are all coded alike.

Mounting

The ME is packaged in an aluminum housing which is designed for bulkhead, base, or rack mounting. The housing size, weight, power requirements, and general information are shown in Figure 8-29.

Cooling

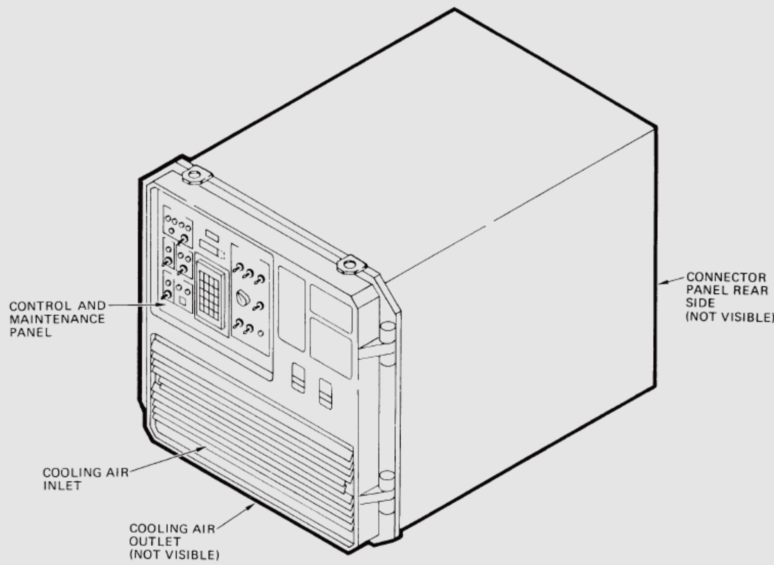
Cooling is accomplished by internal AC fans. The inlet air enters the housing through a louvered opening, an air filter, and an EMI/RFI screen mounted on the front door. The air is directed over the modules by means of a plenum system. The air is exhausted through an EMI/RFI screen and opening in the right side of the housing as viewed from the front.

Security Provision

The ME front door is capable of being locked with a standard padlock.

8.1.27 Data Processing Set AN/UYK-44

The AN/UYK-44 (Figure 8-32) is a general-purpose digital computer that serves as the central processor for the MG. The AN/UYK-44 memory stores the MG software program. The loading of this program into memory is via the AN/USH-26 and the MG program tape. In addition to the program, the CM master data are stored in the AN/UYK-44 memory. This CM data must be loaded into memory via the AN/USH-26 and a CM master data tape. The AN/UYK-44 has multiple input/output ports that interface with associated equipment as shown in Figure 8-27.



EQUIPMENT CONFIGURATION	
INPUT POWER: PRIMARY: 107 TO 123V, 1 PH, 60 Hz, 900 WATTS MAX EMERGENCY: NONE COOLING: *AC-POWERED INTERNAL FANS ENVIRONMENT: OPERATING STORAGE TEMPERATURE -54 TO 65°C -62 TO 71°C RELATIVE HUMIDITY 0 TO 95% 0 TO 95% MOUNTING PROVISIONS: RACK, BASE REDUNDANT CONSTRUCTION: NONE *DMS CONFIGURATION	DIMENSIONS (INCHES), WEIGHT (LBS): UNCRATED CRATED HEIGHT 20.00 28.50 WIDTH 19.00 26.50 DEPTH 24.00 38.25 WEIGHT 165.00 250.00 (APPROX) SECURITY PROVISION: NONE DESCRIPTION DATA: OFFICIAL NOMENCLATURE: DATA PROCESSING SET AN/UYK-44(V) MANUFACTURER'S NOMENCLATURE: DATA PROCESSING SET MANUFACTURER'S CODE 90536

Figure 8-32. Data Processing Set AN/UYK–44(V).

Physical Construction

The AN/UYK-44 is packaged in a single cabinet that is designed for rack or base mounting. The front hinged door forms the front of the cabinet. The front side of the hinged door contains the operator's control and maintenance panel with the basic controls and indicators. A cooling fault alarm horn is mounted on this door. The rear panel of the cabinet contains the power connector, input/output cable connectors, and grounding stud.

Cooling

With DMS, cooling is by convection. Ambient air is drawn through an air inlet and filter located on the front door. The air is directed over the electronic subassemblies and exhausted through a port located on the bottom of the cabinet.

8.1.28 Signal Data Recorder-Reproducer Set AN/USH-26

The AN/USH-26 (Figure 8-33) is a recorder-reproducer with up to four tape drives that use magnetic tape cartridges. The read and write speed of each tape drive is 30 inches per second. One tape drive is used for reading the MU program tape. The second drive is used for reading the CM master tape. The third drive is used for writing the CM data tape reflecting the final DMS installation configuration. The fourth drive, if it has not been removed from the unit, is not used. The AN/UYK-44 interface is NTDS fast.

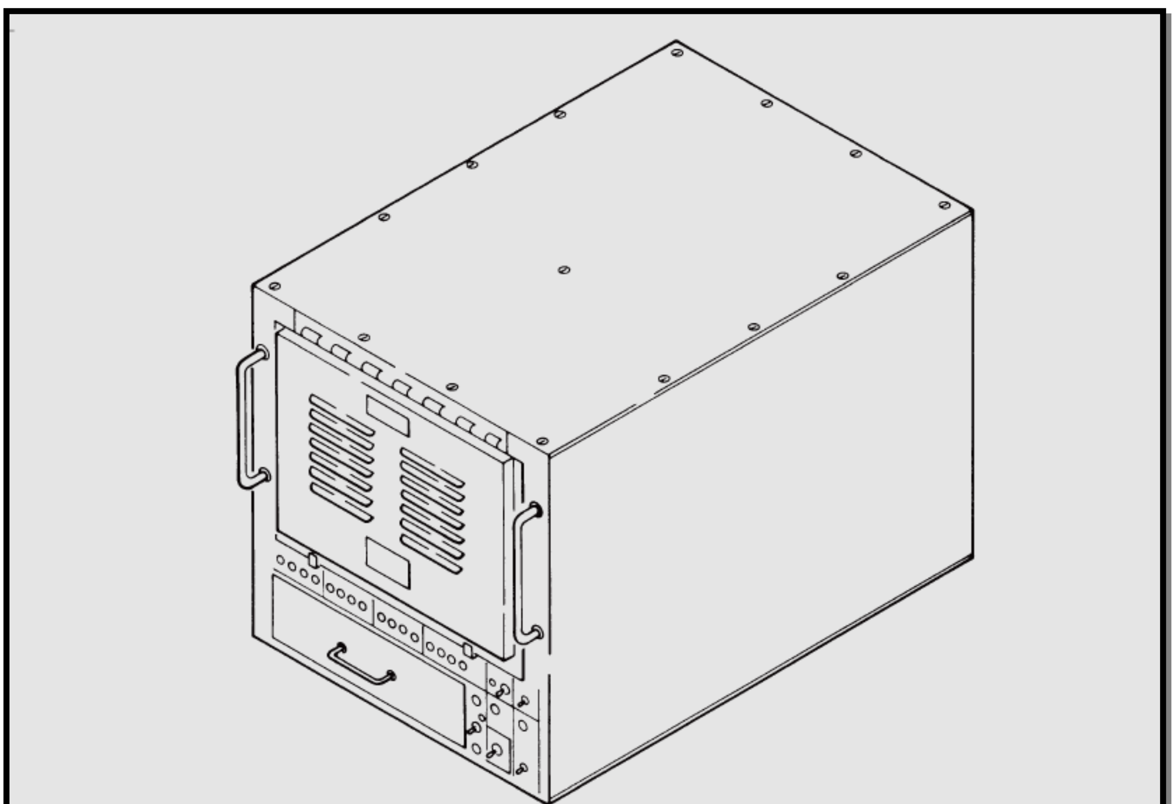


Figure 8-33. Signal Data Recorder–Reproducer Set AN/USH–26(V).

AN/USH-26 Physical Description

The AN/USH-26 is packaged in a single cabinet that is designed for rack or base mounting. See Figure 8-33. The louvered front hinged door covers the tape drive assemblies. Below the hinged door is the operator's control panel and maintenance panel. An alarm horn is mounted behind the front hinged door. The cabinet rear panel contains five jacks for power and external interfacing cables. The housing size, weight, power requirements, and general information is shown in Figure 8-33.

Cooling

Cooling is accomplished by internal fans. The air enters the housing through louvered panels on the front hinged door. The air is directed over the electronic subassemblies and is exhausted through filtered air exhaust grills on the cabinet’s rear side.

8.1.29 Plasma Display Set AN/USQ-96(V)

Plasma Display Set AN/USQ-96(V) (Figure 8-34) is a microprocessor-based alphanumeric/ graphics display coupled with a keyboard. Firmware includes split screen, editing, and diagnostic RAM test features.

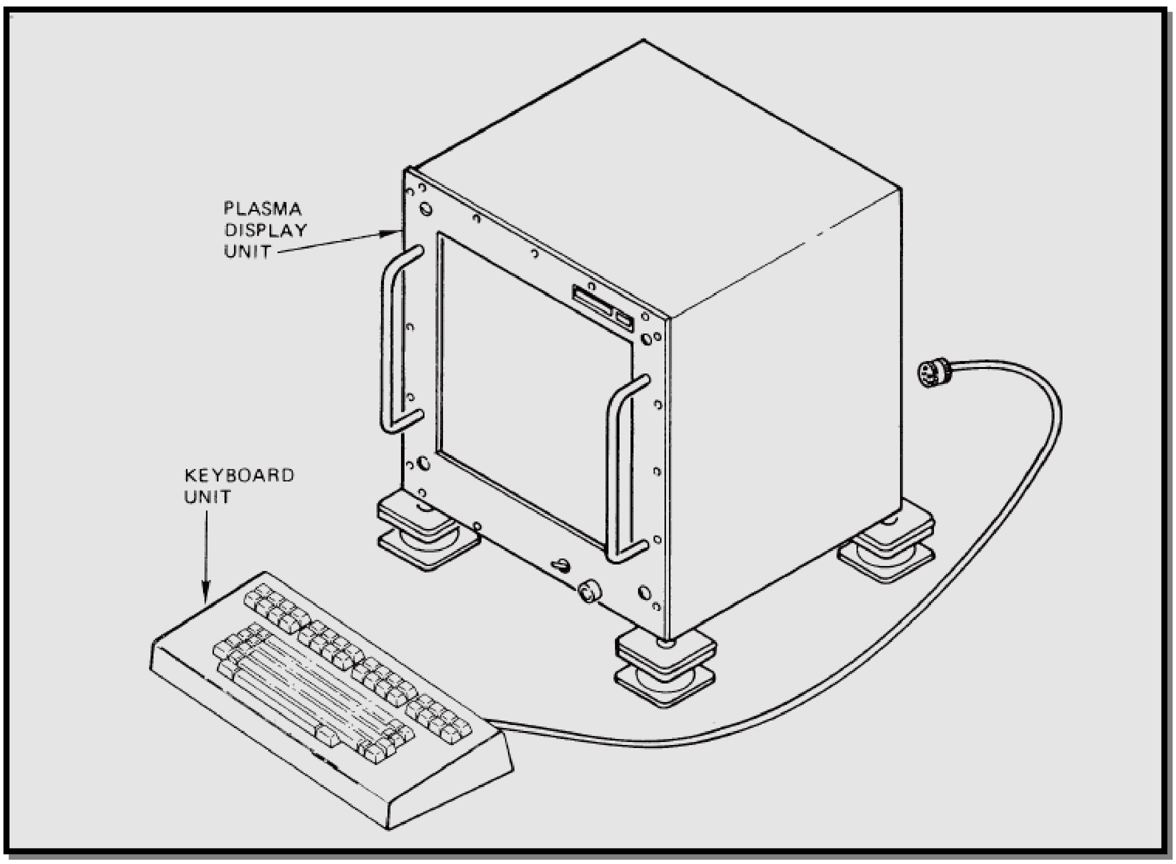


Figure 8-34. Plasma Display Set AN/USQ–96(V).

Interfacing With AN/UYK-44 And Display Capability

The interface with the AN/UYK-44 is serial RS-232C asynchronous. The display is capable of generating and presenting analog point plots and endpoint vector graphic displays as well as alphanumeric characters. Direct digital addressing of the display panel provides selective activation (writing) or deactivation (erasing) of any point on the screen.

Display And Keyboard Functions

The display provides DMS status, fault localization and configuration monitoring. The keyboard is used by the operator to request data from the system.

Plasma Display Set Physical Construction

The plasma display set is packaged in two enclosures: a plasma display unit and a keyboard unit. The set is designed for rack or base mounting. The plasma display unit (PDU) is comprised of five 12 by 12 inch printed wiring assemblies and a 512 by 512 electrode matrix gas plasma display panel. The 512 by 512 electrode matrix gas plasma display consists of two 0.25-inch thick glass substrates. Each plate has parallel conductive electrodes deposited on the inner surface and is coated with a dielectric glass that has a protective layer of magnesium oxide.

Keyboard Unit

The keyboard unit (PDKU) consists of solid-state key switches mounted on a printed wire circuit board. Keys are standard ASCII design with QWERTY layout and twelve special function keys. The rear panel of the plasma display unit contains the power connector and input/output cable connectors.

Cooling

Cooling is accomplished by an internal AC fan. The inlet air enters the plasma display unit through the bottom inlet air filter. The air flow passes over the electronic subassemblies and is exhausted through the exhaust air filter located on the rear panel.

8.1.30 Teletypewriter Set AN/UGC-136AX

The teletypewriter set (Figure 8-35) provides permanent hard-copy records of DMS status, fault localization, and configuration monitoring. The interface with Data Processing Set AN/UYK-44(V) is MIL-STD-188C at 6 volts. BAUD rate with DMS is 2400. Communications protocol is International Telegraph Alphabet-5 (ITA-5), also known as ASCII (American Standard Code for Information Interchange). Messages can be composed and edited off-line and stored for later transmission. Stored messages can be recalled and edited. Incoming messages also can be stored for later printout. Built-in test equipment (BITE) and self-test features provide the means for detecting faults.

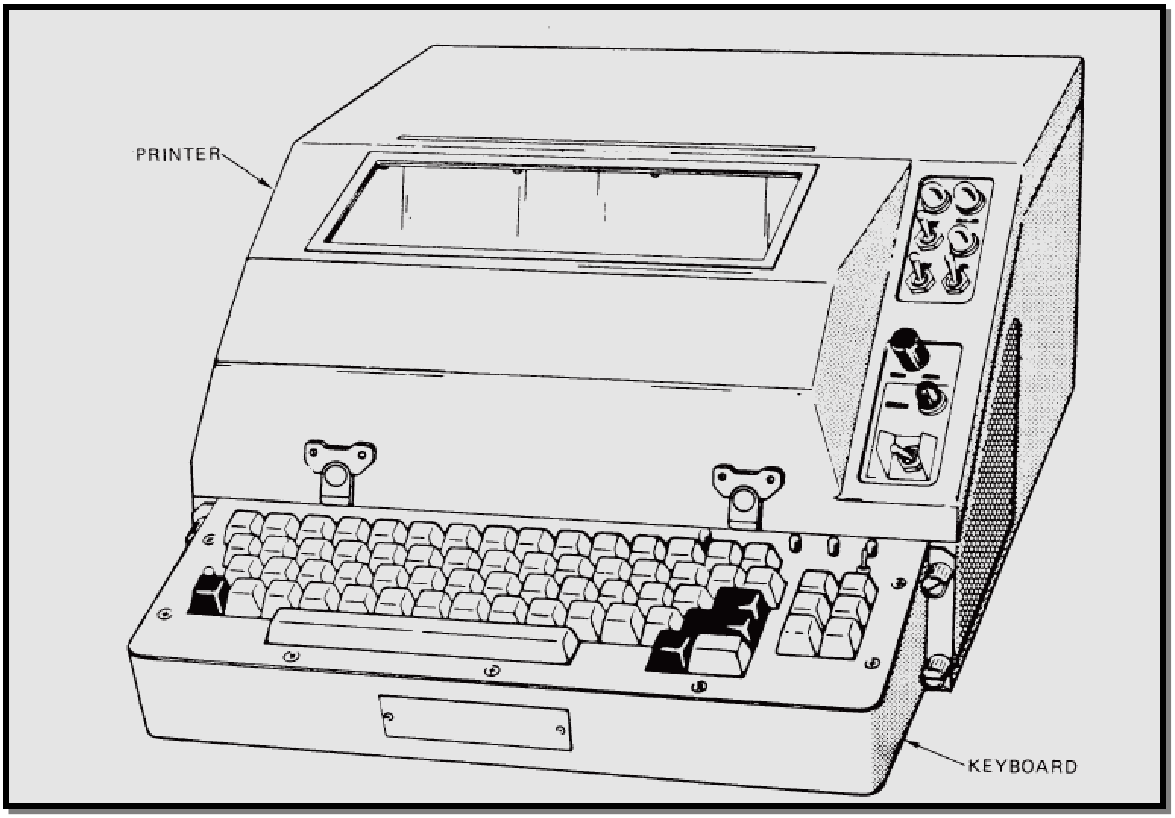


Figure 8-35. Teletypewriter Set AN/UGC–136AX.

Printer Description

For Operation with DMS, data prints at 120 characters per second with a character font of 7x9 dot matrix. Paper is single or multiply, either 8-1/2 or 8-7/16 inches wide with a diameter up to 5 inches. The ribbon is cassette type. Copy capability is original plus two copies. Character spacing is 10 per inch horizontal, 6 per inch vertical. Message storage capability is 40 messages or 19,998 characters. If stored messages exceed 40 or 19,998 characters, further stored messages force printout and deletion of earlier message(s).

Keyboard Description

The keyboard is four row MIL-STD-1280 type I, class 1. Keys are standard ITA-5 (ASCII) design with QWERTY layout and six control keys. Operator requests for data can be entered at this keyboard as well as the plasma display keyboard unit (PDKU). The PDKU is the primary keyboard with this the alternate (or backup). Either may be used, at the discretion of the operator.

MG Cable Set

The MG Cable Set is used to interconnect the AN/UYK-44 to the following MG equipment: two MEs, AN/USH-26, teletypewriter set, plasma display set, and PROM programmer (PROM programmer is not part of MG). Refer to ship's drawings applicable to ship/station for cable set usage.

8.1.31 Cabling System

Loose Equipment Set

Fabrication and installation of the interconnecting cables listed in Table 8-16 are functions of the installation shipyard. The part number for the cable connectors, backshells, and clamps to terminate the shipyard installed cables are provided in the loose equipment parts list.

CABLE
Primary Bus Cables Assembly
Stub Bus Cable Assembly
Secondary Bus Cable Assembly
I/O Bus Cable Assembly
AM Power Electrical Cable Assembly
ARM (LHD only) Power Electrical Cable Assembly
IOU8 Power Electrical Cable Assembly
IOU16 Power Electrical Cable Assembly
ME Power Electrical Cable Assembly
RM Power Electrical Cable Assembly
TC Power Electrical Cable Assembly
AN/UYK-44 Power Cable Assembly
AN/USH-26 Power Cable Assembly
Plasma Display Set Power Cable Assembly
Teletypewriter Set Power Cable Assembly

Table 8-16. Shipyard Fabricated Cables.

Cabling System Components

(See Figure 8-36). The interconnecting cabling system consists of primary bus segment cables, stub cables, secondary bus cables, input/output bus cables, power cables, line tap couplers, and dummy load-line terminators. These cables and components are used to interconnect the major DMS assemblies throughout the ship.

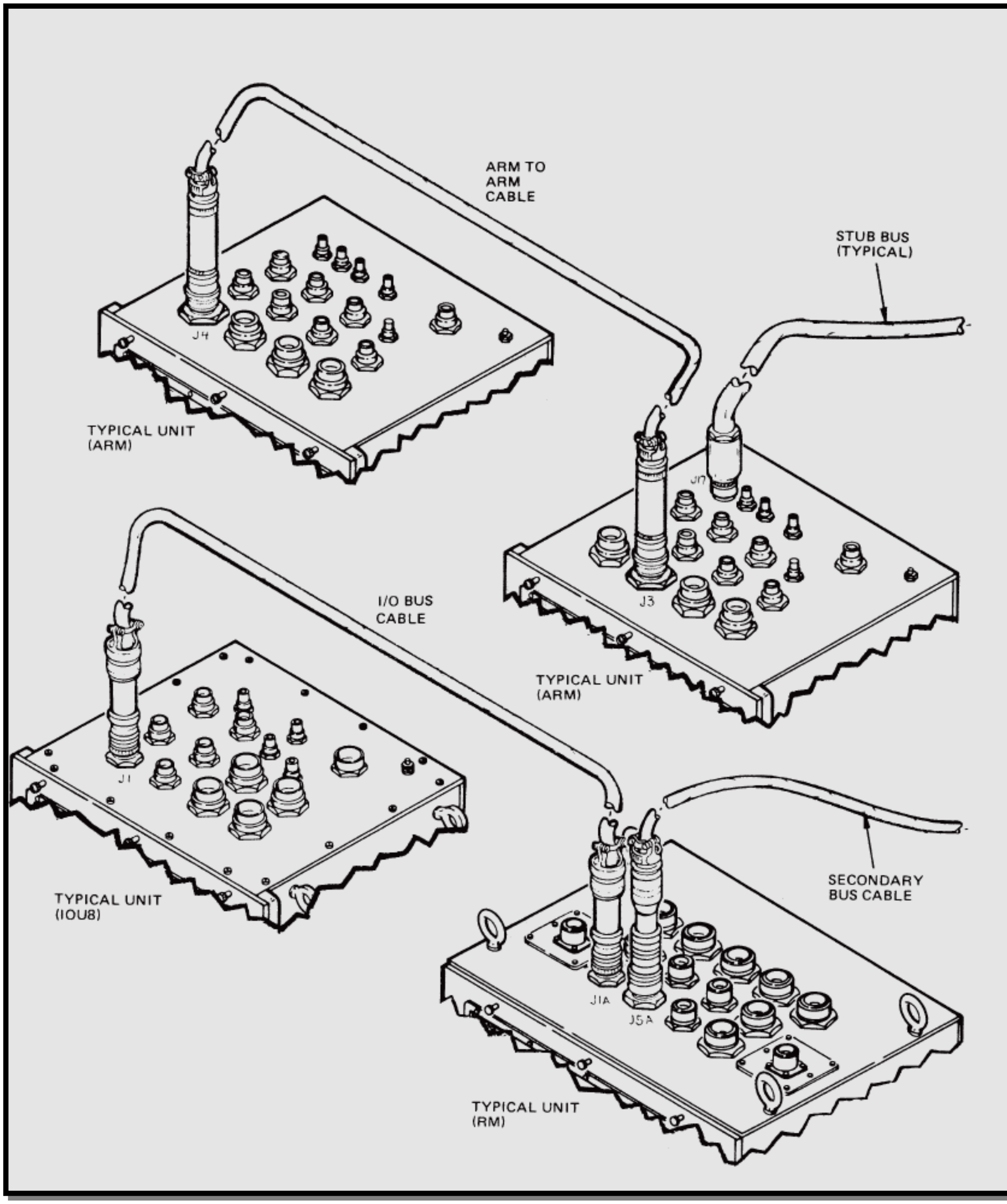


Figure 8-36. Cabling System Components (Sheet 1 of 2).

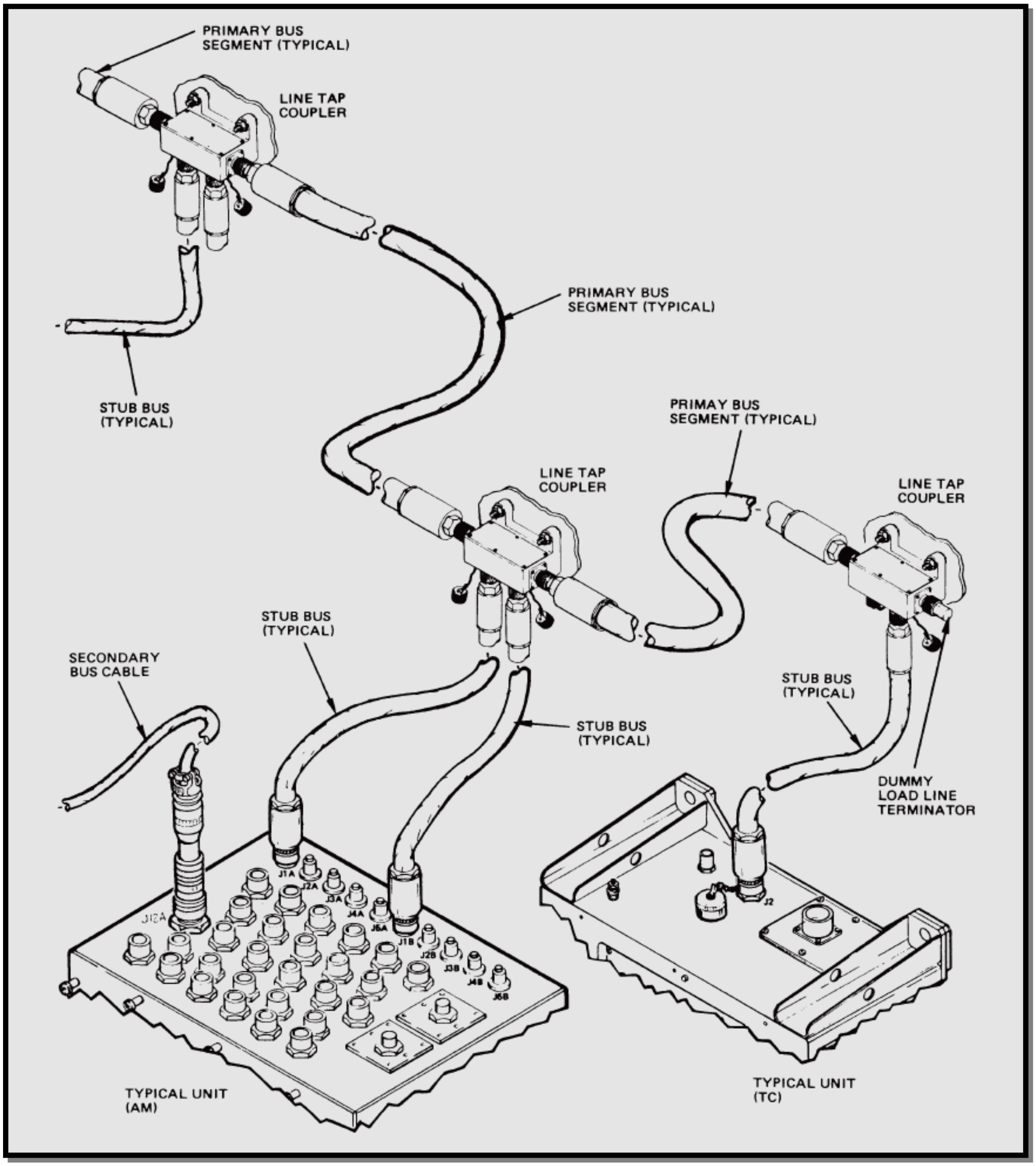
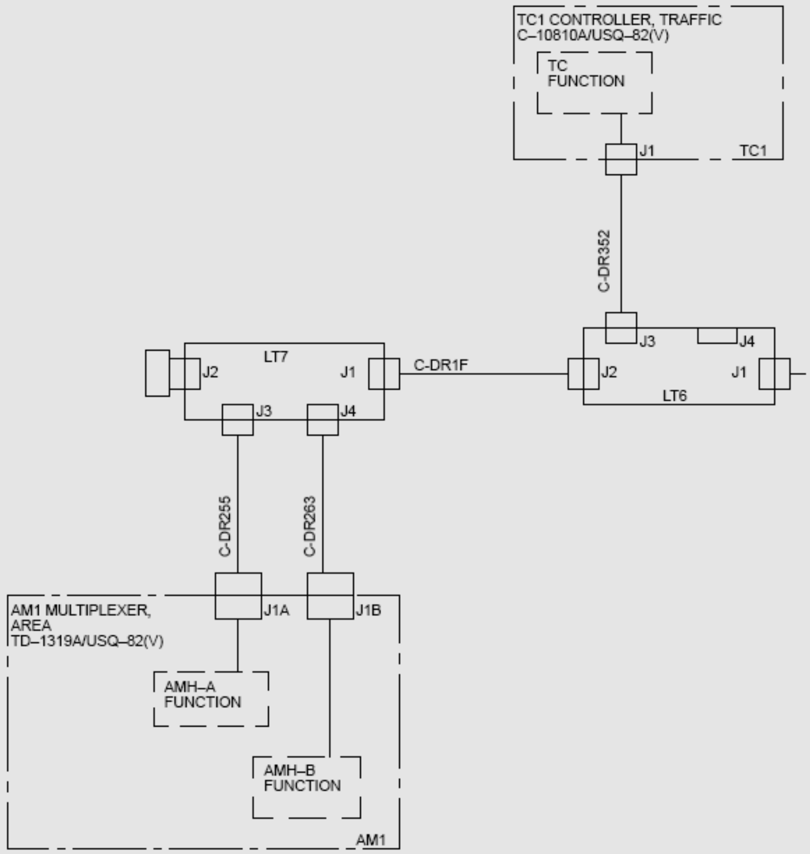


Figure 8-36. Cabling System Components (Sheet 2 of 2).

Cable Numbering System

A single primary bus consists of up to 17 primary bus segments, up to 18 line tap couplers, and two dummy loadline terminators. The primary buses are numbered PB1, PB2, PB3, etc. The primary bus segments are numbered PB11, PB12, PB13, etc.., for primary bus number 1. The primary bus segments are number PB21, PB22, PB23, etc., for primary bus number 2. The primary bus segments are numbered PB31, PB32, PB33, etc.., for primary bus number 3 and so on. Using PB32 as an example, 3 represents the primary bus number and 2 represents the segment number. The line tap couplers are numbered sequentially: LINE TAP 1, LINE TAP 2, LINE TAP 3, etc., starting from the forward end of the ship on a single bus. If the last number used is LINE TAP 18 at the end of primary bus 1, then the first line tap coupler on the next primary bus is numbered LINE TAP 19 and so on. To locate a defective primary bus segment, when given a fault index number, refer to the Ship Specific Database applicable to your ship for a cross reference between a fault index number and the defective cable. Then refer to the in primary bus layout diagram (Figure 8-37) and ship's drawings applicable to your ship for its location on the ship. The primary bus number is determined by which jack it is connected to on ME as follows:

a. The primary bus connected to jack J11 on ME No. 1 is primary bus PB1.
b. The primary bus connected to jack J10 on ME No. 1 is primary bus PB2.
c. The primary bus connected to jack J9 on ME No. 1 is primary bus PB3.
d. The primary bus connected to jack J11 on ME No. 2 is primary bus PB4.
e. The primary bus connected to jack J10 on ME No. 2 is primary bus PBS.



LINE TAP LOCATIONS, PRIMARY BUS 1		
LINE TAP NUMBER		LOCATION
* PHYSICAL	** PROGRAM	
T1–1 (LT7)	00	PASSAGE 1–254–6–L
T1–2 (LT6)	01	PASSAGE 1–254–6–L
T1–3 (LT5)	02	PASSAGE 1–254–6–L
T1–4 (LT4)	03	PASSAGE 1–174–01–L
T1–5 (LT3)	04	SHIP'S STORE STRM #2 1–78–4–A
T1–6 (LT2)	05	SHIP'S STORE STRM #2 1–78–4–A
T1–7 (LT1)	06	PASSAGE 1–42–01–L

* NUMBER ACTUALLY MARKED ON LINE TAP
** NUMBER DISPLAYED ON PLASMA DISPLAY TERMINAL (PDT) IN RESPONSE TO FNLG COMMAND

FAULT INDEX NUMBERS FOR PRIMARY BUS 1	
FAULT INDEX NUMBER	BUS SEGMENT SUSPECT
20	C-DR1F
36	C-DR1E
21	C-DR1D
22	C-DR1C
23	C-DR1B
24	C-DR1A

Figure 8-37. PRIMARY BUS NO. 1 DISTRIBUTION (SHEET 1 OF 2).

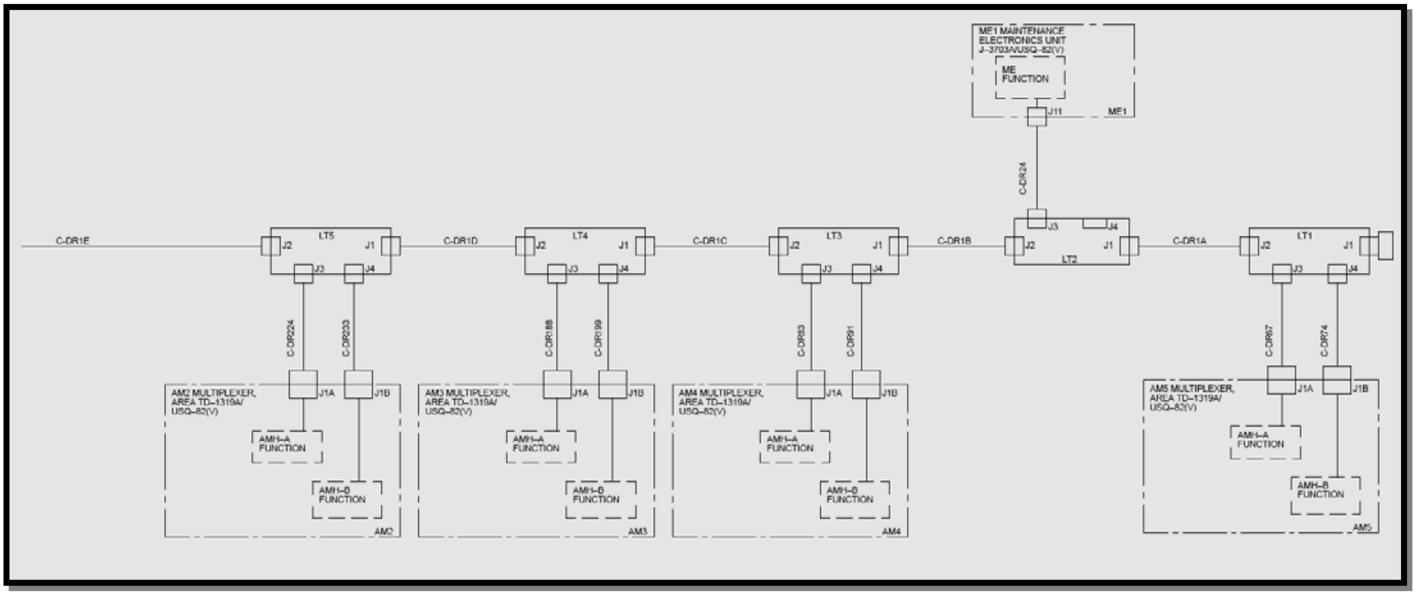


Figure 8-37. PRIMARY BUS NO. 1 DISTRIBUTION (SHEET 2 OF 2).

Primary Bus Description

NOTE

Primary bus segment 16 is always the segment to which the TC's line tap coupler is connected. There are two segments connected to the line tap coupler. The segment that is located between the TC's line tap coupler and the ME's line tap coupler is segment 16.

The DMS configurations may be comprised of any number of primary multiplex buses as needed to meet survivability requirements. A single-bus system is not recommended for tactical applications because of the lack of redundancy. A typical single-stage configuration uses three primary buses. A typical dual stage configuration has five primary buses. Five primary buses are the greatest number of buses which will provide full interconnectivity, (all terminals connected to all other terminals via all buses). Larger systems with six to nine or more buses are possible for applications in which some buses are dedicated to a limited set of terminals. Each of the five primary buses consists of a set of up to 17 coaxial cable segments of varying lengths, 2 dummy load-line terminators, and a set of up to 18 line tap couplers to which TC, AM, ARM (LHD only), and ME stub bus cables are connected.

Typical Primary Bus Configuration

A typical maximum dual-stage DMS configuration has a primary bus system that consists of 5 coaxial main primary buses, 85 main bus coaxial cable segments of various lengths, 90 line tap couplers, 10 dummy load-line terminators, and 170 coaxial stub cables of various lengths. These quantities are based on a maximum size dual stage configuration with 16 AMs, 5 TCs, and 2 MEs. Each main primary bus consists of 18 line tap couplers interconnected in series with 17 coaxial cable segments and terminated at both ends with a dummy load-line terminator. The length limitation of each primary bus segment cable is also 1500 feet. The primary bus segment cables are fabricated with type M17/ 067-RG177 flexible coaxial radio frequency 50-ohm cable. The coaxial cable has a solid copper wire inner conductor with two braided shields.

Primary Bus Interface

The primary cable interface is performed by RF transceivers (located in the TCs, AMs, ARMs, and MEs) that have the capability of selecting any one of the five frequency separated channels. The channel selection for the data receivers and data transmitters (part of the RF transceiver) is controlled by logic signals. Control channel receiver (part of RF transceiver) frequency selection is accomplished through strapping options.

STUB Bus Description

The stub cables connect the TCs, AMs, ARMs and MEs to the main primary bus through line tap couplers. Each of the five main primary buses is connected to one TC, 16 AMs, and one part of two MEs by means of 34 stub cables through 18 line-tap couplers. These quantities are based on a maximum size dual state DMS configuration. When ARMs are used in a hybrid integrated DMS the ARMs connect to the primary buses by means of three stub cables. The TC, AM and ME stub cables are type RG217/U coaxial cables. The coaxial cable has a stranded inner conductor wire and a braided wire outer conductor. Length limitation of each stub cable is 300 feet.

Secondary Bus Cable Description

The secondary bus cables interconnect the RMs to the AMs. The secondary bus consists of a set of 448 cables. Each RM redundant half is connected to two separate AMHs by means of two secondary bus cables. Therefore, there are four secondary bus cables that connect each of 112 RMs to AMs. These quantities are based on a maximum size dual stage configuration. The cable has two 21-pin connectors and assembled with type 2 SWAU-7 wires. The length limitation of each secondary bus cable is 300 feet.

I/O Bus Description

The I/O bus cables, interconnect the IOU8 and IOU16 to an ARM (LHD only) or RM. The I/O bus consists of a set of 896 cables. There are 896 cables since 2 I/O bus cables from each of 448 IOUs connect the IOUs to RMs. These quantities are based on a maximum size dual-stage configuration. The cable has two 42 pin connectors. Type 2 SWAU-19 cable is used for the electrical pin-to-pin circuits between the connectors. The length limitation of each I/O bus cable is 150 feet.

8.1.32 ARM-TO-ARM (LHD only) Interconnect Cable Description

The three ARM-TO-ARM (LHD only) interconnecting cables, pair two ARMs (LHD only) for redundancy since a single ARM (LHD only) is internally non-redundant. Two of the cables have 92-pin connectors on both ends and the third cable has 42-pin connectors on both ends. Type 2 SWAU-44 cable is used for the electrical pin-to-pin circuits between the connectors. The length limitation of all these cables is 5 feet.

8.1.33 Line Tap Couplers

Each AMH, ARM (LHD only), and ME is connected to the primary bus by means of cable stubs and up to 18 line-tap couplers. The line tap couplers that are connected between primary bus segment cables are passive networks that provide impedance matching and 20 db isolation between the stub cables and primary bus. Each primary bus segment cable is interconnected by a line-tap coupler.

8.1.34 Primary Bus Line Termination

Each primary multiplex bus is terminated at both of its extreme ends by dummy load line terminators. Therefore, there are 10 dummy load line terminators on a five-primary bus system. The dummy load line terminators have a characteristic impedance equivalent to that of the cable.

8.1.35 Power Cables

Fabrication of all power cables is a function of the installation shipyard since the length of the cable varies and cannot be predetermined. The cable length is determined at the time of installation. The following is a list of the power cables and the number required for each major assembly. The AM and RM require two power cables for redundancy reasons.

POWER CABLE	NUMBER REQUIRED PER UNIT
Electrical Cable Assembly	2
ARM (LHD only) Power Electrical Cable Assembly	1
IOU8 Power Electrical Cable Assembly	1
IOU16 Power Electrical Cable Assembly	1
ME Power Electrical Cable Assembly	1
RM Power Electrical Cable Assembly	2
TC Power Electrical Cable Assembly	1
AN/UYK-44 Power Cable Assembly	1
AN/USH-26 Power Cable Assembly	1
Plasma Display Set AN/USQ-96(V) Power Electrical Cable Assembly	1
Teletypewriter Set AN/UGC-136AX Power Electrical Cable Assembly	1

Table 8-17. Cabling Requirements.

8.2.0 FIBER OPTIC DATA MULTIPLEX SYSTEM (FODMS)

The Fiber Optic Data Multiplex System (FODMS) AN/USQ-82(V) (Figure 8-38) is a modular, general purpose, information transfer system designed to integrate interior ship system equipment.

Figure 8-38. FODMS System AN/USQ–82 (V).

Mission of Fiber Optic Data Multiplex System

FODMS provides data transfer services for communication between mission critical, distributed user systems. The Machinery Control System, Steering Control System, Alarm & Indicating System, and Navigation System are examples of systems, which employ FODMS for data transfer. The FODMS mission profile is continuous operation at 24 hours per day, 365 days per year.

System Functional Relationships

FODMS provides information transfer services within individual systems, between one system element to another, or between ship systems. FODMS provides signal and interface protocol conversion capabilities so equipment with different interface requirements can communicate. The connected user system data can be routed from any source user equipment to any sink user equipment. FODMS also provides data transfer multiplexing of a single data source transfer to multiple sinks and from multiple data sources to a single data sink.

The FODMS incorporates configuration interface elements for a variety of user system equipment. A wide assortment of users can be connected to FODMS: digital, discrete, Synchro, analog, Ethernet/RS-422 connected IP hosts are just some of the user types accommodated.

FODMS Functional Description/SAFENET Basics

FODMS is based on the military Survivable Adaptable Fiber Optic Embedded NETwork (SAFENET) standard. The SAFENET standard is an extension of the commercial Fiber Distributed Data Interface (FDDI) standard, ANSI X3T9.5. SAFENET defines a fiber optic network based on dual, counter-rotating, packet-switched, token passing rings. Figure 8-39 is a simplified diagram of a SAFENET network with five nodes. As many as 256 nodes can be supported on the Network. Each node can originate messages for one or more of the other nodes and each node can receive messages from other nodes. During normal operation, all user message traffic is on the primary ring. Messages are broken up into data "packets" to facilitate transfer. Each packet contains information, which identifies both the source (sender) and sink (destination) of the packet. Messages on the rings are processed as follows:

- If neither the source nor the destination address of the packet corresponds to the receiving node, the node simply retransmits the packet to the next downstream node.
- If the source address is not the receiving node but the destination address is the receiving node, the message packet is copied for use. This packet is simultaneously retransmitted to the next downstream node.
- If the source address corresponds to the receiving node's address, the packet has made a complete path around the network and is discarded.

The secondary ring is used for user message traffic only if damage occurs to the network. Otherwise, the only messages on the secondary ring are system messages used to verify which nodes are operating and which data paths are intact. Should a break occur in the network, the nodes nearest the break will go into "wrap" to form a single functional ring. If multiple breaks occur, the network will "segment" and communications will no longer be possible between all nodes.

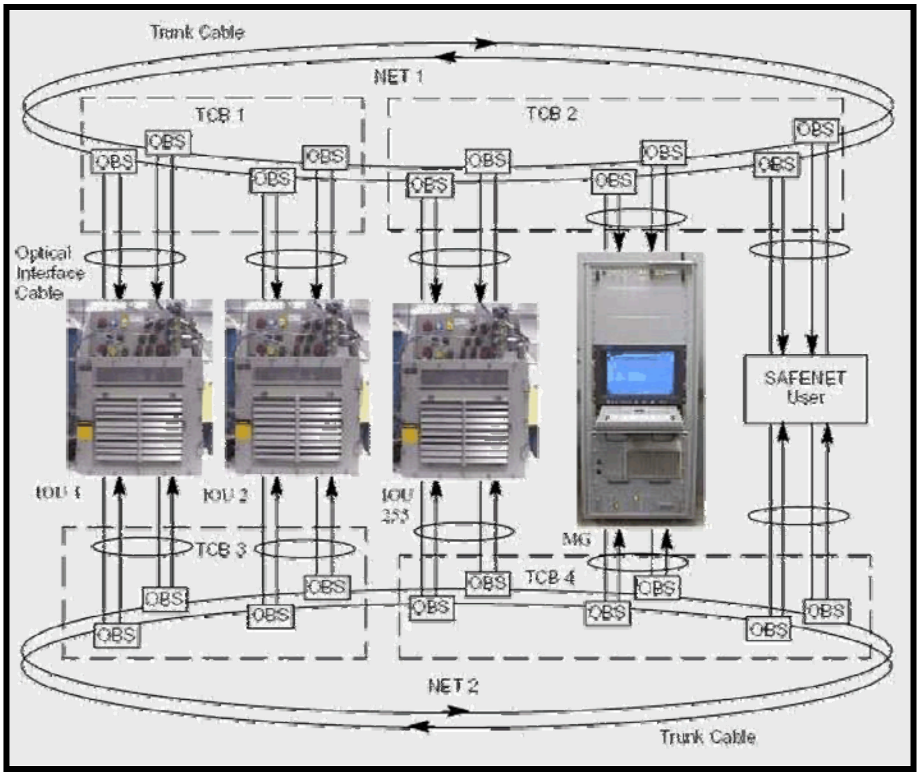


Figure 8-39. FODMS – Block Diagram.

<u>FODMS SAFENET Networks</u>

The FODMS design uses two independent SAFENET data networks along with internally distributed processing to transfer all connected user system data to and from Input-Output Units (IOUs). The two independent SAFENET data networks operate redundantly to provide a reliable, survivable information transfer system. Using two totally independent networks ensures all FODMS units can communicate in casualty situations so long as one of the networks has no more than one break.

The two FODMS networks are physically isolated from each other as much as possible to minimize the probability that both networks will be damaged by a single event. In shipboard installations, Optical Bypass Switches (OBSs) are located in separate watertight Interconnection Boxes called Trunk Coupling Boxes (TCBs). The physical layout of the FODMS networks is defined in ship or site drawings.

Major FODMS System Components

The major components of FODMS are SAFENET networks, Trunk Coupling Boxes (TCBs), Input Output Units (IOUs), and Maintenance Group (MG). FODMS System AN/USQ-82(V) illustrates these major components. FODMS TCB - The FODMS TCB is an interconnection box containing eight Optical Bypass Switches (OBSs). During normal operation, the OBSs connect the IOUs to the SAFENET networks. In the event of a loss of IOU power, total loss of the IOU, or through direct FODMS control, the OBSs operate to remove the IOU from the SAFENET networks. The fiber optic cable, terminated with ST connectors, physically connect fiber cables between an IOU and OBS and between OBSs.

FODMS IOU - The FODMS IOU is a SAFENET node containing IOU system modules and Input-Output Modules (IOMs). The IOU system modules control data flow to/from FODMS networks and to/from the IOMs. The IOMs interface user system equipment with the FODMS (see Figure 8-40).

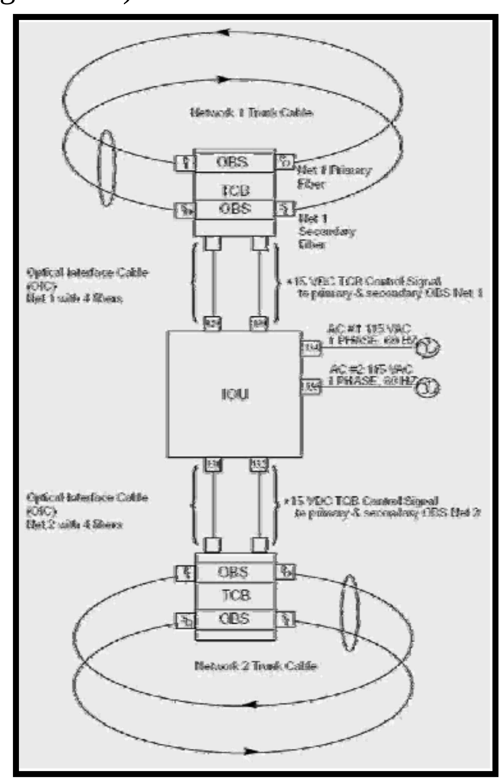
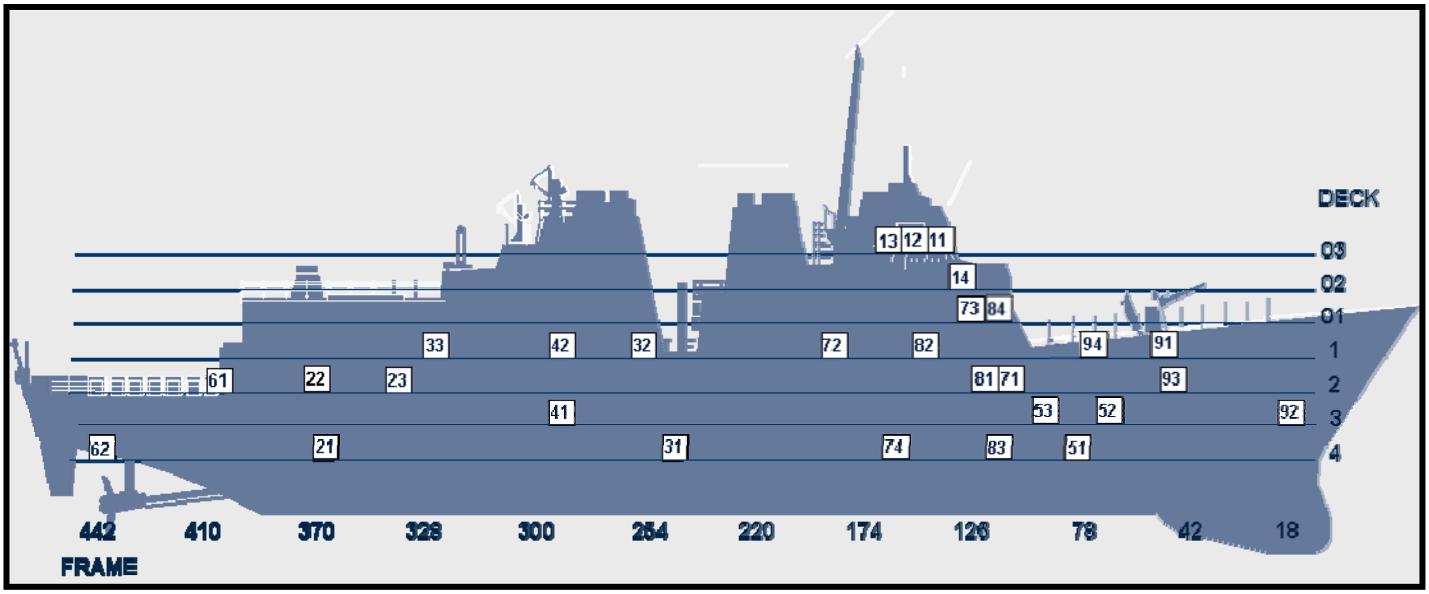


Figure 8-40. Typical Interconnections.

8.2.1 Physical Arrangement/System Configurations

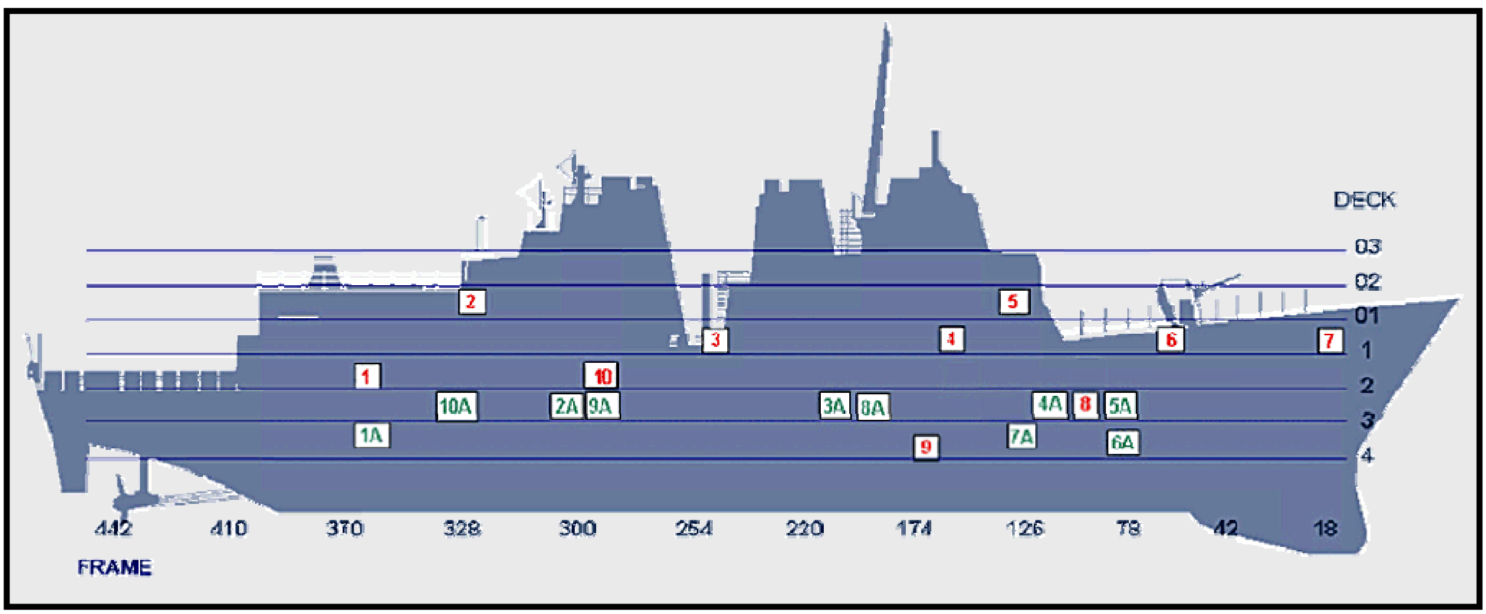
The arrangement of FODMS equipment depends upon the ship or site in which the FODMS is installed. The number and location of IOUs is based on the number and location of connected user equipment. The MG serves as both a maintenance aid and a system monitor. Figure 8-41 (Sheet 1) and Figure 8-41 (Sheet 2) illustrate the typical layout of major FODMS equipment.



IOU #	LOCATION	COMPARTMENT NAME	IOU #	LOCATION	COMPARTMENT NAME
11	03-142-1-Q	ELECTRONIC WORKSHOP NO. 1	61	2-410-2-A	REPAIR 3
12	03-142-1-Q	ELECTRONIC WORKSHOP NO. 1	62	4-442-0-E	STEERING GEAR ROOM
13	03-142-2-Q	ELECTRIC LOAD CENTER NO. 1	71	2-126-1-C	COMMUNICATIONS CENTER
14	02-154-1-L	PASSAGE	72	1-206-3-A	REPAIR 5
21	4-370-5-A	SUPPLY DEPARTMENT STOREROOM NO.3	73	01-130-0-Q	CSMC
22	2-378-2-A	AVIATION STOREROOM NO. 1	74	4-174-0-E	ENGINE ROOM NO. 1
23	2-338-1-L	PASSAGE	81	2-126-2-C	COMBAT SYSTEM EQPT RM NO. 2

31	4-254-0-E	ENGINE ROOM NO. 2	82	1-158-4-Q	COMBAT SYSTEM OFFICE
32	1-268-0-C	CENTRAL CONT STA & DC CENTRAL	83	4-126-0-E	AUXILIARY MACHINERY ROOM NO. 1
33	1-330-0-A	DAMAGE CONTROL EQUIPMENT LOCKER	84	01-110-01-Q	TECHNICAL LIBRARY ANNEX
41	3-300-0-C	IC & GYRO ROOM NO. 2	91	.5-42-1-A	INERT GAS CYLINDER STOREROOM
42	1-300-0-C	COMBAT SYSTEM EQPT RM NO. 3	92	3-18-0-Q	SONAR EQUIPMENT ROOM NO. 3
51	4-94-0-C	IC & GYRO ROOM NO. 1	93	2-53-1-C	COMBAT SYSTEM EQPT RM NO. 1
52	3-116-1-T	ACCESS TRUNK	94	1-94-1-A	REPAIR 2
53	3-116-1-T	ACCESS TRUNK	MG	3-300-0-C	IC & GYRO ROOM NO. 2

Figure 8-41. Typical Equipment Distribution (Sheet 1).



TCB #	LOCATION	COMPARTMENT NAME	TCB #	LOCATION	COMPARTMENT NAME
1	2-381-1-Q	ELECTRIC SHOP	1A	4-370-6-A	SUPPLY DEPT STOREROOM NO 4
2	01-338-2-Q	SWBD NO 3 ROOM	2A	3-310-2-L	CREW LIVING SPACE NO 5
3	1-268-4-A	HALON ROOM NO 2	3A	3-220-2-Q	SUPPLY SUPPORT CENTER
4	1-174-0-L	CPO MESS	4A	3-126-2-Q	POWER SUPPLY/CONVERSION ROOM
5	01-130-0-Q	CSMC	5A	3-97-02-L	CREW LIVING SPACE NO 2
6	1-78-4-Q	SHIPS OFFICE	6A	4-94-0-C	IC/GYRO ROOM NO 1
7	1-18-0-Q	SONAR EQUIPMENT ROOM NO 1	7A	4-126-0-E	AUXILIARY MACHINERY RM NO 1
8	3-116-1-T	ACCESS TRUNK	8A	3-220-01-A	SUPPLY DEPT STOREROOM NO 1
9	4-174-0-E	ENGINE ROOM NO 1	9A	3-300-1-L	CREW LIVING SPACE NO 4
10	2-300-01-L	CREW LIVING SPACE NO 3	10A	3-338-3-L	CREW LIVING SPACE NO 6

Figure 8-41. Typical Equipment Distribution (Sheet 2).

8.2.2 System Equipment/Major Unit Basic Functions

Input/Output Unit (IOU)

The Input/Output Unit (Figure 8-42) provides user-to-user communications paths for transmission of data between users. The IOU converts user signals at the IOM input to fiber optic signals for transmission to other IOUs, and converts incoming fiber optic signals from the other IOUs for transmission to users connected to IOM outputs. The IOU consists of a mechanical enclosure containing a set of Input/Output Modules, two Fiber Distributed Data Interface Controller (FDDIC) modules, a Data Multiplex System Controller (DMSC) module, a fan assembly, and a power supply. The module housing provides backplane interconnections; i.e. IOU bus, VSB (B-bus) and VME Subsystem Bus, fiber optic cable connectors, user interface cable connectors, and environmental protection for the functional elements.

An IOM converts data from a user to standard digital format, converts digital data from the network to user format, and services user interface handshakes. The specific set of IOMs in an IOU is determined by the application. The maximum number of IOMs in an IOU is 15. The DMSC module and on-board firmware controls message traffic to/from the IOMs and the FDDIC modules. Each FDDIC module and on-board firmware controls message flow on the dual ring network. The Ethernet IOM has the capability to communicate over the VSB backplane (B-bus) utilizing IP-to-IP protocol. This interface provides a direct link to the FDDIC module then to the network, effectively bypassing the DMSC module.

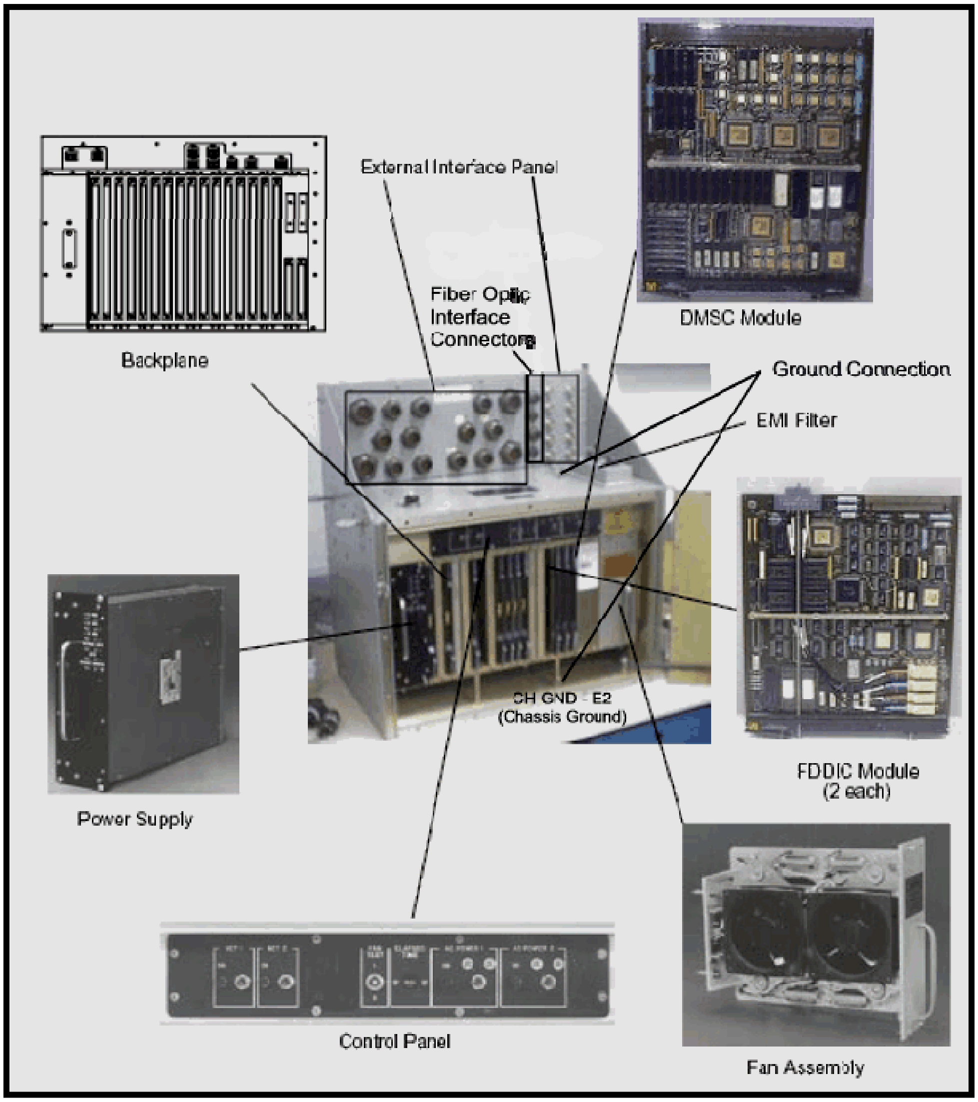


Figure 8-42. Input/Output Unit (IOU).

IOU Block Diagram

The configuration of elements within an IOU is shown in Figure 8-43.

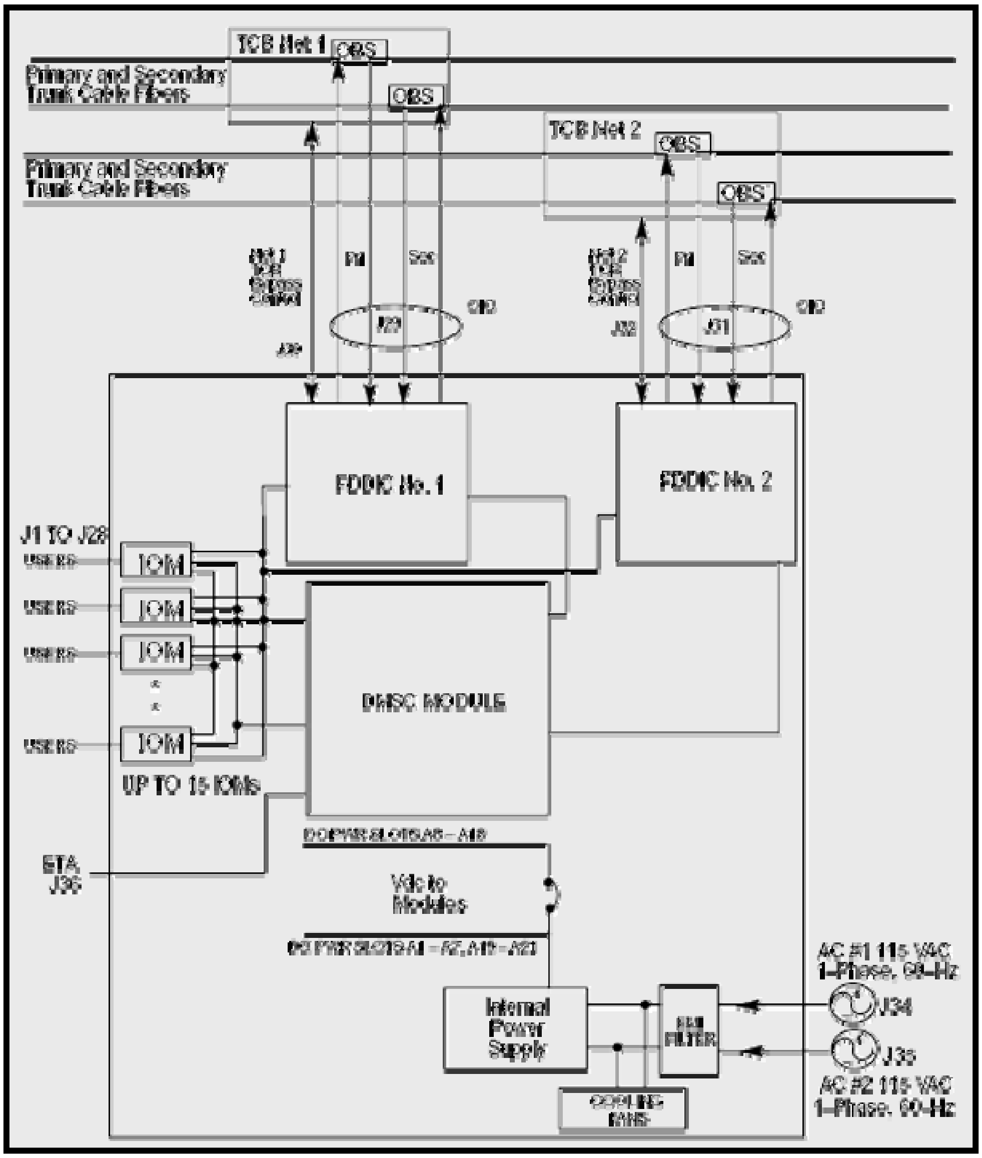


Figure 8-43. Input/Output Unit (IOU) Block Diagram.

Interface Definition

The IOU interfaces to the ship, IOM users, the Event Time Analyzer (ETA), and the Fiber Optic Networks.

IOU/Ship Interface

The FODMS units will mechanically interface with the ship at attachment points specified in NAVSEA 10052-113. The FODMS units interface with the ship's compartment air which is used for ambient air cooling of each unit. The interface to ship electrical power (voltage, power dissipation, etc.) is a dual AC, single phase, 115 VAC 60-Hz input.

IOU/IOM User Interface

The IOU interfaces to the IOM user equipment via a mix of 92-pin, 42-pin, and TRIAX connectors.

FODMS/Network Interfaces

The IOU contains an electrical and fiber optic interface with each of the two networks (NET 1 & NET 2). The IOU transfers data and command or status messages over redundant networks. Each network uses FDDI dual-ring topology with Optical Bypass Switches (OBSs) and fiber optic cables to interconnect IOUs. The electrical interface consists of a +15 VDC IOU control signal to activate the OBSs. The fiber optic interface provides the optical data connection for each ring.

ETA Interface

The Event Time Analyzer (ETA) provides an operator interface to the DMSC module to monitor system performance. The interface signals between the ETA and each DMSC consists of an RS232 interface and an ETA Interface (ETAIF). The RS232 interface is used to transfer commands, system message numbers and data between the ETA and the DMSC module. The system message numbers are used by the DMSC for message number comparison. The ETAIF contains an interface and storage for each DMSC interface, control registers and status registers. The interface is a bayonet-type multi-pin connector mounted on the IOU Horizontal Panel. The ETA is a special purpose piece of test equipment and not normally available for ship maintenance.

IOU Physical Construction

The IOU is a bulkhead-mounted enclosure for IOMs and system modules. The IOU provides power, cooling, and environmental protection for the modules and houses two FDDIC modules, one DMSC module, and 1-15 Input/Output modules. It also contains a fan assembly, a control panel, power supply, and a backplane and EMI filter (Figure 8-42).

Control Panel

The control panel contains two circuit breakers which act as AC power on/off switches, two AC power-on indicators (AC Power 1/2), Network controls and indicators (Net 1/2), an Elapsed Time Meter (ETM), and a Fan Test Switch. Refer to Chapter 2 for a complete list of all controls and indicators and their functions.

Mounting

The IOU is designed to be mounted on the bulkhead, using a bracket supplied by the installing activity attaches to the mounting holes on the sides of the unit.

Security Provision

The front door is capable of being locked with a standard padlock.

External Interface Connector Panel

A vertical panel on top of the IOU provides for user connections to IOMs, and connection to Networks 1 and 2. The horizontal top surface of the IOU provides connections for power and for the ETA.

Module Housing and Interconnection

The following paragraphs detail the IOU Module housing and interconnections.

Backplane Assembly

Interconnection within the IOU is made with the backplane assembly. The backplane assembly interconnects the modules and power supply using a multi-layer Printed Wiring Board (PWB). The backplane provides for bi-directional transfers between IOM to IOM, IOM to DMSC, IOM to FDDIC, and DMSC to FDDIC transfers. The backplane contains a Terminal Junction Box that provides the means to terminate harnesses for the Control Panel, Fan Assembly, and connector panels. The interfacing connector panel is located on the top section of the enclosure.

Terminal ID Shunt

The IOU backplane provides a means for setting a unique 8-bit IOU identification code that can be read by the DMSC module. The device for setting the code is mounted on a socket that is designed for multiple insertions without deterioration. This socket is mounted on the front side of the backplane in proximity to the FDDIC module connector, so that it can be changed without dismantling the IOU.

Module Location

Slots for FDDIC modules at slots A20 and A21, one DMSC module in slot A19, and 1-15 Input/Output modules are numbered from A01 through A08 and A12 through A19 (slots A09, A10, A11 and connectors J09, J10, J11 do not exist). For IOMs, the slot numbers and user interface connector numbers correspond; i.e., A01 is connected to J01, etc.

Module Insertion/Extraction

The IOU provides for insertion and extraction of modules from the front of the unit and for secure locking of fully inserted modules. Self-contained cams, for inserting and extracting modules, are part of the modules. A locking screw must be extracted before attempting to extract the FDDIC using the self-contained cams.

Power Supply and Fan Assembly Insertion/Extraction

The IOU provides for insertion, locking, and extraction of the power supply and fan assembly from the front of the unit.

Power Distribution

The IOU backplane provides distribution of +5VDC, +15VDC, and -15VDC from the internal IOU power supply to module locations A01 through A21.

IOU External Connections

Table 8-18 below contains a complete list of IOU connector types, reference designators, and slot locations.

Connector Types, Reference Designators, and Slot Locations		
Reference Designator	**Connector Type**	**Slot Location**
J36	ETA	N/A
J30, J32	FDDIC (OBS)	N/A
J29, J31	FDDIC (Fiber Optic)	N/A
J34, J35	AC Input	N/A

Table 8-18. Connector Types, Reference Designators, and Slot Locations.

IOM User Connections

IOM user access is via the mix of four 92-Pin connectors, eleven 42-Pin connectors, and ten Triaxial connectors. Mating connectors to the 92-Pin, 42-Pin, and Triaxial connectors will be specified on shipboard installation drawings. All 92-Pin connectors and all 42-Pin connectors have the same keying arrangement.

Fiber Optic Connections

The IOU provides a Fiber Optic Interface Connector (FOIC) for each of the two networks. Each connector can accommodate four fibers (Primary Transmit, Primary Receive, Secondary Transmit, and Secondary Receive). Fiber optic cable connection from the FOIC to the associated FDDIC module is via the backplane-mounted fiber optic connector that permits insertion and extraction of the FDDIC module without need to dismount the IOU. The two FOICs have different keying arrangements. The FDDIC provides an optical transmitter output and an optical receiver input for each ring of the network.

Trunk Coupling Box Connections

The IOU provides a three-pin, bayonet coupling connector for each of the two networks for control of the primary and secondary OBSs. The connectors have the same keying arrangements. The mating connector identification on the interface cable must be observed when connections are made to assure that controls to Net 1 and 2 are not reversed.

ETA Connection

The IOU provides a bayonet coupling connector with a removable cap for the Event Time Analyzer (ETA) interface signals. The connector is mounted on the IOU Horizontal Panel near the front of the unit.

Input Power Connector

Each of the IOU power connectors, located on the EMI Filter Assembly, is a three-pin MIL-C-5015 type connector. The EMI filter is located on the top surface of the IOU in front of the vertical connector panel.

Cooling System

Cooling is accomplished by internal AC fans. The inlet air enters the housing through a louvered opening on the front of the unit, passes an air filter, and exits through an opening in the right side of the housing (as viewed from the front).

Fan Assembly

The fan assembly contains four fans (two banks of two fans). One bank of fans is operated by the AC#1 input, the other by the AC#2 input. Loss of one AC input will reduce cooling capacity but will not result in immediate IOU shutdown or damage to the IOU. When all fans are operating, the cooling system maintains the temperature of all semiconductor and microelectronic devices at acceptable levels. The fan assembly is shown in Figure 8-44.

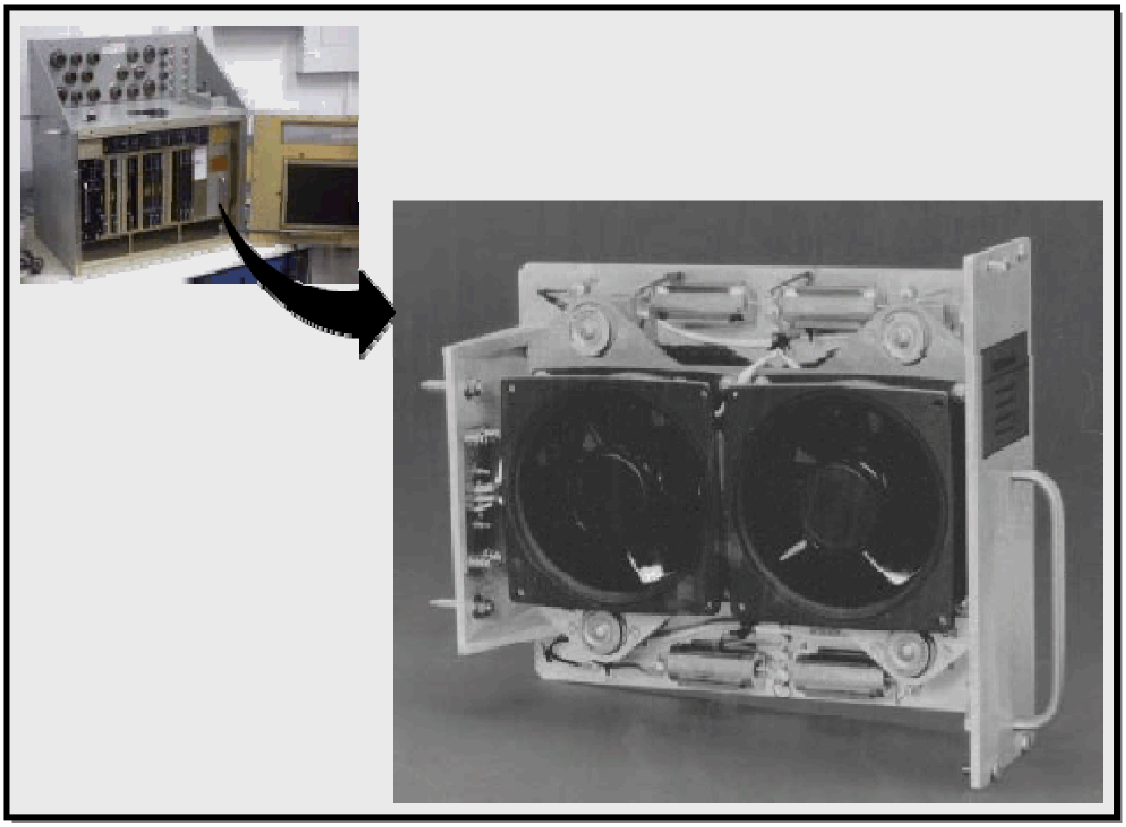


Figure 8-44. Fan Assembly.

AC Power Input

The IOU operates from dual AC sources (Figure 8-45). Each input is 115 volts, single phase, 60-Hz, Type I power.

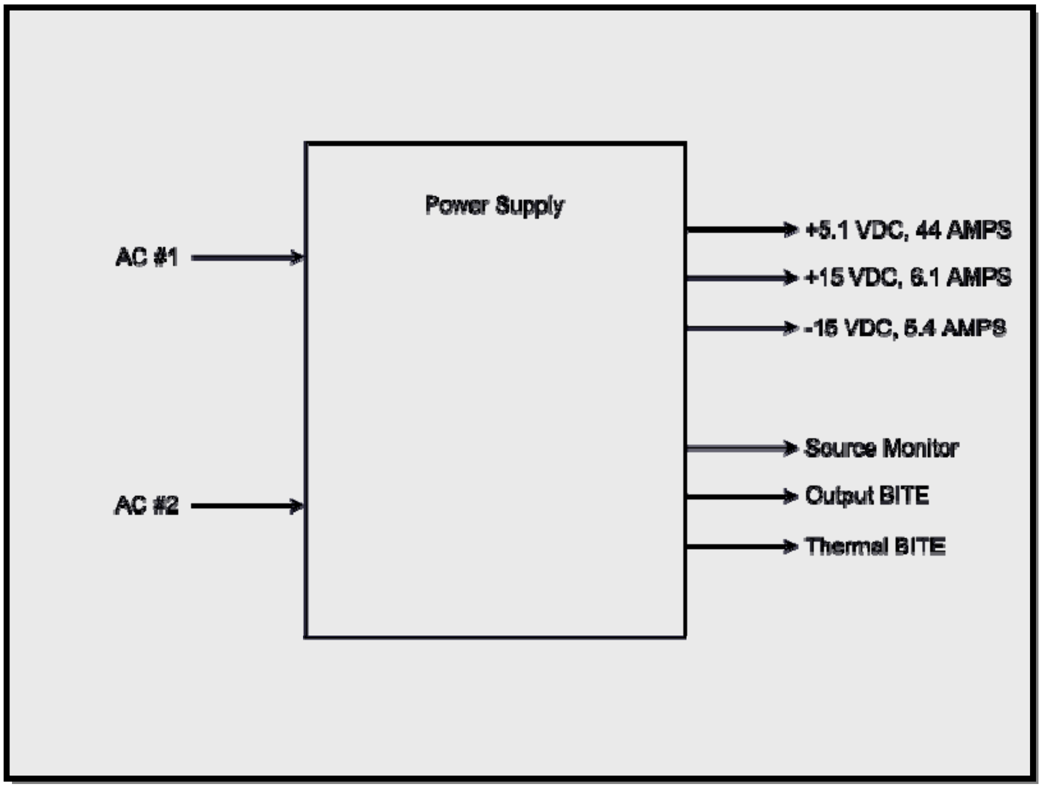


Figure 8-45. AC 1 & AC 2.

Primary Power Dissipation
The maximum power dissipation of the IOU is 650 watts.

Primary Power Interruptions
The IOU will remain fully operational through momentary power interruptions of 650 milliseconds or less on either of the two inputs. If power interruptions of any duration occur simultaneously on both AC inputs, the IOU will restart and be on-line to both networks in 3.0 seconds or less. If power is interrupted on one of the AC inputs for durations greater than 650 milliseconds, the IOU cooling capacity may be reduced to one-half that which is available when both inputs are present, but all other functions of the IOU will operate indefinitely with one AC input present.

Power Supply
The IOU power supply configuration is shown in Figure 8-46.

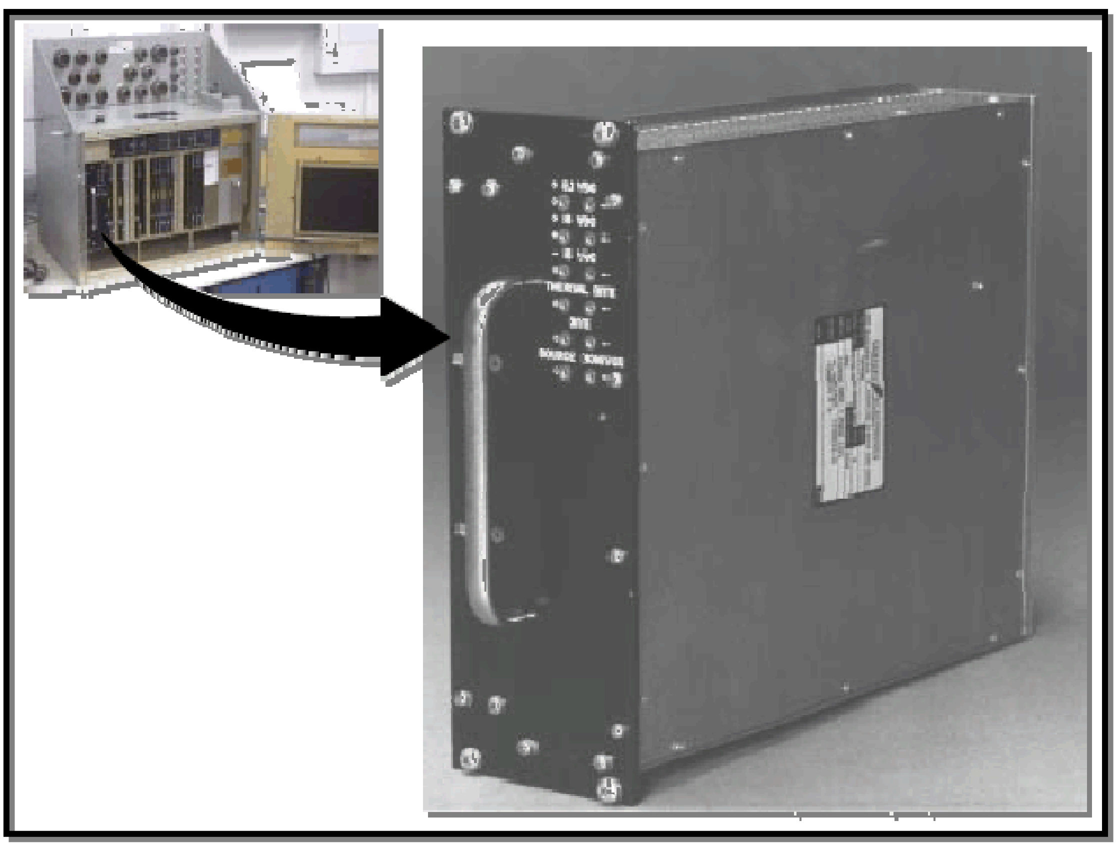


Figure 8-46. Power Supply.

Power Supply Outputs

The IOU power supply provides the following outputs: +5 at 44 amps maximum, +15 at 6.4 amps, -15 at 5.4 amps.

DMSC Module

The Data Multiplex System Controller (DMSC) module provides for transfer of data messages between the IOMs and the FDDI Controller (FDDIC) modules and is mounted in slot A19 of the IOU.

FDDIC Modules

The Fiber Distributed Data Interface Controller (FDDIC) module converts digital to optical information and controls the transfer of FODMS messages between the DMSC module and the FDDI network. In addition, the FDDIC module, in conjunction with the Ethernet module, controls the transfer of messages via its VSB backplane (B-bus) and the FDDI network. The modules are mounted in slots A20 and A21 of the IOU.

Input/Output Modules (IOMs)

An IOM set consists of all of the IOMs installed in a particular shipset configuration (Figure 8-47), Typical Input/Output Module (IOM)). To avoid complicating the configuration control documentation of the IOUs, each IOM type in a set is identified as a separate item. A brief functional description of each of the various IOMs is contained in Table 8-19.

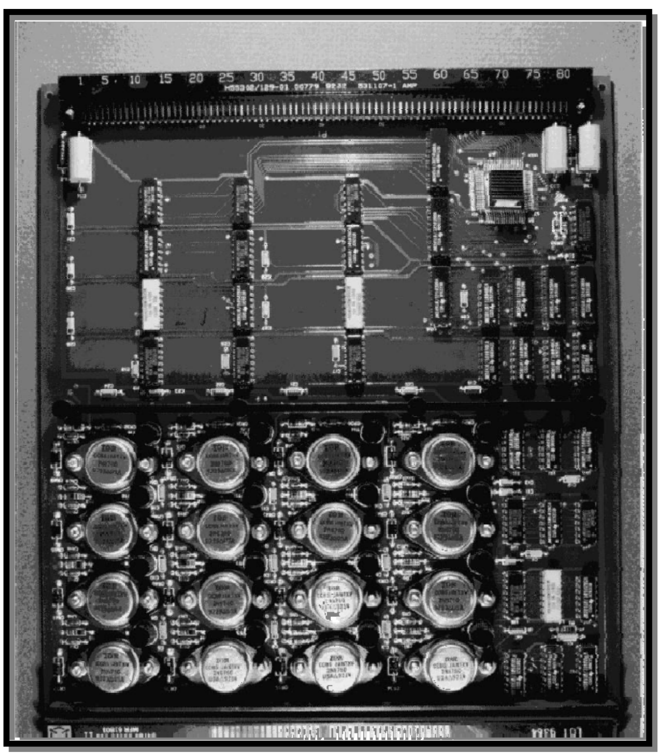


Figure 8-47. Typical Input/Output Module.

Input/Output Modules - Summary Descriptions		
IOM Name	**IOM Type**	**Purpose**
Discrete Input Switch Closure	AI	Interfaces with up to 16 single-pole, single-throw user switch circuits.
Discrete Output, Isolated Switch Closure, DC	AAO	Controls (open and closes) up to 16 user DC load circuits by means of 16 solid state relays.
Discrete Output, Isolated Switch Closure, AC	ABO	Controls (open and closes) up to 16 user AC load circuits by means of 16 solid state relays. Contains the Message Validation Processor (MVP) circuit.
Discrete Filtered Output, Isolated Switch Closure, AC	ACO	Controls (open and closes) up to 16 user AC load circuits by means of 16 solid state relays. Contains a filter to prevent known errors.
Tri-Level Input Active	BI	Interfaces with up to eight Tri-State passive/active sensor circuits that provide a nominal short circuit in an ALARM condition.
Tri-Level Discrete Output	BBO	Interfaces with up to eight channels of user switchboard and/or alarm panel circuits.
Discrete Input Isolated Voltage	DI	Interfaces with up to 16 channels of DC or AC/pulse type discrete signals.
Discrete Output Voltage Level	DCO	Provides a 16-channel bi-level discrete output interface to sink user devices.
Ethernet Module	E	Provides communication between users on an Ethernet network and FODMS users and other Ethernet networks using FODMS as a backbone. The EIOM also provides serial communication to both RS232 and RS422 users.
Synchro Input, Four-Channel	JI	This IOM has four channels of 90-Vrms, 60-Hz (2-Channels) or 400-Hz (4-Channels) Synchro signals, and converts each Synchro input channel to 14 bits of digital information.
Synchro Output, Four-Channel, 60-Hz	JAO	Provides four 90-Vrms, 60-Hz, 3-wire Synchro signal outputs.
Synchro Output, Four-Channel, 400-Hz	JBO	Provides four 90-Vrms, 400-Hz, 3-wire Synchro signal outputs.
Synchro Input, Four-Channel	JXI	This IOM converts four channels of 90-Vrms, 60-Hz or 400-Hz Synchro signals to 10-bit digital information.
NRZ 4 CH. Serial Data Input/Output	N	Functionally similar to NRZ 2 Channel I/O. When configured as a 2 Channel I/O, it can be used in place of the NRZ 2 Channel I/O.
NRZ 2 CH. Serial Data Input/Output	N	Each module provides interfaces to two NATO STANAG 4156 NRZ type users.
Parallel Data Output NTDS Fast	P1O	Interfaces with a user sink device that has an NTDS fast, category I (computer to peripheral) interface.
Parallel Data Input NTDS Slow	P2I	Interfaces with a user source device that has an NTDS slow, category I (computer to peripheral) interface.

Parallel Data Output NTDS Slow	P2O	Interfaces with a user sink device that has an NTDS slow, category I (computer to peripheral) interface.
Low-Level Serial Input	RI	Enables FODMS to communicate with user through MIL-STD-1397 type E (low-level-serial interface) protocol.
Low-Level Serial Output	RO	Enables FODMS to communicate with user through MIL-STD-1397 type E protocol.
Storage Module	SM	Does not interface directly with user. Used to store data between Input/Output Module.
Message Processor	Y	Does not interface directly with user. Used to control transfer of data between Input/Output Module.

Table 8-19. Input/Output Modules - Summary Descriptions.

Features Common to all IOMs

All IOMs contain BITE circuitry and include the same dual-channel interface to the DMSC. The digital signal connections provided by the IOU backplane assembly are between the DMSC module (IOC interface) and IOMs over signal buses (pins) A and C and are referred to as IOC A and IOC B. An IOM may contain BITE circuitry only in the interface IC (LSI) common to all IOMs, or may also include BITE circuitry in addition to that contained in the LSI.

IOM Types and Applications

In a specific application, each IOM performs one of four general system functions: (1) input, (2) output, (3) input plus output, (4) special function.

Input Functions

When requested by the DMSC or when a transfer is initiated by the source user, an input IOM receives source user device data in source user format, converts the data to the serial digital format used for internal DMS communications, and forwards this data to the DMSC for routing. A second active redundancy protocol, AREP, was developed specifically for use between IOMs communicating over the VSB backplane (B-bus). Since the B-bus communications do not have access to the DMSC, AREP was developed to provide IP-to-IP communications. The AREP protocol resides on the B-bus connection module (EIOM).

Output Functions

An Output IOM receives digital signals from FODMS circuitry, stores them in memory, converts the digitized signal into the format required by the sink user device(s), and outputs the converted signal to the sink user device(s). The reverse flow for the B-bus connected modules is similar to the input functions. The FDDIC module polls a buffer memory in all of its B-bus IOMs to see if any have pending service requests to provide outgoing data packets to IP devices.

Input Plus Output
An NRZ serial data IOM functions as an input module, an output module, or both an input and output module.

Special Functions
Message Processor Modules (MPMs) contain a general-purpose processor (68000) to perform data manipulation, message formatting, and message switching functions as required for specific applications. These IOMs do not have direct interfaces with a user device.

Module Keying
A variable keying device is located on each side of the module connector. The keying device is coded to match the mating keying device on the Backplane Assembly connector to prevent insertion of the module into the wrong connector. A variable keying device (Figure 8-48) is located on the Backplane Assembly for each IOM slot in the IOU. This keying device is provided to prevent insertion of the wrong module. The mating keying device on each IOM is fixed and unique for each IOM type. When it has been determined which module will be inserted in a particular Backplane Assembly connector, the Backplane Assembly connector-keying device is coded to match the module-keying device. A minimum of 32 keying codes is provided. When set for a particular module type, the keying arrangement will prevent a different module type from being physically inserted sufficiently to make electrical contact. Once coded, the connector-keying device can be changed later to accommodate a different IOM.

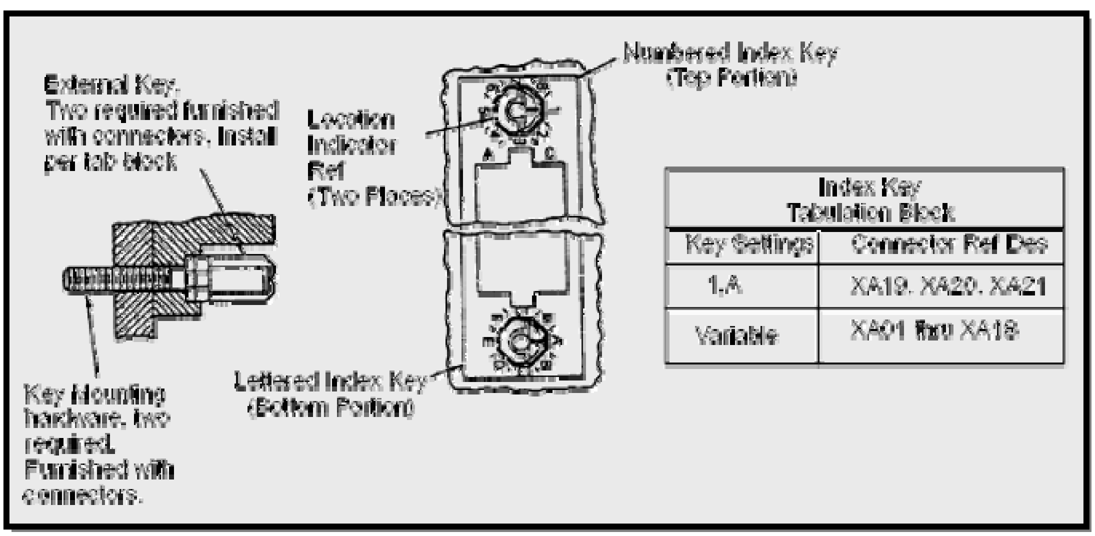


Figure 8-48. IOM Variable Keying Device.

Maintenance Group (MG)

The MG (Figure 8-49) consists of a computer workstation. It contains maintenance group applications and software for user interaction.

Figure 8-49. Maintenance Group Workstation.

MG Item Diagrams

The internal component breakdown of the MG is shown in Figure 8-50.

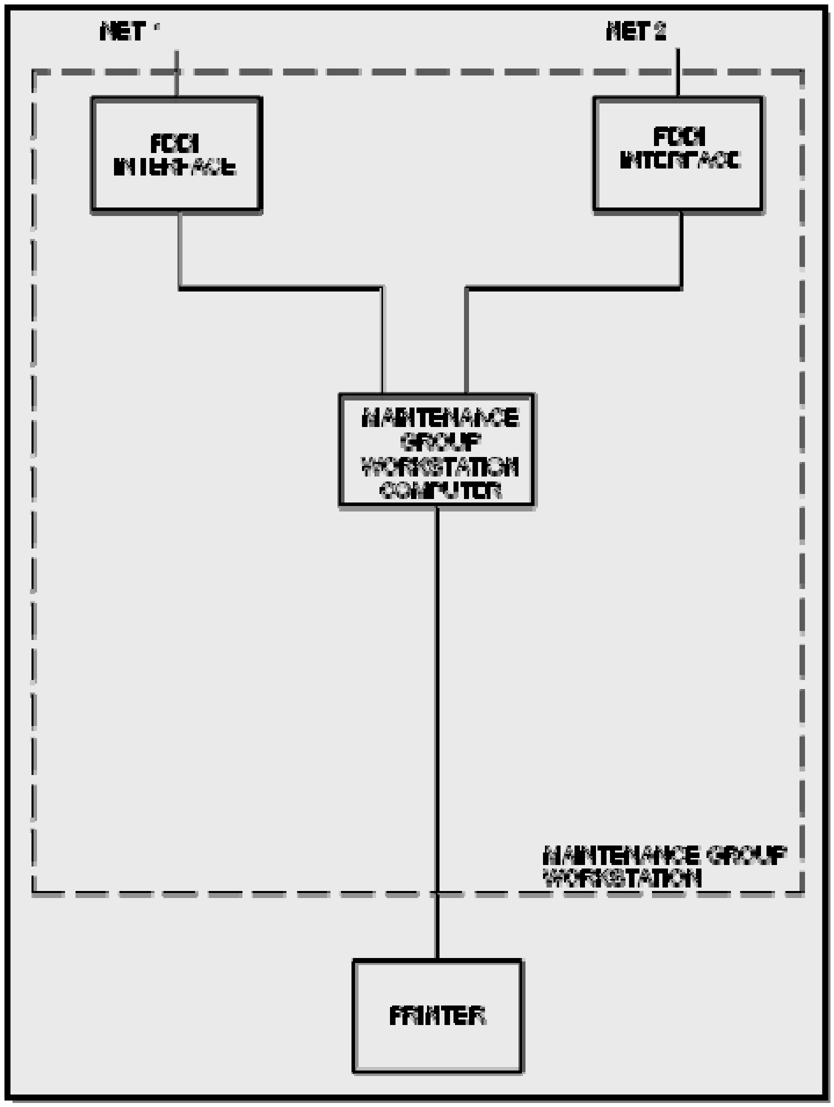


Figure 8-50. Maintenance Group Relationship of Units (MG Level).

Interface Definition
The MG interfaces are described in the following paragraphs:

Network Interface
The MG interfaces to FODMS via the FDDI cards. These are Dual Attach Station (DAS) cards that allow direct connection to the dual FDDI rings. They are connected to the rings via the Optical Bypass Switches (OBSs) which are powered from the card.

Printer Interface
The MGs connection to the printer is through a RS232 serial interface.

Tape and Floppy Disk Drive Interfaces
The tape and floppy disk drive interface is via the Small Computer Systems Interface (SCSI) bus.

MG Physical Components
The MG computer system measures 72" high by 22" wide by 28" deep. It weighs approximately 790 lbs.

Workstation
The MG is composed of a Hewlett Packard HP-UX Workstation.

FDDI Module
The MG provides two interface cards to allow dual attach connection to an FDDI network. There are four EISA slots provided in the chassis. The FDDI cards require only two of the EISA slots (DDG 79-98). DDG 99-102, FDDI modules, use VME (Versa Module Eurocard or Virtual Machine Environment) type. They are installed in the two VME slots directly above the processor card.

Maintenance Group Workstation Printer
The MG laser printer provides permanent hard-copy records of FODMS status, fault localization, configuration monitoring, and real-time integration support digital data. The interface with the MG is accomplished through a RS232 serial printer interface.

Maintenance Group Software Applications
Software applications on the MG include System Initialization, PM/FL, Electronic Technical Manual, Ship Specific Database, System Integration Support, Configuration Monitoring Support. The MG Software may change the screen display names throughout many iteration but the above (i.e. System Initialization, PM/FL, etc) will always be a function.

System Initialization
The system initialization software controls the initialization of the MG operating system software and the other FODMS specific software.

Performance Monitoring and Fault Localization (PM/FL)
PM/FL is the primary function of the MG and requires no operator inputs. The PM/FL mode generates displays and printouts to inform maintenance personnel that the FODMS is either operating properly or that a failure has occurred. The PM/FL consists of several sub-functions; these include Status Monitor, Fault Localization, Fault Annunciation, Fault Presentation, Repair Support, and Configuration Monitoring. The PM/FL provides the operator with a ring map display of both networks showing the status of the networks, FODMS IOU connections, and the list of reported faults.

PM/FL Status Monitor
The Status Monitor function collects status data from all FODMS IOUs defined by the system configuration file. Status data includes the DMSC BITE data report. This report also includes the IOM, FDDIC module, Network, and IOU BITE status.

PM/FL Fault Localization
The Fault Localization function provides a unique fault identification index number that can be used to access the applicable maintenance and repair procedure in the on-line Electronic Technical Manual. The Fault Localization function analyzes data collected during the MG polling cycle (from Status Monitor) and determines whether or not a system error condition exists. When a system error condition exists for a specified number of polling cycles (the number of polling cycles is defined in the fault code database file for each unique fault code and this file is provided as part of the MG Master Configuration Files), the fault index number for that error condition is entered into the fault index buffer. This buffer can hold 256 fault index numbers.

PM/FL Fault Annunciation
The object of the Fault Annunciation function is to notify the operator that a new fault or faults have been entered into the fault index buffer. This is done via an audible alarm and/or a message printout on the system printer.

PM/FL Fault Presentation
The Fault Presentation function provides fault annunciation on the video display. In addition, any of the video data can be sent to the system printer. For each fault index number, this function provides:

a. Identification of the unit to which the maintenance action applies.
b. A text description of the fault.

PM/FL Repair Support

The Repair Support function sends the contents of the fault index buffer to all FODMS IOUs once per MG polling cycle. The message contains a unique message ID. The DMSC module stores the message in RAM and provides a readout via the DMSC RS-232 serial port when requested by the Event Time Analyzer.

PM/FL Configuration Monitoring

The Configuration Monitoring function requests message PROM content from all IOUs defined by the Master Configuration File. The data received is compared to the data in the Master Configuration File. If the same comparison error is detected on two consecutive polling cycles (30 seconds per poll cycle), the fault index number for this error is added to the fault index buffer. This function provides verification that desired system changes have been implemented, detects unauthorized changes, and detects PROM failures that result in code changes. The polling cycle for this function will not exceed 60 minutes.

Interactive Electronic Technical Manual (IETM)

The MG is capable of installing and executing the FODMS Interactive Electronic Technical Manual (IETM). The IETM was originally developed using Interleaf software. It has been updated and incorporated into HTML. It is now viewed using Netscape Navigator software which runs under the MG operating system.
The Netscape Navigator is started at power-up and can be restarted from the main pull-down menu. If Netscape is exited, it will restart automatically. This window can be used by the operator for any type of access to the manual, from browsing to searching troubleshooting procedures.

The IETM is also accessible from the PM/FL function. The PM/FL function opens the IETM with the selected fault code as a command line parameter. Using the fault code, the IETM will load the section of the manual with the repair procedure for that fault code.

Ship Specific Database (SSD)

The ship specific data and configuration sensitive items are contained in a separate executable database program that is accessible through the IETM and the PM/FL.

System Integration (SI)

This function provides the capability to establish and verify the system configuration of each IOU. Selecting an IOU from either network ring map on the PM/FL display initiates the SI mode which provides the user with the following capabilities:

a. Request, display, and print BITE reports from each IOU.
b. Request, display, and print the contents of the DMSC status registers.
c. Request, display, and print the enable/disable status of remotely controlled messages.
d. Request, display, and print the contents of the DMSC message PROMS.
e. Enable or disable any remotely controlled messages.
f. Create an "as installed" message PROM definition file on the hard disk drive by sequentially requesting message PROM content from each IOU in the system.
g. Download a message PROM file to a specified IOU.
h. Establish and change password access to a message PROM download and DMSC module start/stop command functions.

Configuration Management (CM)

The CM function provides the operator the capability to retrieve, store, and modify the configuration of the FODMS. This function provides the user with the following capabilities:

a. Copy Master Configuration Files from floppy disk to the hard disk drive.
b. Create PROM files on floppy disk for the firmware specified by the MG operator.
c. Copy a message PROM data to the floppy disk.
d. Create an IOM PROM file on floppy disk for the IOU and an IOM slot number specified by the MG operator.

Additional MG Software Provided

The MG software also includes the following software in addition to the FODMS software:

a. HP-UX UNIX operating system.
b. Motif© graphics development software.
c. TCP/IP communication software for the FDDI cards.

Trunk Coupling Box (TCB)

The Trunk Coupling Box (TCB) is the interface element between the FODMS IOUs and the Fiber Optic Networks. Each of the redundant fiber optic networks consists of a Trunk Cable (TC) and an Optical Interface Cable (OIC) connected via a Optical Bypass Switch (OBS). The TCB contains OBSs for three IOUs on one of the TCs (Primary and Secondary optical paths) and one set of spare optical switches. This means that two Optical Bypass Switches (Primary and Secondary) are required for three of the IOUs in the system.

Trunk Coupling Box Physical Construction

Physically, the TCB consists of an Interconnection Box (ICB) (Figure 8-51) that contains the ST patch panel module (has space for 48 couplers of which only 20 are used to connect three IOUs and 4 are used to connect the spare switches (2) connectors), OBS module, voltage regulator module (of which 3 channels are used and the 4th is a spare), and space reserved for future use.

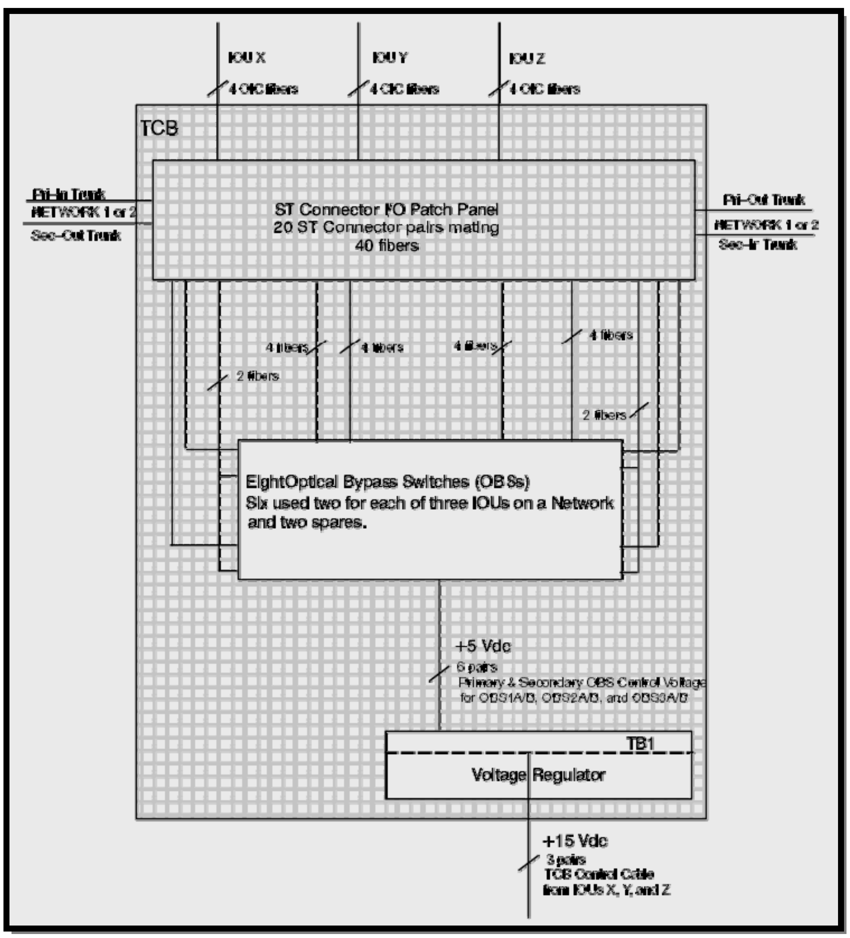


Figure 8-51. Trunk Coupling Box Block Diagram.

ST Patch Panel Module
The ST patch panel provides for the connection of all IOU, OBSs connectors to the network and spare trunk cable connectors. The ST connectors are attached together via an ST coupler mounted with a hex nut and lockwasher.

OBS Module
The OBS module contains four fiber optic cables and two power cable. A OBS consists of both optical and electronic components necessary to control the switches. The OBS functional diagram is shown in Figure 8-52 Sheet 1 and Figure 8-52 Sheet 2 for both the IOU inserted and IOU bypassed modes.

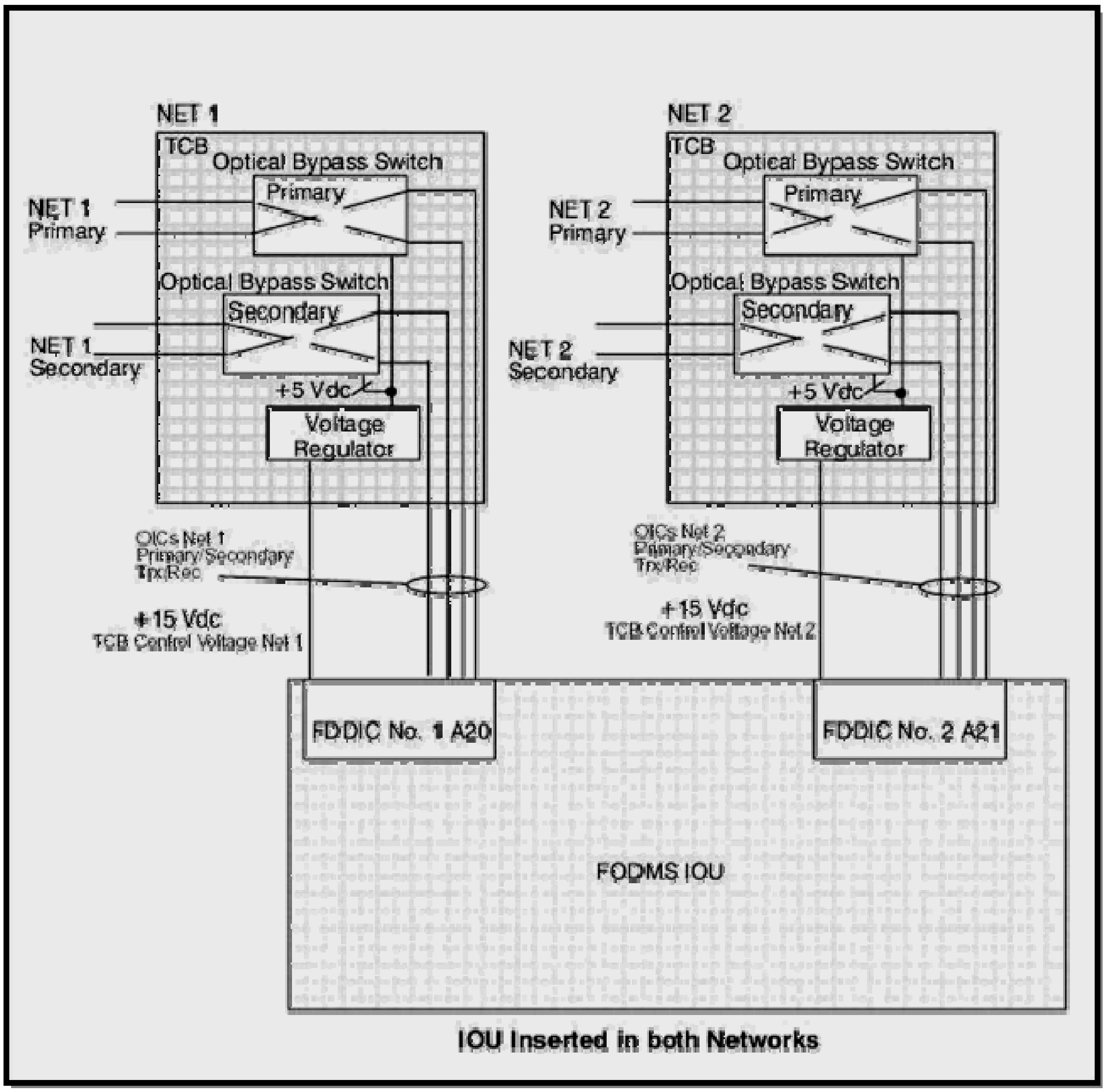


Figure 8-52. OBS Functional Block Diagram (Sheet 1 of 2).

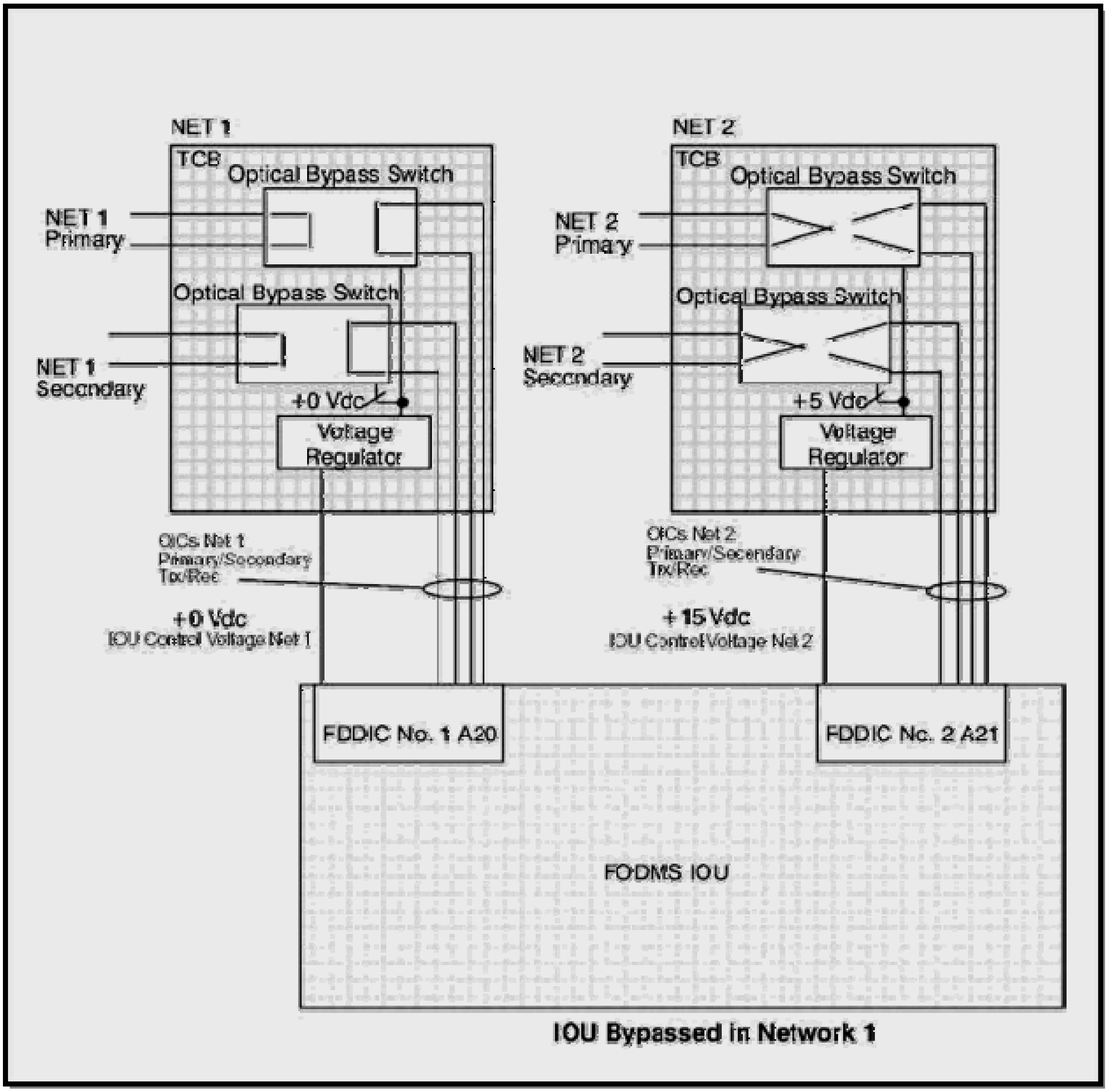


Figure 8-52. OBS Functional Block Diagram (Sheet 2 of 2).

Cabling Plant

The interconnecting cabling system consists of Net 1 Trunk Cable, Net 2 Trunk Cable, two OICs to each IOU, two OBS connector cables for each IOU, and power cables.

Reference Publications

Table 8-20 below provides the List of Reference Publications and contains all publications used throughout this manual.

List of Reference Publications		
Publication No.	**Title**	**Purpose**
A4511-90602	OWNER'S GUIDE FOR HP-UX USERS; MODEL 744 VMEBUS BOARD COMPUTER	General owners manual
A4511-90603	SERVICE HANDBOOK FOR HP-UX USERS; MODEL 744 VMEBUS BOARD COMPUTER	General Service
120BA1SM	UNINTERRUPTIBLE POWER SYSTEM	Software Interface Manual
120BA1UM	UNINTERRUPTIBLE POWER SYSTEM	User's Manual
PDU 2000	POWER DISTRIBUTION UNIT	Operating Manual
UG04811-001 Rev. K	4811 E/FDDI ADAPTER	User's Guide
CPD-300SFT	TRINITRON COLOR COMPUTER DISPLAY	Owner's Guide
70920-1	OPERATIONS AND TECHNICAL INFORMATION MANUAL FOR STANDARD CONFIGURATION TAC-4 RUGGED RACKS	User's Manual
N/A	FODMS/DMS USER INTERFACE HANDBOOK	Troubleshooting Guide
N001780008	AN/USQ(V) FODMS IETM	Technical Manual
S0382-32-789-D-P-O	FODMS USER'S LOGISTIC SUPPORT	Summary
MIL-HDBK-263	ELECTROSTATIC DISCHARGE CONTROL HANDBOOK FOR PROTECTION OF ELECTRICAL AND ELECTRONIC EQUIPMENT	Provides instructions for handling electrostatic discharge sensitive devices
MIL-STD-1310D	SHIPBOARD BONDING, GROUNDING, AND OTHER TECHNIQUES FOR ELECTROMAGNETIC COMPATIBILITY AND SAFETY	Provides military specifications for grounding equipment
MIL-L X118 (SH)	FIBER OPTIC SHIPBOARD CABLE TOPOLOGY DESIGN STANDARD	Installation of Fiber Optic Network

MIL-STD-2042-6	FIBER OPTIC CABLE TOPOLOGY INSTALLATION STANDARD METHODS FOR NAVAL SHIPS (TESTS) PART 6 OF 6	This standard practice provides detailed methods for testing fiber optic cable topology installations.
N/A	PS-1503 GLOBAL UNIVERSAL DEPLOYABLE UNINTERRUPTIBLE POWER SUPPLY	User's Manual

Table 8-20. Reference Publications.

8.3.0 GIGABIT ETHERNET DATA MULTIPLEX SYSTEM (GEDMS)
The GEDMS system will be a technology refresh to the Fiber Optic Data Multiplex System (FODMS), which is currently being installed on the Arleigh Burke DDG51 Flight II Class of destroyer ships (DDG 79 – 110). The GEDMS system will increase the overall networking bandwidth by replacing the Fiber Distributed Data Interface (FDDI) backbone associated with the FODMS system and installing a Gigabit Ethernet backbone. The GEDMS system provides a means to transfer data, command or status messages between various types of user source and user sink devices. For purposes of survivability, the GEDMS system will incorporate a Mesh Topology over two independent network backbones. Each network will utilize Backbone Switch Enclosures (BSEs) for connection to both network and user links via the fiber optic cable plant. The network links (Switch-Switch) will establish the mesh topology backbone associated with GEDMS. The user links (Switch-User) will provide the connection of the Input/Output Units (IOUs).

Balancing the Navy’s current response to world conflicts with the development of systems that address future objective requirements must be the driving criteria in implementing flexible system approaches. GEDMS fulfills this objective, while demonstrating proven performance, incrementally infusing technology to meet evolving fleet needs, and successfully fielding this capability into the fleets with minimal impact. The Boeing Company Data Multiplex System (DMS) AN/USQ-82(V), the first ship-wide control system network installed in a US Navy ship class, was introduced in the mid-1980s primarily as a means of significantly reducing cable weight point-to-point cable runs with a common, networked cable plant. Moreover, DMS ushered in unprecedented flexibility in shipboard system configuration and monitoring. For the first time in Navy ships, the various major systems in the Arleigh Burke (DDG 51) Class of guided missile destroyers could intercommunicate without manual cable plant changes. Long before the era of ubiquitous Internet Protocol (IP) adoption, DMS was switching messages among control system components distributed throughout these ships. The system has evolved beyond its original five-way redundant, linear, coaxial cable bus architecture to the actively redundant Fiber Distributed Data Interface (FDDI) networks of the Fiber Optic DMS (FODMS), to the dual-mesh topology of the developmental Gigabit Ethernet DMS.

With the advance of FODMS and GEDMS came the migration of user devices from military interface standards to commercial off-the-shelf interfaces and protocols, including Ethernet and the Internet Protocol (IP). Support for these commercial standards became imperative to serve the new generation of Navy systems. Introduction of IP instantly made every device connected to each DMS and FODMS ship uniquely addressable on a global scale. Current upgrade work on FODMS, in concert with the US Navy DDG 51 Class Modernization Program, addresses the upcoming replacement of DMS and FODMS with GEDMS in back-fit and forward fit ships.

8.4.0 SUMMARY

In this chapter we covered Data Multiplex Systems, configurations, functions, and interfaces. In addition we have discussed Fiber Optic Data Multiplex Systems, and Gigabit Ethernet Data Multiplex Systems.

9 ALARM, SAFETY, AND WARNING SYSTEMS

Upon completion of this chapter you will be able to do the following:

- Explain the purpose of alarm, safety, and warning systems installed on Navy ships.
- Identify the various sensing devices used with alarm, safety, and warning systems.
- Identify the various audible and visual devices used with alarm, safety, and warning systems.
- Describe the components and operation of a B-51 alarm panel.
- Describe the components and operation of an IC/SM alarm panel.
- Briefly describe some of the common troubles of alarm, safety, and warning systems and their effects on the systems.

9.0.0 INTRODUCTION

Alarm, safety, and warning systems are installed in Navy ships for certain equipment and compartments. These systems provide audible and visual signals when abnormal or dangerous conditions occur. The principal components of the alarm, safety, and warning systems are sensing devices, audible and visual signals, alarm panels, and alarm switchboards. Circuit designations and classifications of some of the more common systems are listed in table 9-1. Sources of possible trouble areas in many of the interior communication circuits are components that transmit information and the components that warn of malfunctions. Often, even though the detector and repeater parts of a system are aligned, an error is introduced by components that transmit or retransmit information. This chapter discusses some of the devices that transmit information and warn of malfunctions. When you complete this chapter, you should have a basic understanding of transmission, alarm, and indicating systems, and be prepared to deal with malfunctions in such equipment.

Circuit	System	Importance	Readiness Class
BZ	Brig cell door alarm and lock operating	NV	4
BW	Catapult bridle arresterman safety ind.	NV	1
CX	Bacteriological lab. & pharmacy comb. refer failure	NV	1
DL	Secure communications space door position alarm	NV	1
DV	Wrong direction alarm	V	2
EA	Reactor compartment or fireroom emergency alarm	NV	1
IEC	Lubricating oil low pressure alarm propulsion machinery	SV	2
2EC	Lubricating oil low pressure alarm auxiliary machinery	SV	1
1ED	Generator high-temperature alarm	SV	1
2ED	Oxygen-nitrogen generator plant low temperature alarm	NV	1
EF	Generator bearing high-temperature alarm	SV	1
EG	Propeller pitch control, hydraulic oil system low-pressure alarm	SV	2
EH	Gas turbine exhaust high-temperature alarm	SV	1 (aux. machinery) 2 (prop. machinery)
EJ	Feed pressure alarm	SV	1
1EK	Pneumatic control air pressure alarm	NV	2
3EK	Catapult steam cutoff and alarm	NV	2
EL	Radar cooling lines temperature and flow alarm	NV	1
EP	Gas turbine lubricating oil high-temperature alarm	SV	1(aux. machinery) 2 (prop. machinery)
1EQ	Desuperheater high temperature alarm	SV	1
2EQ	Catapult steam trough high-temperature alarm	SV	2
3ES	Reactor fill alarm	V	1
ET	Boiler temperature alarm	NV	1
EV	Toxic vapor detector alarm	SV	1
2EW	Auxiliary machinery circulating water high temperature	SV	1
EZ	Condenser vacuum alarm	SV	2
F	High temperature alarm	SV	1
4F	Combustion gas and smoke detector	SV	1
9F	High-temperature alarm system-ASROC launcher	SV	1
11F	FBM storage area temperature and humidity alarm	SV	1
12F	Gyro ovens temperature and power failure alarm	SV	1
FD	Flooding alarm	NV	1
FH	Sprinkling alarm	SV	1

Table 9-1.—Alarm, Safety, and Warning Systems

Circuit	System	Importance	Readiness Class
FR	Carbon dioxide release alarm	NV	1
FS	Flight deck ready light signal system	NV	2
FZ	Security alarm (CLASSIFIED)	V	1
4FZ	Torpedo alarm (CLASSIFIED)	V	1
HF	Air flow indicator and alarm	SV	1
LB	Steering emergency signal system	NV	2
IS	Submersible steering gear alarm	SV	2
MG	Gas turbine over-speed alarm	SV	1 (aux. machinery) 2 (prop. machinery)
NE	Nuclear facilities air particle detector alarm	NV	1
NH	Navigation horn operating system	NV	2
QA	Air lock warning	NV	1
QD	Air filter and flame arrester pressure differential alarm, or gasoline compartment exhaust blower alarm	V	1
QX	Oxygen-nitrogen plant ventilation exhaust alarm	SV	1
RA	Turret emergency alarm	NV	1
RD	Safety observer warning	NV	2
RW	Rocket and torpedo warning	SV	3
4SN	Scavenging air blower high-temperature alarm	V	2
SP	Shaft position alarm	NV	2
TD	Liquid level alarm	NV	1
1TD	Boiler water level alarm	NV	1
2TD	Deaerating feed tank water level alarm	NV	1
5TD	Reactor compartment bilge tank alarm	SV	1
6TD	Primary shield tank, expansion tank level alarm	NV	1
7TD	Reactor plant fresh water cooling expansion tank level alarm	NV	1
8TD	Reactor secondary shield tank level alarm	NV	1
9TD	Lubricating oil sump tank liquid level alarm	SV	1
11TD	Induction air sump alarm	SV	1
12TD	Diesel oil sea water compensating system tank liquid level alarm	SV	1
14TD	Auxiliary fresh water tank low-level alarm	NV	1
16TD	Pure water storage tank low-level alarm	SV	1
17TD	Reserve feed tank alarm	NV	1
18TD	Effluent tanks and contaminated laundry tank high level alarm	V	1
19TD	Seawater expansion tank low-level alarm	SV	1
20TD	Gasoline drain tank high-level alarm	SV	1
21TD	Moisture separator drain cooler high-level alarm	NV	1
24TD	Reactor plant on board discharge tank level alarm	V	1
25TD	Crossover drains high-level alarm	SV	1
29TD	Sonar dome fill tank low-level alarm	SV	1

Table 9-1 (Cont).—Alarm, Safety, and Warning Systems

Circuit	System	Importance	Readiness Class
30TD	JP-5 fuel drain tank high-level alarm	SV	2
TW	Train warning system	NV	1
W	Whistle operating system	NV	2

Legend:
V-Vital SV-Semivital NV-Nonvital.
1-Continuously energized-supply switch color code yellow.
2-Energized when preparing to get underway, while underway, and until the ship is secured supply switch color code black.
3-Energized during condition watches-supply switch color code red.
4-Energized only when required-supply switch color code white.
All electronic type alarm systems formerly designated as circuits CA, FC, FW, G, GD, GJ, GN, and FP are now classified as a portion of the respective announcing system with which they are associated.

Table 9-1 (Cont).—Alarm, Safety, and Warning Systems

9.1.0 SENSING DEVICES

Devices are used with alarm, safety, and warning systems to initiate alarms when there is a deviation in normal operation. A sensing device senses the deviation and, in turn, causes a switch or relay contact to close and energize the alarm signaling device. Sensing devices include switches, detectors, and relays.

9.1.1 Switches

Switches used with the alarm, safety, and warning systems include lever-operated, pressure-operated, mechanical, water, liquid-level, and thermostatic switches. In addition, the alarm, safety, and warning systems use flow switches, relay switches, and mercury thermostats.

9.1.2 Flow Switches

Flow switches are installed in fluid lines to sense fluid flow. As the fluid flow rate increases or decreases, the contacts in the flow switch will close and initiate an alarm. Flow switches are available in various sizes to sense a variety of flow rates.

9.1.3 Relay Switches

Relay switches are used in critical circuits to sense power failure. Power failure causes the relay contacts to close and initiate an alarm.

9.1.4 Mercury Thermostats

Mercury thermostats are used with the high- temperature alarm system (circuit F) to detect the presence of fires or overheated conditions in important compartments or spaces. A mercury thermostat (fig. 9-1) consists of a column of mercury in a glass tube. Three electrical contacts are sealed into the glass tube. A resistor is connected in parallel with the top and middle contacts.

The theme contacts along with the resistor and the mercury form a path for current flow. A mercury thermostat functions somewhat like a thermometer in that the column of mercury rises as temperature increases. Under normal conditions, a small amount of direct current flows from one side of the line through the resistor, the middle contact, the mercury, the bottom contact, and back to the other side of the line. An increase in temperature will cause the mercury to rise in the tube. When the mercury reaches the top contact, the resistor will be shunted from the circuit, and the current will increase. The increase in current will cause a relay contact to close and initiate an alarm.

Mercury thermostats are installed in the overhead of magazines, storerooms, paint lockers, and other spaces that house combustible stores. Figure 9-2 is an illustration of a mercury thermostat and its housing. The thermostats require a free circulation of air for proper operation. Barriers that obstruct the free circulation of air should never be placed around thermostats, and thermostats should not be installed in the path of supply ventilation. As many thermostats as needed for the prompt detection of high temperature can be connected to any one line. Figure 9-3 is an illustration of three thermostats connected in parallel on one line.

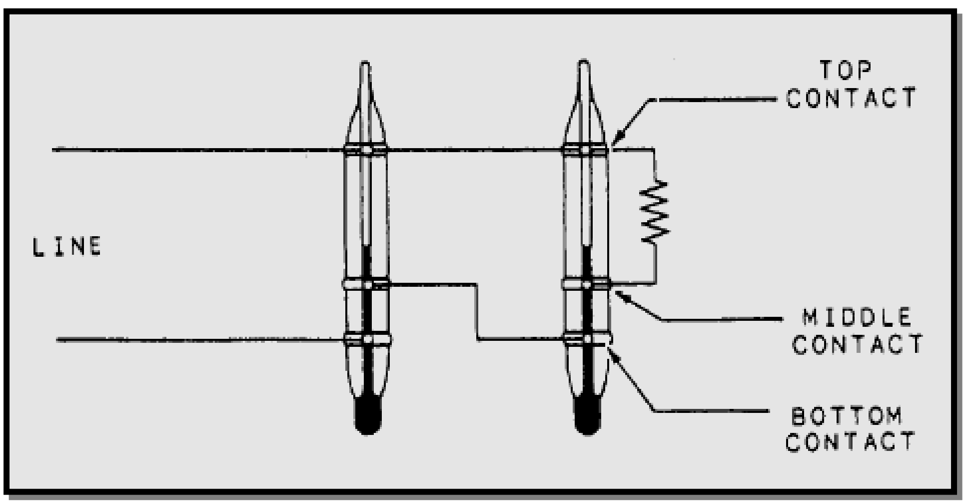


Figure 9.1.—Mercury thermostat.

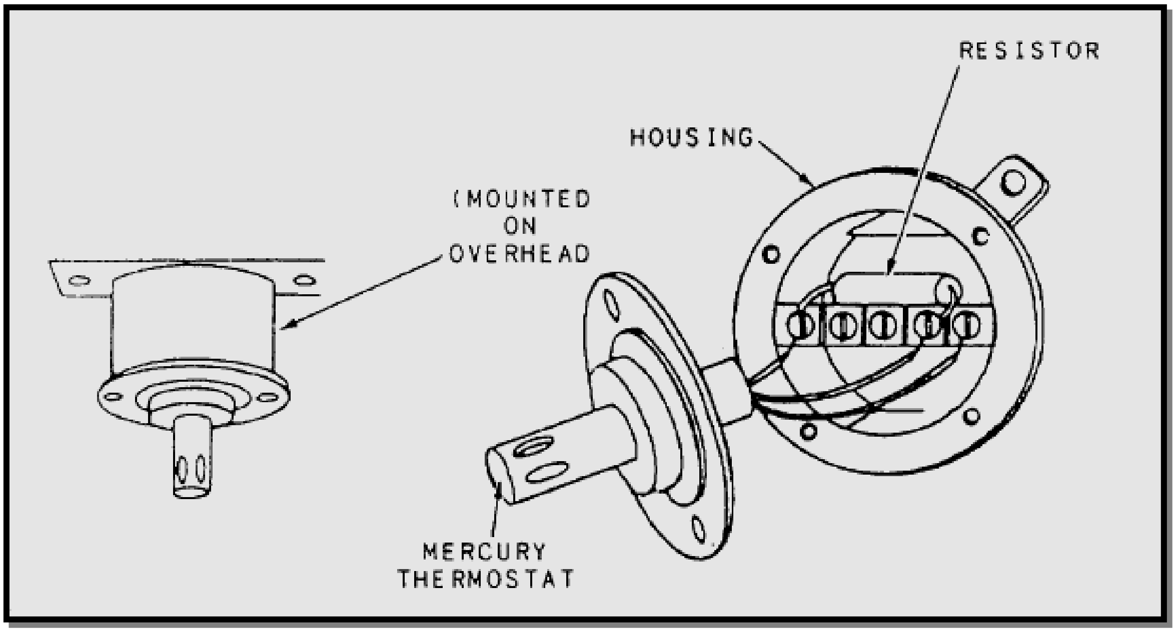


Figure 9-2.—Mercury thermostat and housing.

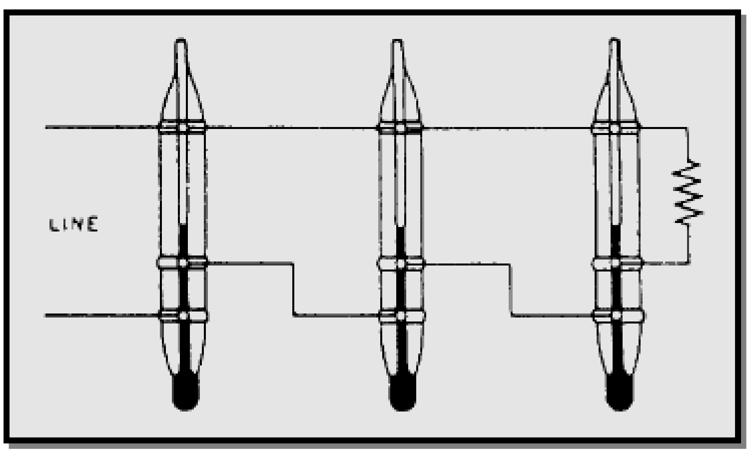


Figure 9-3.—Three mercury thermostats connected in parallel.

Mercury thermostats are available in three temperature ratings: 105°F, 125°F, and 150°F. The 105°F thermostat is normally installed in magazines, while the 125°F and 150°F thermostats are normally installed in storerooms and paint lockers. The thermostats are identical except for the differences in temperature ratings. When replacing a defective thermostat, you should always replace it with one having the same temperature rating.

9.1.5 Detectors

Detectors used with the alarm, safety, and warning systems include ionization detectors and dual-purpose detectors.

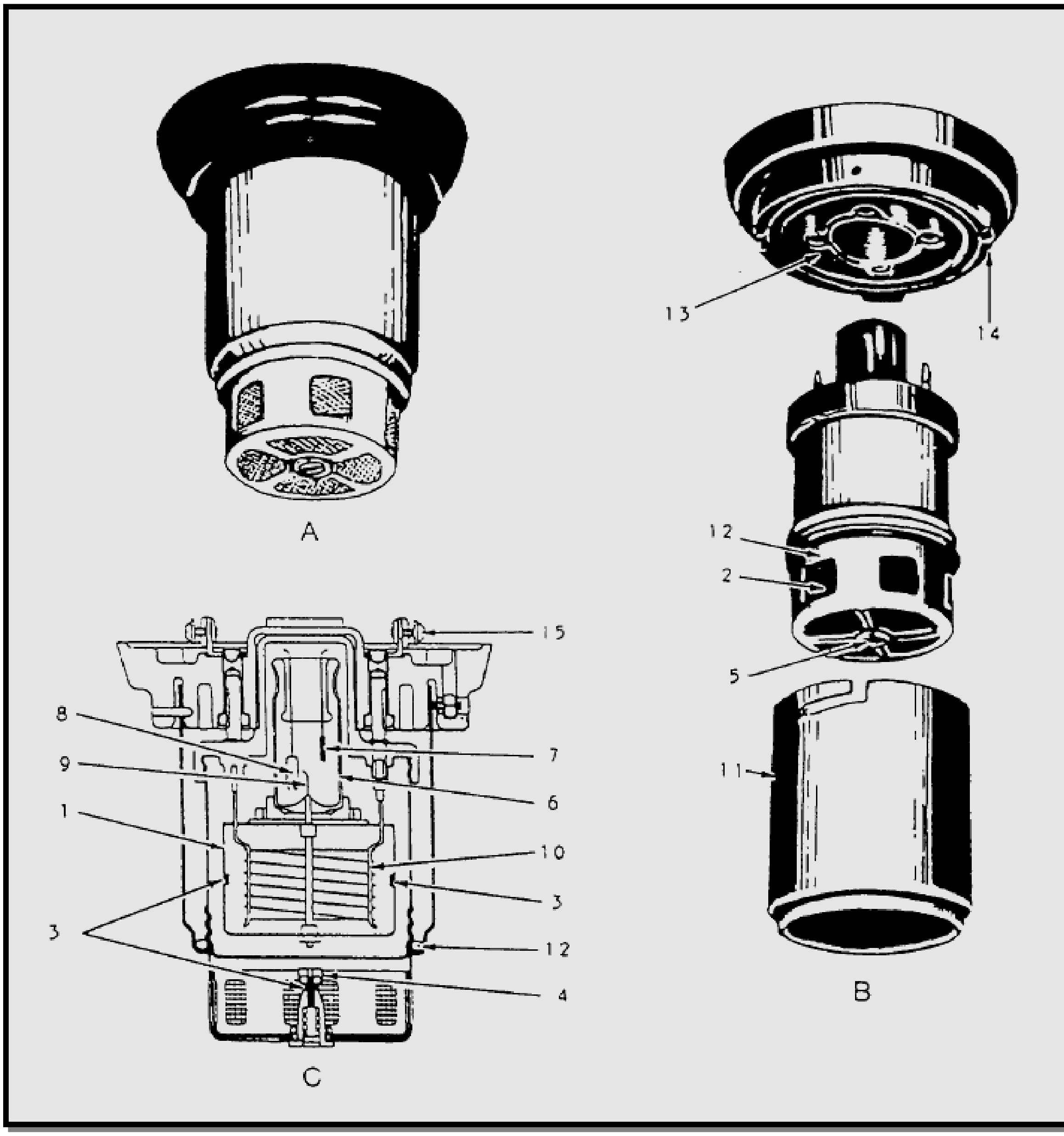
9.1.6 Ionization Detectors

Ionization detectors are used with the combustible gas and smoke detector system (circuit 4F) to detect the presence of combustible gases and smoke. The combustion gas and smoke detector head (fig. 9-4, view A) is installed on the overhead in the compartment or space to be protected. A four-pin polarized plug fits into a socket base, allowing easy replacement (fig. 9-4, view B). The major units of the detector head are the inner and outer chambers and the cold cathode tube (fig. 9-4, view C). The detector compares the air in the inner chamber with the air in the outer chamber. When combustion gases and/or smoke are present in the air of the outer chamber, the cold cathode tube fires and supplies the current to initiate an alarm.

The air in the inner and outer chamber is made conductive by a small quantity of radium (fig. 9-4, view C). Alpha particles given off by the radium have the ability to ionize air into positive ions and negative electrons. If this ionized air is introduced into an electric field, a current will flow.

Figure 9-5 illustrates this principle. A potential from battery B is applied to plates P1 and P2. The air between the plates is ionized by the radium. The charged particles move in the direction indicated by the arrows. A sensitive galvanometers measures the current, the value of which depends on the strength of the radium source, and part of the ions and electrons collide and neutralize each other. It is only when the potential reaches a certain limit that all of the ions formed reach the plates. This is known as the saturation point. Beyond this point, the current remains virtually constant regardless of the increase of potential. Only a change in the gas in the chamber will cause a change in the current flow when the unit is operating at the saturation point.

The presence of combustion gas or smoke particles between the plates will cause a sharp decrease in current flow through the galvanometers. This is true because the combustion gas and smoke particles are many times larger and heavier than the air molecules and require a stronger radioactive source to become ionized. Also, the ionized combustion gas and smoke particles are all neutralized by free electrons before reaching one of the plates.



1. Inner or Reference Chamber
2. Outer or Detecting Chamber
3. Radium Sources
4. Sensitivity Adjustment Cap
5. Sensitivity Adjustment Screw
6. Gas Discharge (Cold Cathode Tube)
7. Anode
8. Cathode
9. Starter Electrode
10. Inner Wire Grid Electrode
11. Locking Shell
12. O-Ring
13. Socket Base
14. Locking Set Screw
15. Terminal Screws

Figure 9-4.—Combustion gas and smoke detector head.

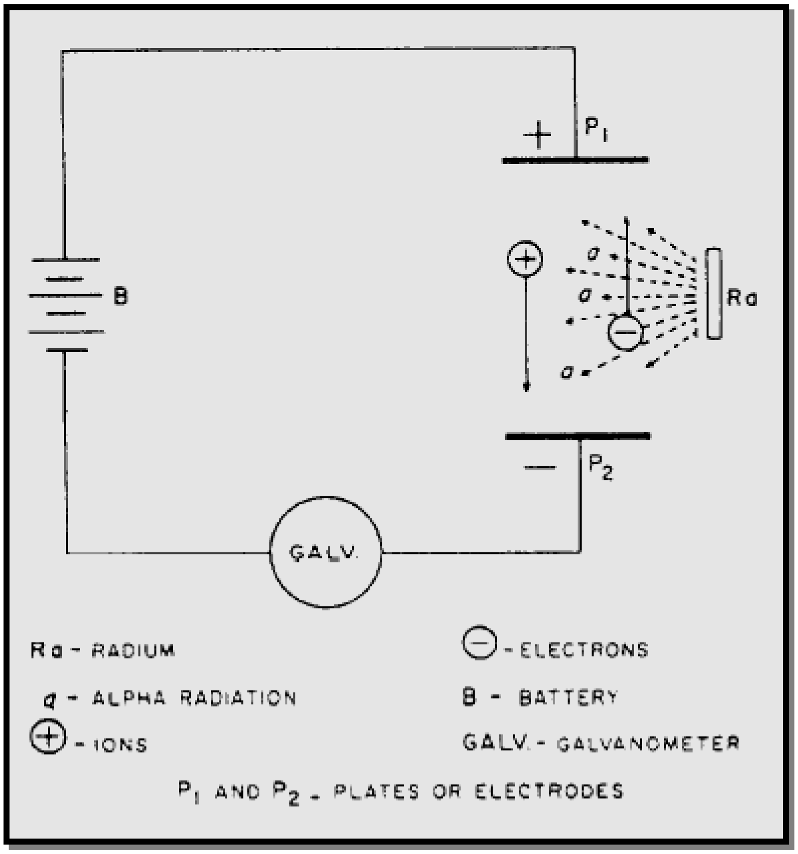


Figure 9-5.—Ionization principle.

9.1.7 Dual-Purpose Detectors

Dual-purpose detectors combine an ionization detector and a mercury thermostat in the same circuit in parallel.

9.1.8 Relays

Relays are used in alarm, safety, and warning systems to open and close circuits that may operate audible and/or visual signals.

9.2.0 AUDIBLE AND VISUAL SIGNALS

Audible and visual signals are used with the alarm, safety, and warning systems to alert personnel that an alarm condition exists. The types of signals and their locations depend on the circuit they are used with. Audible and visual signals are also used with alarm panels and alarm switchboards, and as extension signals in remote spaces.

9.2.1 Audible Signals

There are many types of audible signals in use on board Navy ships. The type of signal used depends upon the noise level of the location and the kind of sound desired. The principle types of audible signals are bells, buzzers, horns, sirens, and electronic signal units.

Bells

Bells used with alarm, safety, and warning systems are either ac or dc operated. Bells that are ac operated have four types of gongs: circular 3-inch diameter (type IC/B8S4), circular 4-inch diameter (types IC/B5DF4 and IC/B5S5), circular 8-inch diameter (types IC/B1S4 watertight and IC/B2S4 watertight explosion-proof), and cowbell (type IC/B3S4). Figure 9-6 is an illustration of a type IC/B3S4 bell.

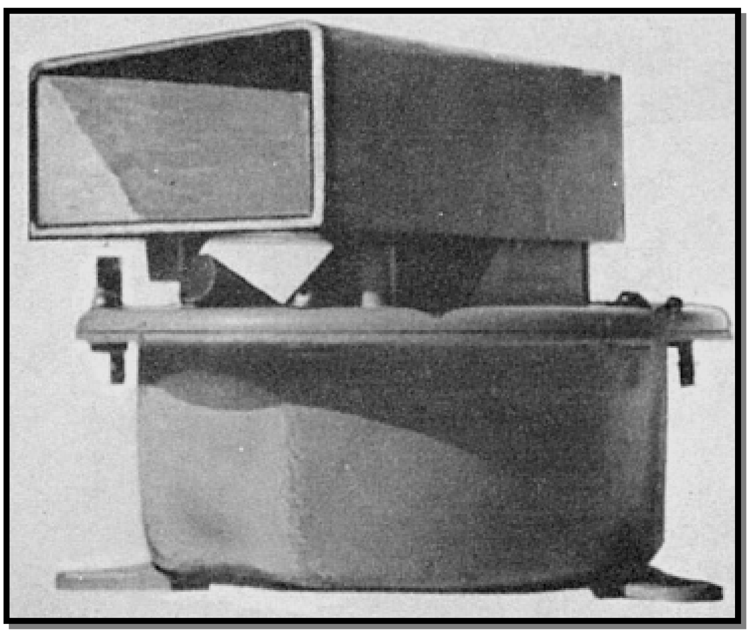


Figure 9-6.—IC/B3S4 bell.

Bells that are dc operated have three types of gongs: circular 2 1/2-inch diameter (type IC/B1D4), circular 8-inch diameter (type IC/B2D4), and cowbell (type IC/E13D4). Figure 9-7 is an illustration of a type IC/B2D4 bell.

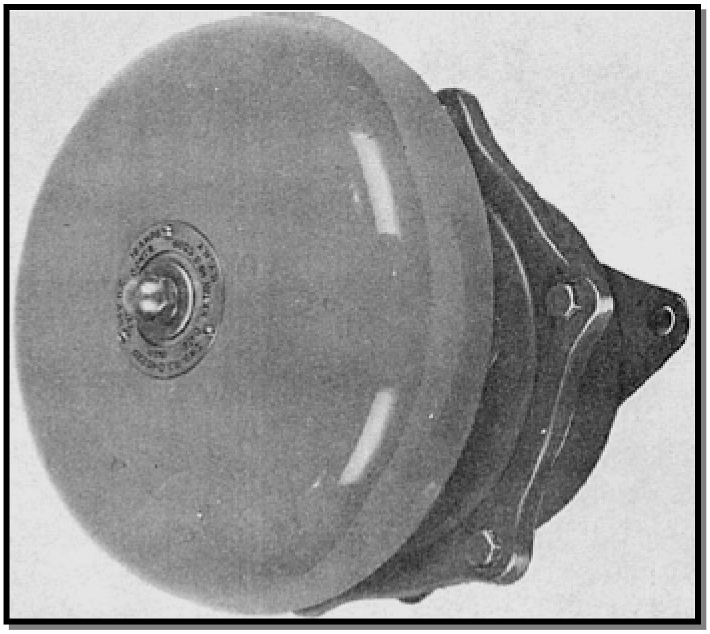


Figure 9-7.—IC/B2D4 bell.

<u>Buzzers</u>

Buzzers are used only in relatively quiet spaces, There are two types of buzzers used with alarm, safety, and warning systems, Type IC/Z1D4 is dc operated and has make and break contacts. Type IC/Z1S4 is ac operated and has no contacts. Figure 9-8 is an illustration of a type IC/Z1D4 buzzer.

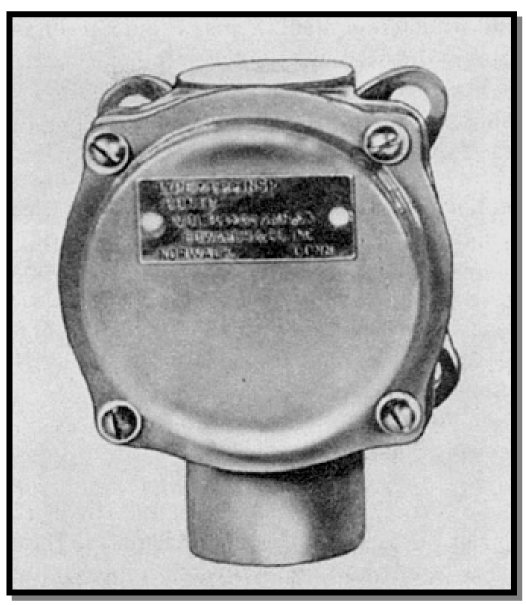


Figure 9-8.—IC/Z1D4 buzzer.

Horns

There are three types of horns used with the alarm, safety, and warning systems. They are (1) non-resonated horns, (2) resonated horns, and (3) motor-operated horns.

Non-resonated horns (types IC/H1D4, IC/H4D2, and IC/H4D3) use a diaphragm actuated by a vibrating armature to produce sound of the required intensity.

Resonated horns (types IC/H2S4 and IC/H2D4) also use diaphragms and, in addition, have resonating projections to give the sound a distinctive frequency characteristic. The resonated horn is designed in a variety of types, differing as to intensity, frequency, or power supply. Figure 9-9 is an illustration of a resonated horn.

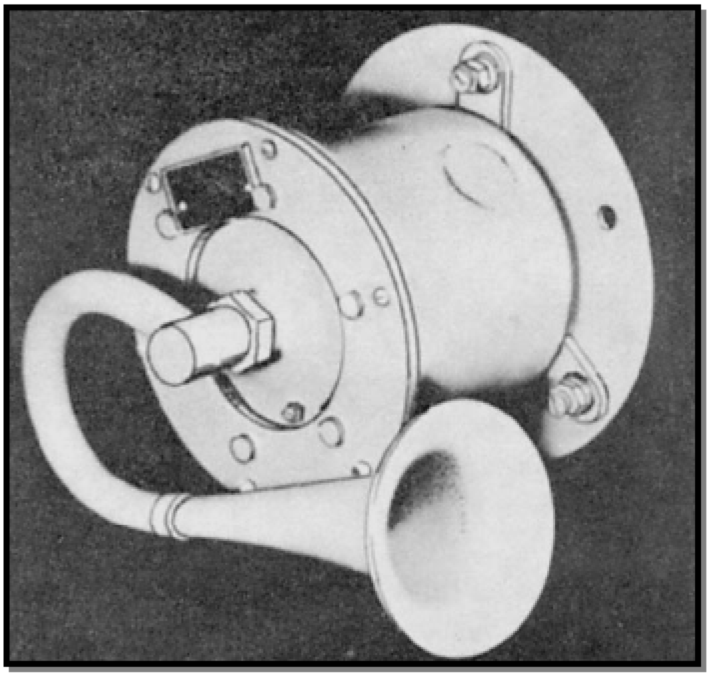


Figure 9-9.—Resonated horn.

Motor-operated horns (types IC/H8D3, IC/H8D4, and IC/H8S3 use electric motors to actuate the sound-producing diaphragms. Figure 9-10 is an illustration of a motor-operated horn.

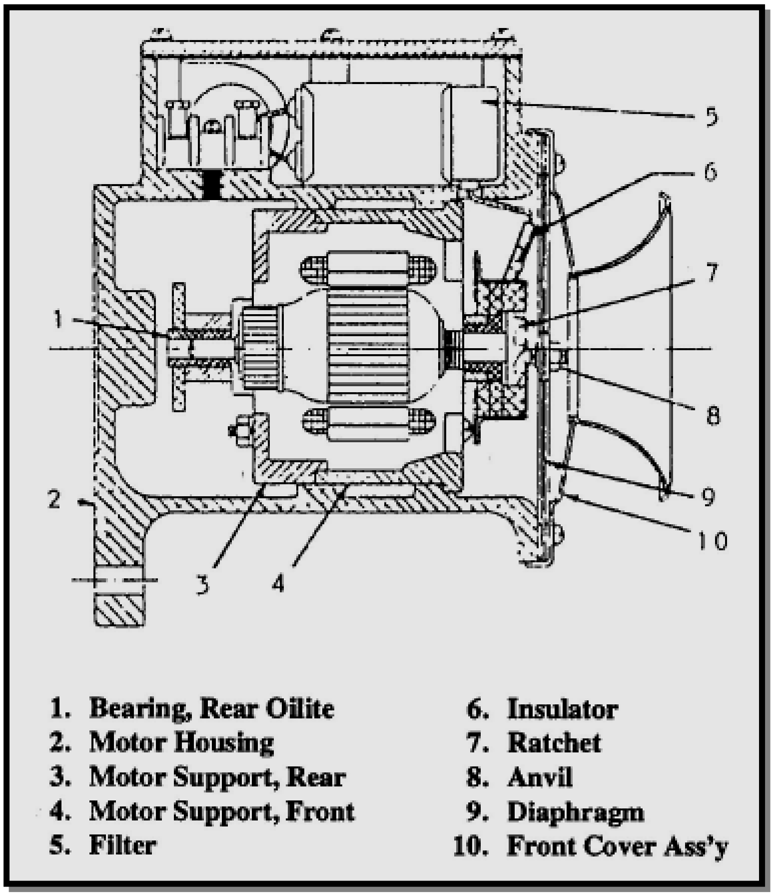


Figure 9-10.—Motor-operated horn.

<u>Sirens</u>

Sirens are used in very noisy spaces or to sound urgent alarms. The sound is produced by an electric motor driving a multi-blade rotor past a series of ports or holes in the housing. The air being forced through the ports gives a siren sound, the frequency of which depends upon the number of ports, the number of rotor blades, and the motor speed. Figure 9-11 is an illustration of a siren.

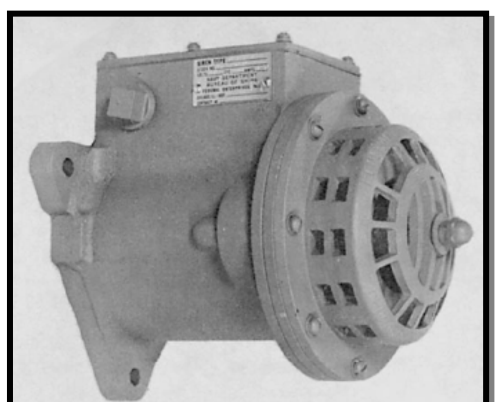


Figure 9-11.—Siren.

Electronic Signal Units

The IC/E3D2 electronic signal unit (fig. 9-12) is designed for use with alarm switchboards. The unit consists of a solid-state oscillator and an amplifier. The unit is capable of generating three distinct tones: a wailing or siren tone, a steady tone, and a pulsating tone.

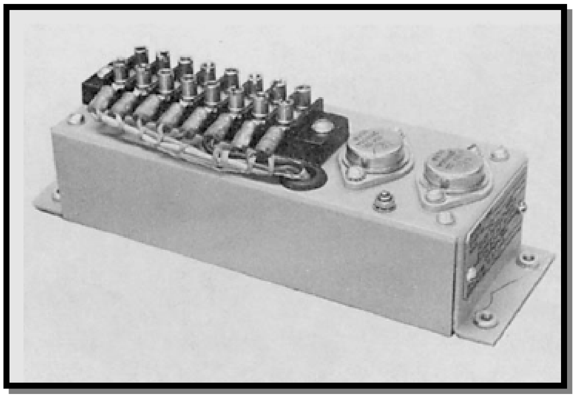


Figure 9-12.—Type IC/E3D2 electronic signal unit.

9.2.2 Visual Signals

Visual signals are used with many alarm, safety, and warning systems to provide an additional means of identifying the alarm being sounded. Audible and visual signals are often used together. In noisy spaces, audible signals are supplemented by visual signals; and in brightly lighted spaces, visual signals are supplemented by audible signals. In many instruments, the same audible device is used in combination with several visual signals. The principal types of visual signals are lamp indicators.

Standard watertight lamp indicators are designed as single-dial, two-dial, four-dial, and six-dial units. Two 115-volt lamps are connected in parallel and mounted behind each dial. The use of two lamps in parallel provides protection against the loss of illumination in case one lamp bums out. A colored-glass disk and sheet-brass target engraved with the alarm identification are illuminated from the rear by the two lamps. The 115-volt lamps are in parallel with the audible signal. When the audible signal sounds, the lamps illuminate the colored glass and brass target of the indicator and identify the alarm being sounded.

Standard watertight lamp indicators are also designed as two-dial variable-brilliancy, two-dial fixed-brilliancy, and four-dial variable-brilliancy units. Two 6-volt lamps are connected in parallel and mounted behind each dial. A colored jewel disk and sheet-brass target are illuminated from the rear by the two lamps. Special lamp indicator panels are designed to give good visibility at all viewing angles. These panels contain rows of prism-shaped red and green jewels, Each indicator has two 6-volt lamps in parallel.

9.3.0 ALARM PANELS AND ALARM SWITCHBOARDS

Alarm panels and alarm switchboards are normally installed in spaces that are continuously manned both underway and in port. Alarm panels and alarm switchboards are capable of monitoring a number of circuits, depending on the type and size of the panel or switchboard used. All systems using alarm panels or alarm switchboards have a supervisory feature that indicates whether the system is operating in a normal mode. This supervisory feature usually consists of a 7000-ohm, 5-watt resistor connected across the terminals of the sensing device used in each system. When two or more sensing devices are used in the same line, the supervisory resistor will be connected across the terminals of the last sensing device in the line. The primary power source for alarm panels and alarm switchboards is 120-volt, 60-Hz ships' service power.

There are three basic conditions for each system being monitored. The first condition is the supervisory or normal condition. This condition exists when the system is functioning correctly. During this condition, a small continuous current flows in the circuit, which indicates that the circuit is in a normal condition.

The second condition is the alarm condition. This condition exists when there is an increase in current flow in the circuit.

The third condition is the trouble condition. This condition exists when an open in the circuit stops the flow of current in the circuit. Under this condition, an alarm condition cannot be detected.

9.3.1 Alarm Panels

The alarm panel consists of a 3-inch alarm bell, a low-pitch trouble alarm buzzer, a three-position test switch, a test light, an alarm test light, a trouble test light a pilot light, negative and positive ground lamps, and four double-fuse holders (fig. 9-13).

The alarm bell, type IC/B1S4, is mounted in the upper left-hand comer of the alarm panel. The alarm bell sounds whenever an alarm condition exists.

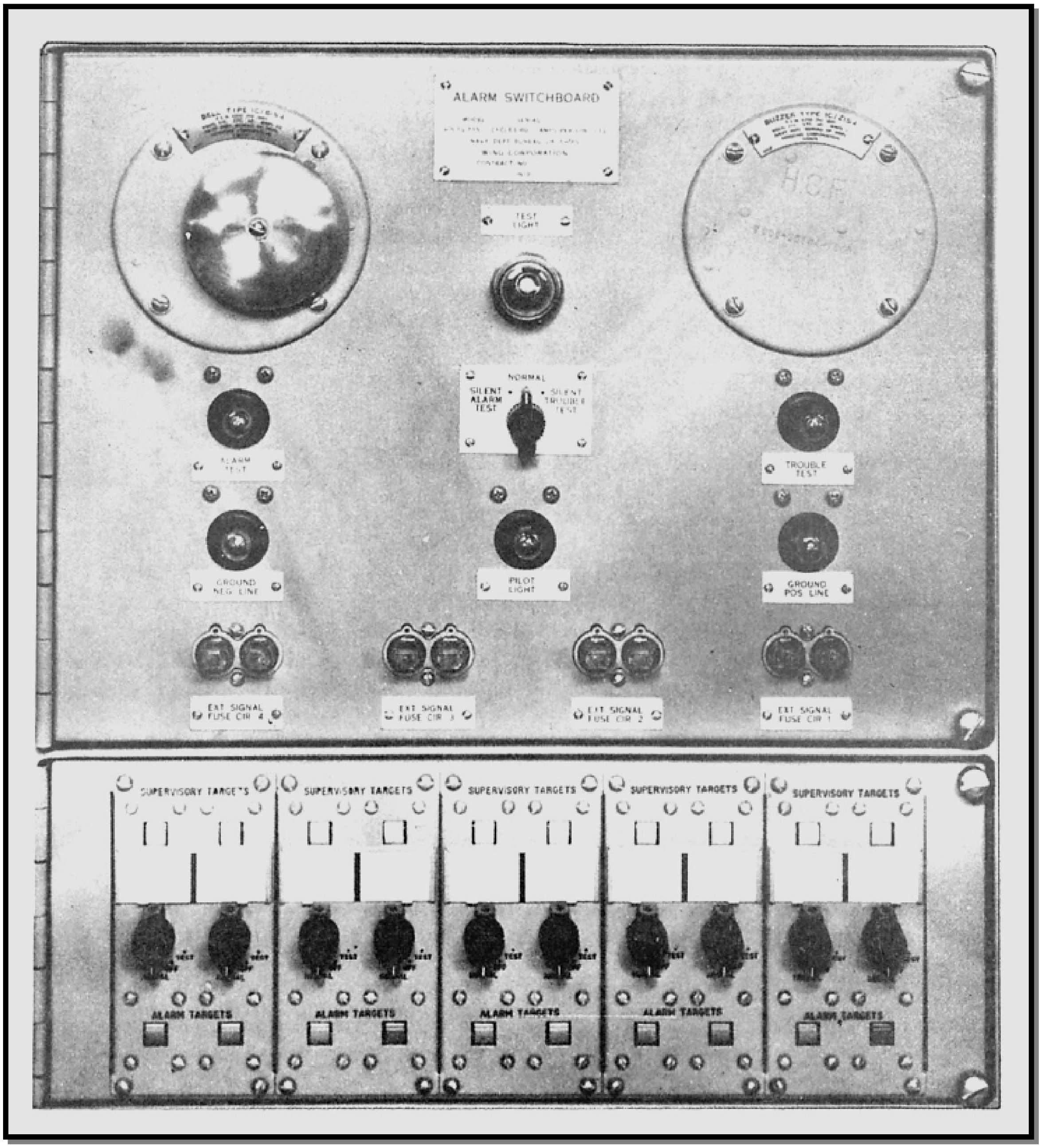


Figure 9-13.—Ten-line alarm switchboard.

The trouble buzzer, type IC/Z1S4, is mounted in the upper right-hand comer of the alarm panel. It is energized when there is a malfunction in the alarm circuit.

The test switch, type SR03, is a three-position, four-pole rotary switch. It is located in the center of the alarm panel. One section of the switch is not normally used, and can be used as a spare if another section malfunctions. The middle switch position is NORMAL, the left position is SILENT ALARM TEST, and the right position is SILENT TROUBLE TEST.

A TEST LIGHT is mounted between the bell and the buzzer. It is energized anytime the test switch is in any position other than NORMAL. When the TEST LIGHT is energized, it indicates the alarm bell or trouble buzzer have been disconnected from its circuit.

ALARM TEST and TROUBLE TEST lamps are mounted on the left and right of the test switch, respectively, The ALARM TEST light takes the place of the bell in the circuit when the test switch is put in the SILENT ALARM TEST position. The TROUBLE TEST light takes the place of the buzzer when the test switch is placed in the SILENT TROUBLE TEST position.

A PILOT LIGHT is located underneath the test switch. It is energized whenever power is available to the alarm switchboard.

Ground indicating lamps are located on either side of the PILOT LIGHT. The GROUND NEG LINE lamp is on the left and the GROUND POS LINE lamp is on the right side of the panel.

There are four double-fuse holders across the bottom of the alarm panel. These fuses are for remote alarms.

The most common types of alarm panels used with the alarm, safety, and warning systems are the B-51 and the B-52. The B-51 is a two-line panel, and the B-52 is a four-line panel. The only difference between these two panels is the number of lines. We will discuss the operation of the B-51 alarm panel in the following paragraphs.

The B-51 alarm panel, or two-line alarm unit (fig. 9- 14), provides complete equipment for supervising two circuits or contact-maker lines. Five of these alarm units are mounted for each 10-line panel.

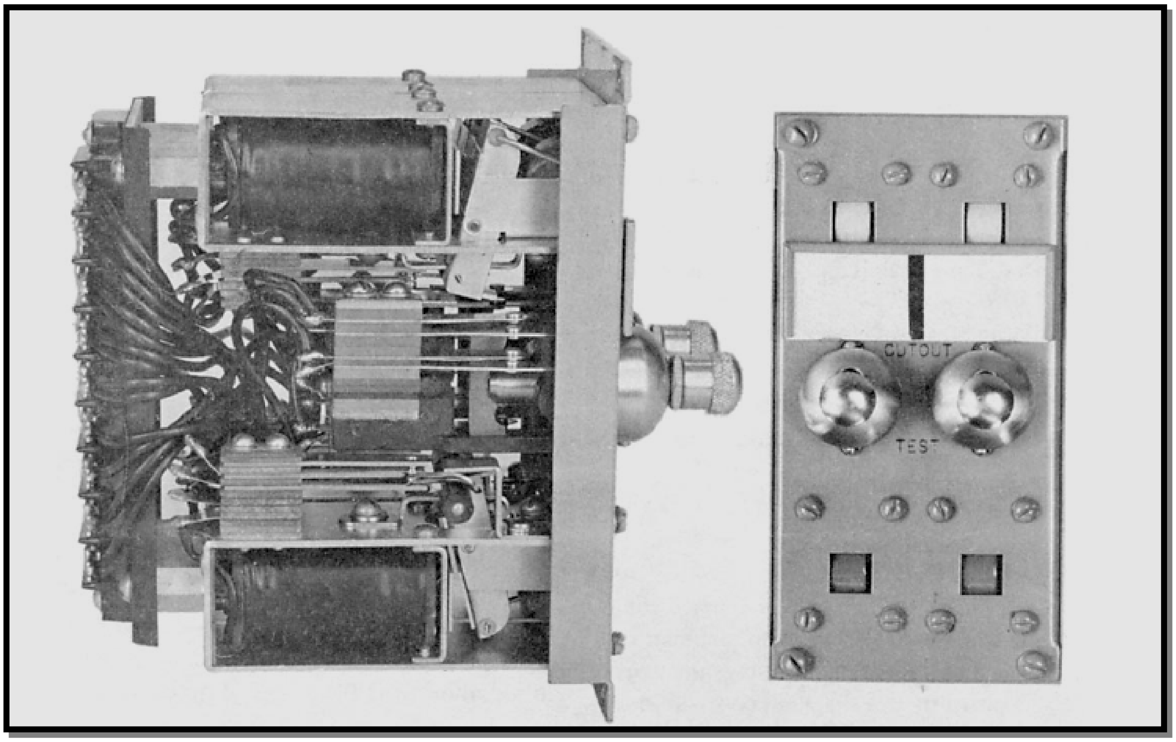


Figure 9-14.—B-51 alarm panel.

Each unit is secured to its case by four screws. This method of mounting permits the inspection of a unit by simply removing the four screws and pulling the unit out of its housing.

The equipment necessary for supervising a circuit or contact maker is comprised of an alarm-target relay, a supervisory-target relay, and a three-position rotary switch. Two sets of the equipment constitute a two-line alarm unit.

The two-line panel has two alarm relays mounted side by side at the rear and near the bottom of the unit panel. Each relay has an indicator drum that projects into square openings in the face of the panel. The two three-position rotary switches are mounted above the alarm relays. The two supervisory relays, with their indicator drums, are mounted above the switches. A bell and buzzer are connected in the relay circuits to provide audible alarms.

The alarm relay has a U-shaped frame. Inside the frame is a magnetic coil, an armature, and an indicator drum. On top of the frame, two pairs of contact springs are mounted (fig. 9-15).

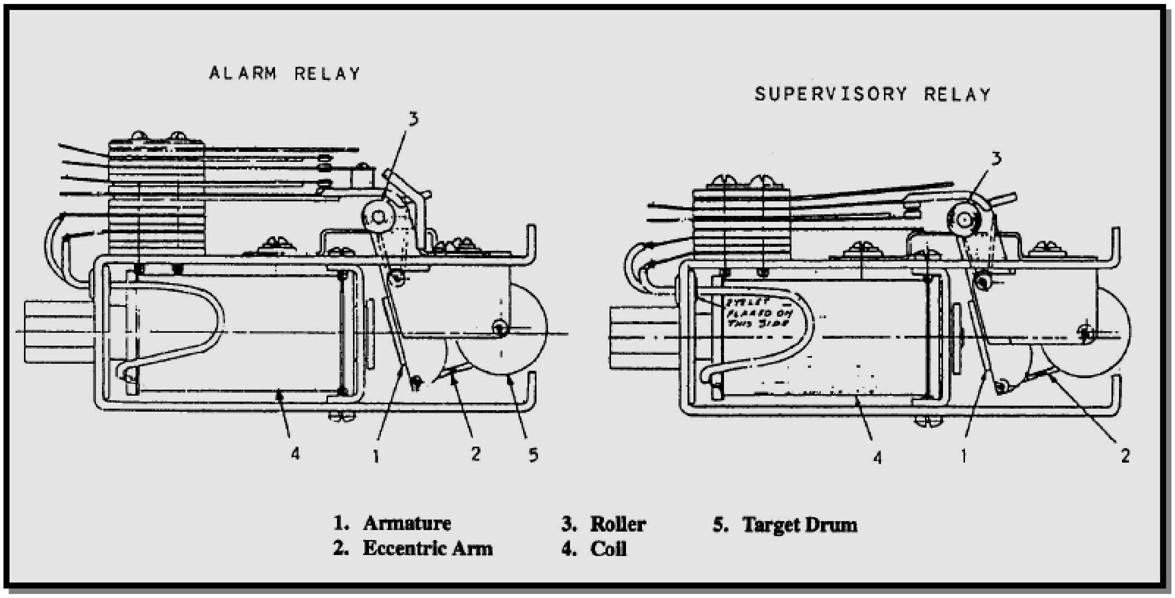


Figure 9-15.—Alarm and supervisory relays.

The magnetic coil of the alarm relay is wound with 13,500 turns of wire to a resistance of 1325 ohms. The armature is located directly in front of the coil and is hinged between the side members of the frame. An insulated roller attached to the upper pm-t of the armature engages the contact spring. A helical coil spring maintains the armature in the open position when the coil is de-energized. The contacts are open when the coil is de-energized or in a normal condition, and closed when energized or in an alarm condition.

The indicator drum is located in front of the armature and is pivoted between the sides of the frame (fig. 9-15). The drum is connected to the armature by a short link, and rotates when the armature operates. The face of the drum protrudes slightly through the panel to be visible. The part of the drum visible when operated is painted red, the rest of the drum is grey.

The supervisory relay is similar in design and construction to the alarm relay. However, the number of turns on the coils and the contact arrangement are different. The supervisory relay is equipped with one pair of contacts. Note that when the armature (1) of the alarm relay operates, it rotates the target drum (5) through an eccentric, and closes the contacts for the audible alarms by moving the roller (3). However, the supervisory-target relay is designed to be normally operated; its alarm contact is closed when the relay is de-energized, and open when energized.

The magnetic coil of the supervisory relay is wound with 14,500 turns of wire and has a resistance of 1350 ohms.

The line unit test switch is a three-position, four-pole, rotary switch. The switch is not adjustable and should require no maintenance.

Normal Operation

The alarm drum has a red section that rolls into view when the alarm-target relay is operated. The supervisory drum shows a yellow section when it is de-energized. The two relays are in series with a sensing device.

When the circuit is in normal operation, the supervisory relay is energized. The supervisory resistor (a 7000-ohm, 5-watt resistor, connected across the terminals of the last sensor or detector) associated with the contact maker is in the circuit. While the alarm relay is also in the circuit, it is not sufficiently energized to operate the armature and close the contacts. When a contact maker closes, it short-circuits the supervisory resistor for that circuit, causing an increase in current. This increase in current increases the magnetic energy of the alarm relay to a point where it will operate its armature, closing the alarm relay contacts, energizing the alarm bell. When the alarm relay operates, it also rotates the target drum to red, indicating the circuit is in an alarm condition.

Since the normal operating current is just sufficient to hold the supervisory relay armature operated, an open circuit will cause the supervisory relay to drop out. This, in turn, closes the supervisory contacts, energizing a buzzer and rotating the supervisory target drum to yellow, indicating the circuit with a problem.

The current flowing under normal conditions (supervisory relay operated, supervisory resistor in the circuit, alarm relay not operated) is approximately 0.012 amperes. If a contact maker closes, shunting the supervisory resistor, the current flow will rise to approximately 0.043 amperes, which is sufficient to operate the alarm relay.

An extension signal relay is also in the alarm circuit (fig. 9-16). When the alarm relay contacts close, the alarm bell is energized by the extension signal relay operating and closing its set of contacts. Figure 9-17 is a schematic of an alarm switchboard.

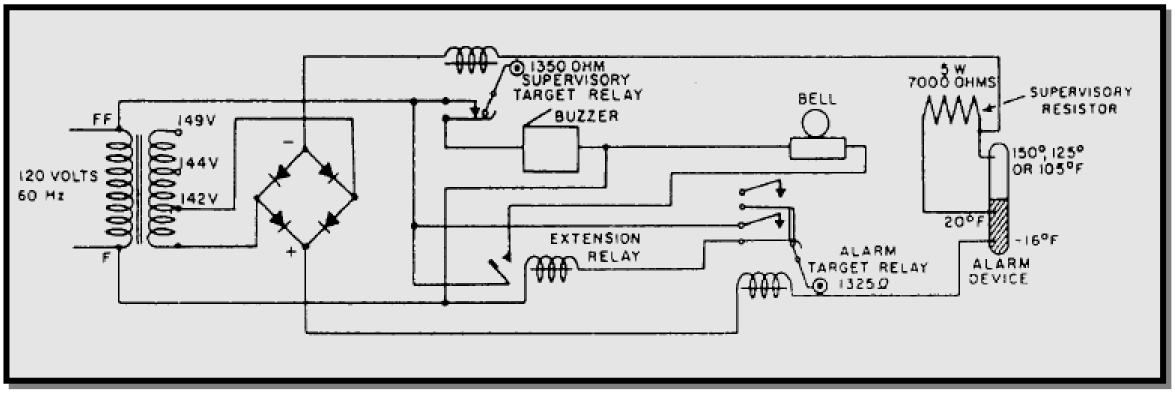


Figure 9-16.—High-temperature alarm circuit.

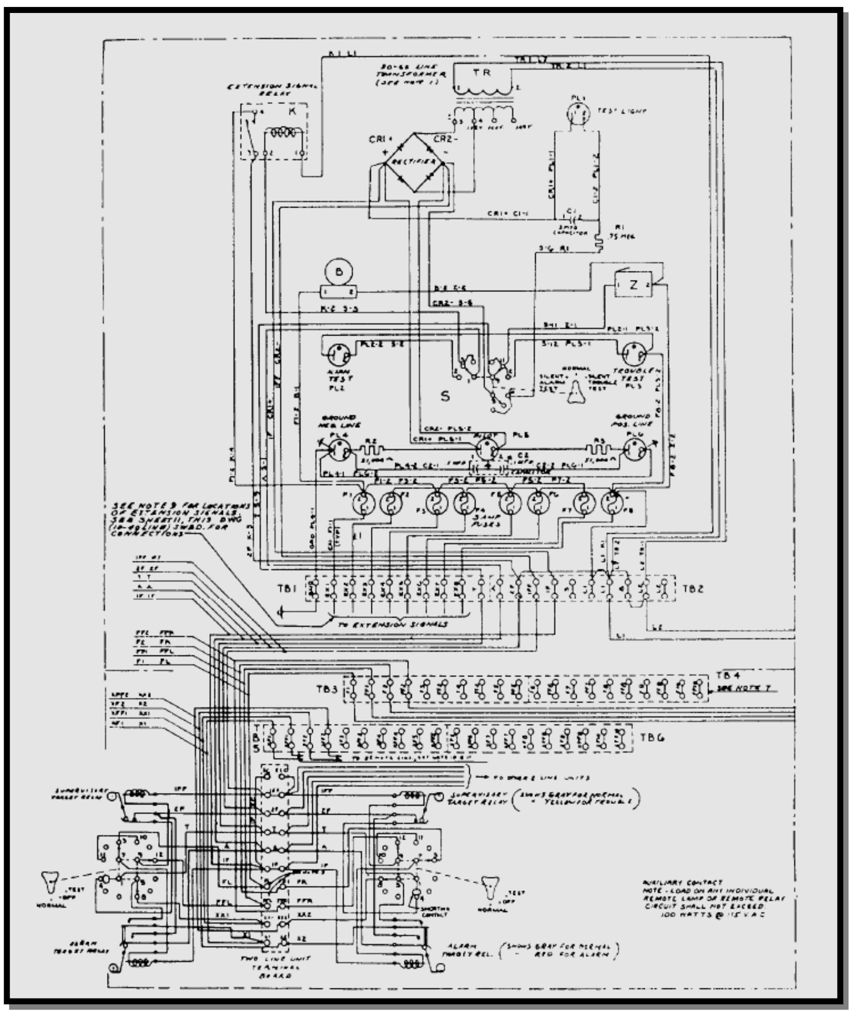


Figure 9-17.—Schematic of an alarm switchboard.

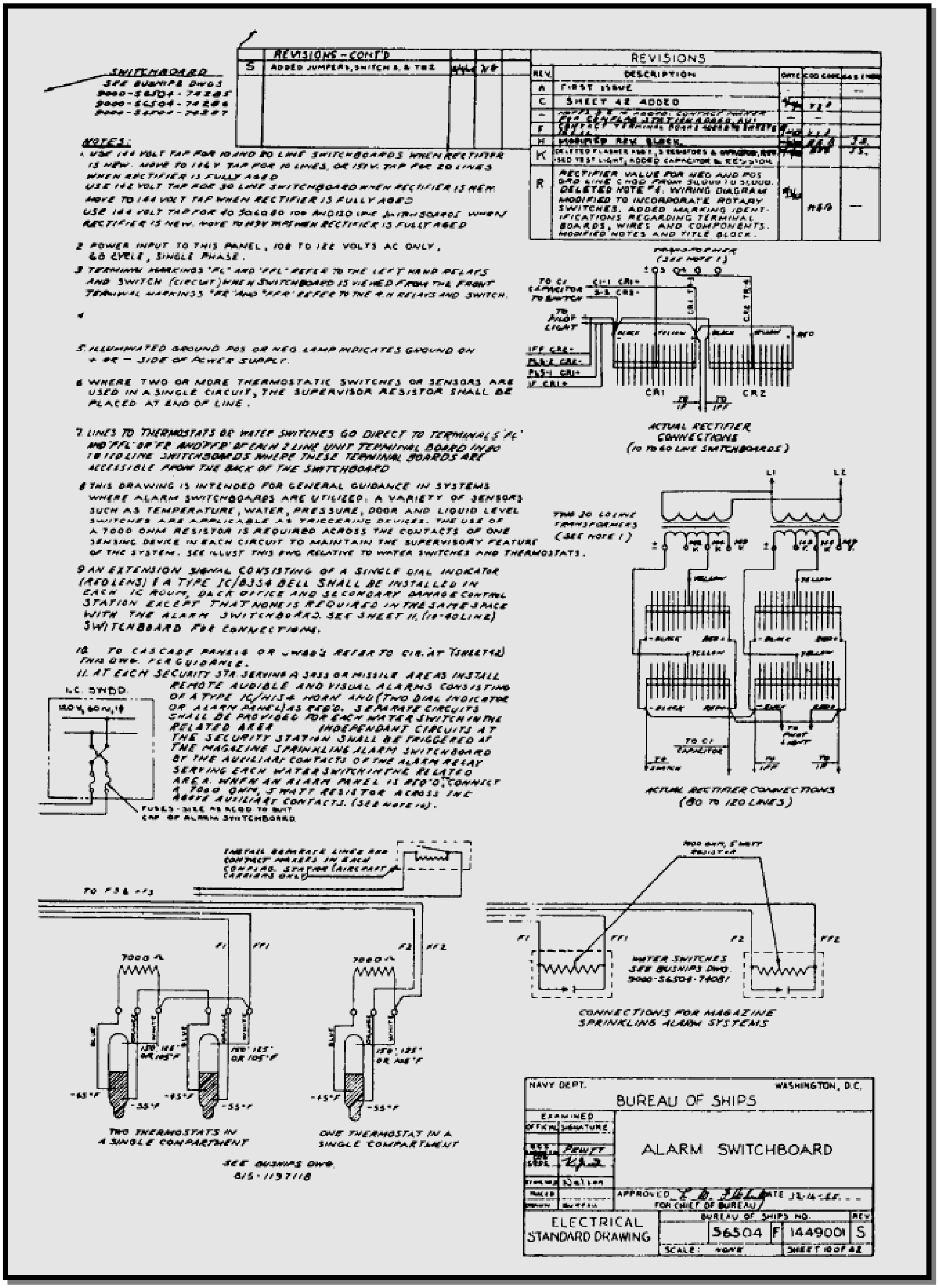


Figure 9-17.—Schematic of an alarm switchboard—Continued.

Test Operation

The supervisory alarm system is designed to require very little attention. Almost any trouble that may affect the system will give both an audible and a visual signal in the form of an alarm, or trouble alarm. However, the system is arranged so that periodic tests of all circuits may be made easily and quickly from the alarm switchboard. These procedures test only the panel and line units. External wiring must be checked at the panel for insulation resistance and continuity.

The silent test switch is centrally located at the top of the alarm switchboard. Keep this switch in the NORMAL position except when testing the switchboard circuits. For the silent alarm test, place the silent test switch in the SILENT ALARM TEST position. This disconnects the extension signal relay, that in **turn** controls the alarm bell and connects the ALARM TEST light into the circuit in place of the bell. When the silent test switch is placed in either test position, the TEST LIGHT on the panel will flash.

To test the capacity of each circuit to act as an alarm, place the silent test switch in the SILENT ALARM TEST position. Place the circuit test switch on the line unit in the TEST position. The ALARM TEST lamp will light and the target will show red on the circuit being tested, If the circuit is in proper condition to turn off the ALARM TEST light, return the station to NORMAL.

To perform the silent trouble test, place the silent test switch in the SILENT TROUBLE TEST position. Placing the switch in this position disconnects the trouble buzzer and places the silent test lamp in the circuit. As in the silent alarm test, the test lamp will also flash, Each supervisory circuit is tested by moving the line unit test switch slowly from NORMAL to OFF. The yellow target will show on the line unit directly above the line unit test switch, and the TROUBLE TEST lamp on the alarm panel will flash momentarily. The yellow target will show as long as the line unit test switch is in the OFF position. The TROUBLE TEST lamp will darken as soon as the line unit test switch is fully operated. If the yellow target does not show, the circuit is inoperative and should be repaired.

Upon completion of the silent alarm test and the silent trouble test, take care to see that all test switches are returned to normal.

9.3.2 Alarm Switchboards

The alarm switchboard is an electrical system installed on board ship for the detection and warning of a variety of important functions or conditions that require continuous monitoring. It also gives warning when trouble or failure occurs in the alarm circuit and indicates which section of the equipment is involved. Alarm switchboards are normally used to monitor alarm, safety, and warning systems that have sensors located in a large number of spaces.

The type IC/SM alarm switchboard uses individual line display alarm modules to present multiple steady and flashing visual displays together with multiple audible signals to indicate the state of the sensors associated with each individual line.

The type IC/SM alarm switchboard is available in many different sizes. Figure 9-18 is an illustration of an IC/SM-50 alarm switchboard. This switchboard is capable of monitoring 50 individual lines. Each switchboard contains a common alarm section and a line display section. The common alarm section includes all components located on the control panel, as well as the subassemblies common to any size alarm switchboard. The line display section contains the individual display modules, one for each circuit.

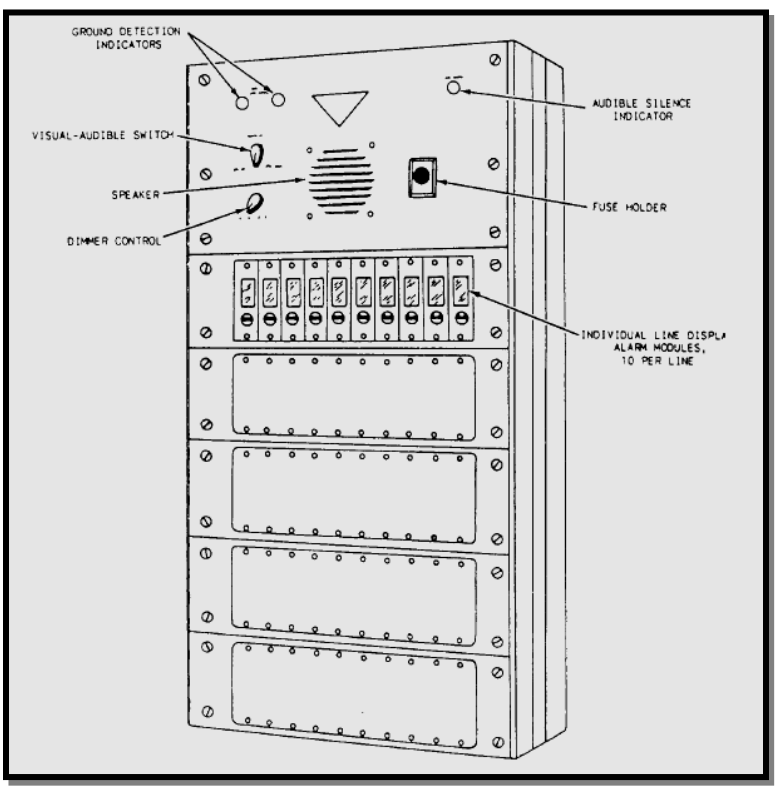


Figure 9-18.—IC/SM-50 alarm switchboard with 10 active modules in place.

Common Alarm Section

The upper section of the switchboard is the common alarm section. The primary function of the common alarm section is to interpret commands from the line display alarm modules and, in turn, generate the appropriate audible signals. The audible signals produced are a wailing (or siren) tone, a pulsating tone, and a steady tone. Each of these signals represents a particular system condition. An alarm condition activates the wailing tone, the supervisory failure activates the steady tone, and a power failure activates the pulsating tone.

The secondary function of the common alarm section is to detect and indicate grounds in the switchboard itself or in any of the individual line circuits.

Mounted on the front of the common alarm section are two ground detection indicators, a visual-audible switch, an alarm silence indicator, a dimmer control, a speaker, and a fuse holder. Located inside the common alarm section are an audible volume control, a tone generator, a battery, a battery charger, the common board, and the power supply.

GROUND DETECTION INDICATORS.— The two ground detection indicators are provided to indicate when a positive or negative ground exists in the switchboard or in one of the lines. When a ground is sensed, one of the lamps will illuminate.

VISUAL-AUDIBLE SWITCH.— The visual-audible switch is a two-position switch. When it is placed in the VISUAL position, no audible alarm will be received, only the alarm silence indicator will indicate an existing alarm condition. This switch is normally left in the AUDIBLE position.

ALARM SILENCE INDICATOR.— The alarm silence indicator illuminates when the visual-audible switch is in the VISUAL position.

DIMMER CONTROL.— The dimmer control dims the alarm module display lamps in all conditions except flashing.

SPEAKER.— The speaker sounds an audible alarm when the visual-audible switch is set in the AUDIBLE position.

FUSE HOLDER.— The fuse holder contains the two main power fuses for the switchboard. If either fuse blows, the fuse holder will illuminate to indicate that there is a blown fuse.

AUDIBLE VOLUME CONTROL.— The audible volume control is used to adjust the volume of the speaker.

TONE GENERATOR.— The tone generator is a type IC/E3D2 electronic signal unit. The tone generator receives inputs from the alarm relays located in the common board and, in turn, generates the appropriate audible signal over the speaker. A wailing tone is generated for an alarm condition. A steady tone is generated for a supervisory failure (trouble condition), and a pulsating tone is generated when there is a loss of power.

BATTERY.— The battery supplies power to the tone generator to generate the pulsating tone when primary power fails. The battery must be hooked up for the switchboard to operate under normal conditions. However, it does not supply emergency power to operate the switchboard. The battery also supplies power to operate the alarm silence indicator when the visual-audible switch is in the VISUAL position.

BATTERY CHARGER.— The battery charger provides a floating charge to maintain the battery during normal switchboard operation. When the battery is charging, the battery voltage should be between 12 and 13.8 volts.

COMMON BOARD.— The common board contains the relays and circuitry to actuate all alarms. It also contains the circuitry for ground detection, dimming, and flashing lamp power.

POWER SUPPLY.— There is a power supply for each lo-line display alarm module. Each power supply consists of a transformer and a bridge rectifier. The output voltage of each power supply is approximately 6.3 volts.

Line Display Section

The lower section of the switchboard is called the line display section. This section contains all the individual line display alarm modules. Figure 9-19 is an illustration of an individual alarm display module.

Recognition of the state of the remote sensor is accomplished by the alarm module (fig. 9-19). One module is associated with each line circuit. Figure 9-20 illustrates an alarm module connected to a sensor circuit. A sensor circuit will be in one of three conditions: normal, alarm condition, or supervisory failure. The upper rectangular portion on the module panel gives the visual display of the circuit condition.

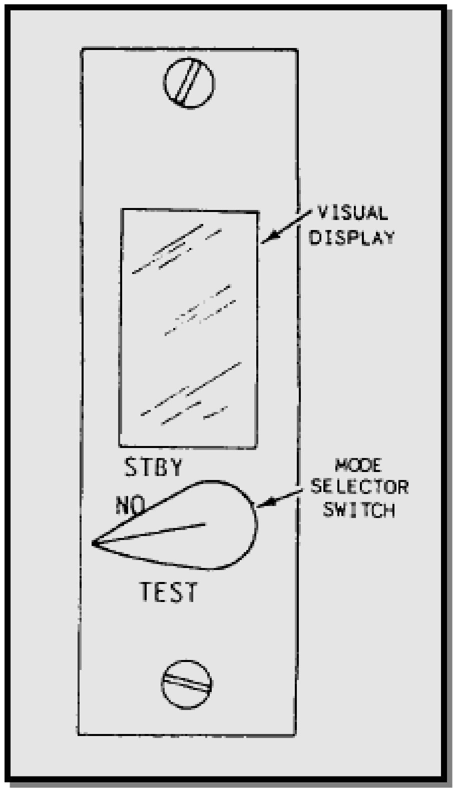


Figure 9-19.—Individual alarm display module.

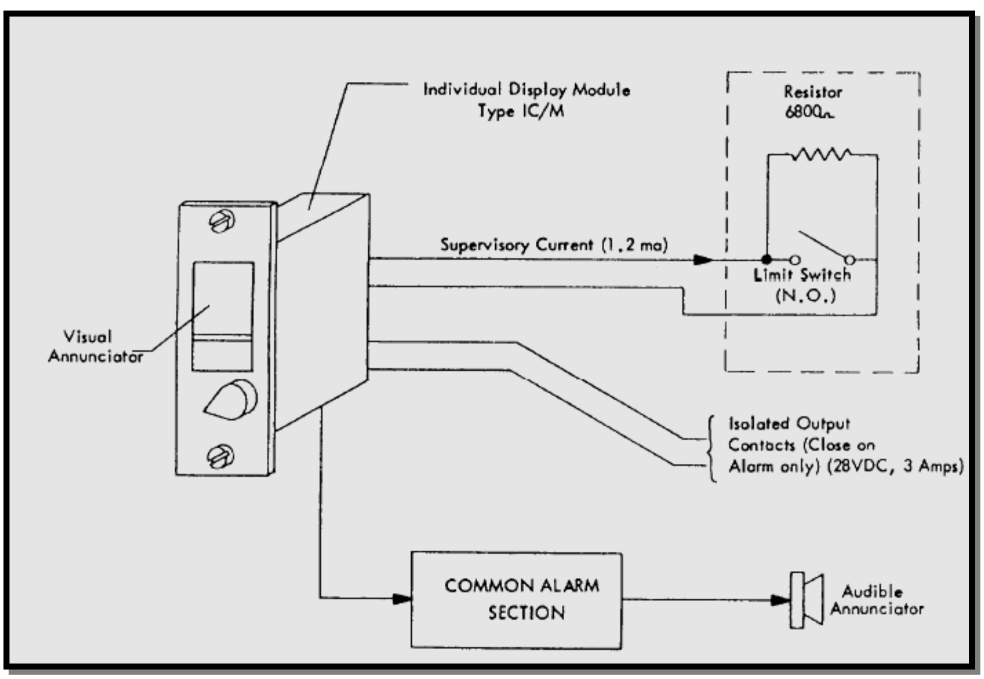


Figure 9-20.—Alarm module type IC/M, functional diagram.

Each module contains a horizontally centered, divided display that can present a steady or flashing red light or no light in either half of the display. All light modes can be dimmed except the flashing mode. The upper half of the display shows the circuit designation and the location of the sensor. The condition of a remote sensor by the alarm module is indicated by visual and audible signals. Figure 9-21 illustrates the visual and audible displays of an alarm module.

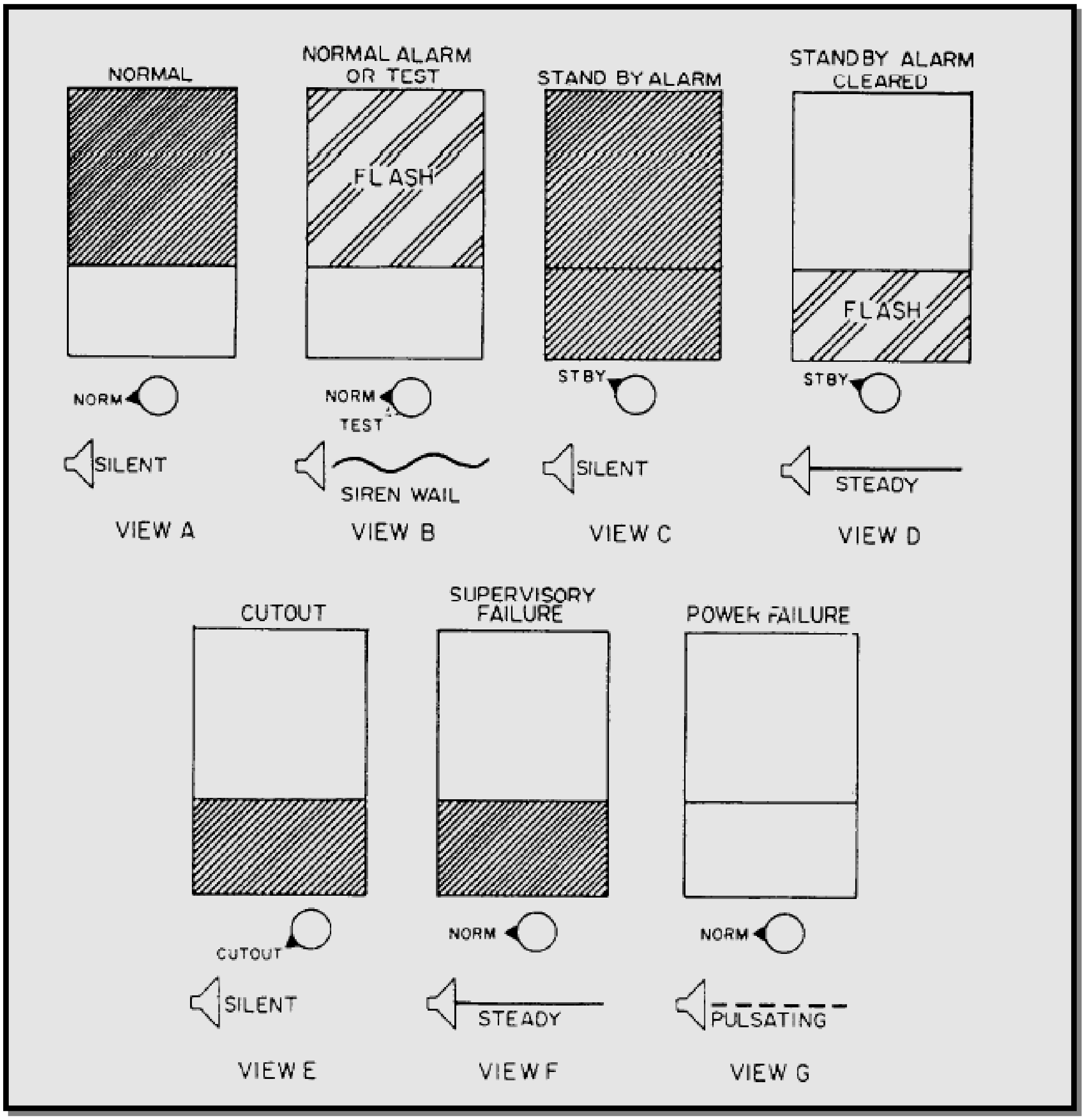


Figure 9-21.—Visual displays and audible outputs.

Each module also has a four-position mode selector switch. The mode selector switch is used to place the module in either the NORM (NORMAL), STBY (STANDBY), CUTOUT, or TEST mode.

NORMAL MODE.— The NORMAL mode is the normal operating position of the mode switch. In this mode, the upper display lamp is on (steady) and the lower display lamp is off (dark). There will be no audible signal. When the remote sensor contacts close, an alarm condition occurs. During an alarm condition, the upper display lamp flashes continuously and the lower display lamp remains off. The alarm module sends a command to the common alarm section. The tone generator in the common alarm section activates the alarm speaker, and a siren wail is heard.

During a trouble condition, such as an open circuit, with the mode switch in NORM, the alarm module will signal a supervisory failure. In this condition, the upper display lamp will go out, the lower display lamp will come on, and a steady alarm tone will sound.

STANDBY MODE.— The STANDBY mode is used to acknowledge an alarm. During an alarm condition, the mode switch is shifted to STANDBY to silence the audible alarm. The upper display lamp will stop flashing and remain on, and the lower display lamp will come on and remain on. When the alarm condition is cleared, the lower display lamp will begin flashing, and the upper display lamp will go out. The alarm module sends a signal to the tone generator and a steady tone will sound on the loudspeaker. The mode switch is then returned to the NORMAL mode to silence the alarm.

CUTOUT MODE.— The CUTOUT mode is used when maintenance needs to be performed on a line. In this mode, power is disconnected to the individual line, the upper display lamp will go off and remain off, and the lower display lamp will come on and stay on. There is no audible signal associated with this mode. The position of the mode switch disconnects power from the sensor circuit to allow maintenance to be performed.

TEST MODE.— The TEST mode is used to simulate an alarm condition. In this mode, the upper display lamp will flash continuously, a wailing tone will sound, and the lower display lamp will remain off.

Power supplies furnish operating power to the alarm modules, their sensors, and to a common circuit board in the common alarm section. The power supplies consist of one transformer and one bridge type diode rectifier for each 10 alarm modules. The output voltage is approximately 6.3 volts rms.

A power failure alarm will sound if a primary power failure occurs. A battery in the alarm switchboard operates the power failure alarm upon loss of primary power. The battery is float charged by a taper charger while primary power is applied. The alarm switchboard is inoperative unless the battery is connected. A power failure is indicated when the upper and lower module lamps are out, and a pulsating tone is heard from the alarm speaker.

9.3.3 Alarm Switchboard IC/SM 4-2

This section provides a source of information for the IC/SM (Interior Communication/Standard Module) Alarm Switchboard. The information combines an overall description, basic operating procedures, and major component details of the three different types of Alarm Switchboards currently manufactured by TANO-EDI, as well as the two types of Intrusion Alarms.

The IC/SM Switchboard is functionally equivalent to IC/SM type alarm switchboard operation as described previously. It is furnished in three versions:

a. 40 Point Alarm Switchboard.

b. 32 Point Alarm Switchboard.

c. 8 Point Alarm Switchboard.

Each panel differs only in the number of alarm channels provided and the number of fused summary outputs. Each Alarm Switchboard is equipped with a redundant serial communications interface that allows an external computer or another Alarm Switchboard to poll the unit for channel status information and summary alarm information. Up to sixteen summary alarm conditions can be configured in an Alarm Switchboard.

Any Alarm Switchboard can be configured to poll other alarm switchboards (over the serial interface) for summary alarm data and display the results on one of the polling switchboard's alarm channels. This feature eliminates the need to parallel wire alarm channel contacts, although this can still be done if desired.

Intrusion Alarm

The Intrusion Alarm provides an alarm contact closure and optional visual indication upon detection of entry into a protected space.

Two types of Intrusion Alarms are covered in this section:

a. Type 4581 - Intrusion Alarm Panel with Indication.

b. Type 4434 - Intrusion Alarm Panel without Indication.

The type 4581 Intrusion Alarm Panel features local and remote compartment attended indication, remote alarm indication, tamper resistant circuitry, alarm contact output, and an exit time delay function.

The type 4434 Intrusion Alarm Panel features remote compartment attended indication, remote alarm indication, alarm contact output, and an exit time delay function.

The IC/SM Alarm Switchboards and Intrusion Alarm Panels are designed for ease of operation, reliability, and ease of maintenance. The redundant serial interface assures a high degree of reliability in transferring status information between units. All internal circuit boards feature "plug-in" style terminal connections making it possible to remove and replace circuit boards without disconnecting wires. All internal logic is driven by a micro-controller, making possible feature changes without replacing hardware.

Each of the three types of Alarm Switchboards (40 point, 32 point and 8 point) differs mainly in the number of channels provided. Front panel controls and indicators are identical in appearance and function. Any differences will be explained in the technical manual.

Front Panel Controls and Indicators

Following is a brief description of front panel controls and indicators. Typical controls and indicators are illustrated in Figure 9-22.

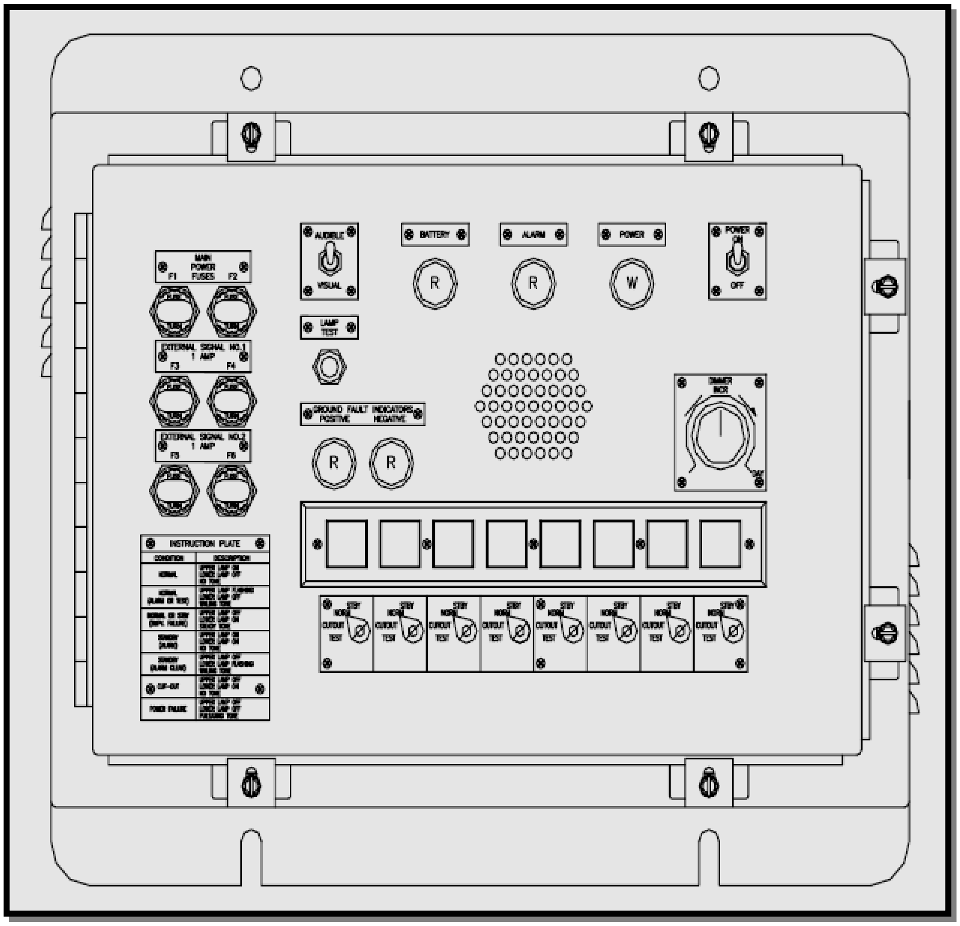


Figure 9-22.— IC/SM 8 Point Alarm Switchboard Front Panel Controls and Indicators (Typical).

a. Power Switch - Applies power to the unit.

b. Power Indicator - Indicates the presence of AC Power to the unit. This indicator will illuminate when AC Power is connected and the Power Switch is in the "On" position.

c. Battery Indicator - Illuminates when the Power Switch is in the "Off" position or AC Power is not present. When either of these conditions occurs, this indicator will be the only one illuminated on the front panel and a pulsating sound will be heard from the speaker if the speaker switch is in the "Audible" position.

d. Speaker Switch - Controls sound output from the speaker. In the "Audible" position, audible tones will be passed to the speaker. In the "Visible" position, audible tones will be inhibited.

e. Lamp Test Button - When held down, will cause all indicators (including channel indicators) to illuminate.

NOTE:
The Power Indicator is not affected by the Lamp Test Button as it is always illuminated when AC power is present.

f. Dimmer Knob - Dims the individual channel indicator lights.

g. Positive Ground Fault Indicator - Illuminates when the positive alarm excitation or the positive power connection of the internal circuitry becomes shorted to the chassis.

h. Negative Ground Fault Indicator - Illuminates when the negative alarm excitation or the negative power connection of the internal circuitry becomes shorted to the chassis.

i. Channel Indicators and Switches – Each alarm channel has two indicators (upper and lower) and a four position selector switch. The indicators show the current status of the alarm channel. The selector switch is used to respond to the different channel states. The selector switch has four positions outlined below (starting at the top most position and moving counter clockwise):

1. Stby (Standby)

2. Norm (Normal)

3. Cutout

4. Test

j. The behavior of the channel indicators and the function of the selector switches is explained later.

k. Channels are numbered from left to right and top to bottom (channel number 1 is at the top left).

l. Main Power Fuses (F1 and F2) - Indicating type fuses that protect each side of the AC line. Fuse rating is 1 amp.

m. External Signal Power Fuses – Indicating type fuses that protect the external output power signals. The function of these signals is explained later. There are two fuses per output (one for each side of the AC line). The number of fuses and the signal type protected by each fuse varies with the type of alarm panel. Table 9-2 shows the fuse designations for the 8 point panel display in figure 9-22.

NOTE:
Each fuse has a rating of 1 Amp.

FUSE DESIGNATOR	SIGNAL TYPE
F3 and F4	110VAC Alarm Summary
F5 and F6	110VAC Supervisory Summary

Table 9-2.— 8 Point Panels.

Internal Components
The typical internal components are described below and illustrated in Figure 9-23 and Figure 9-24.

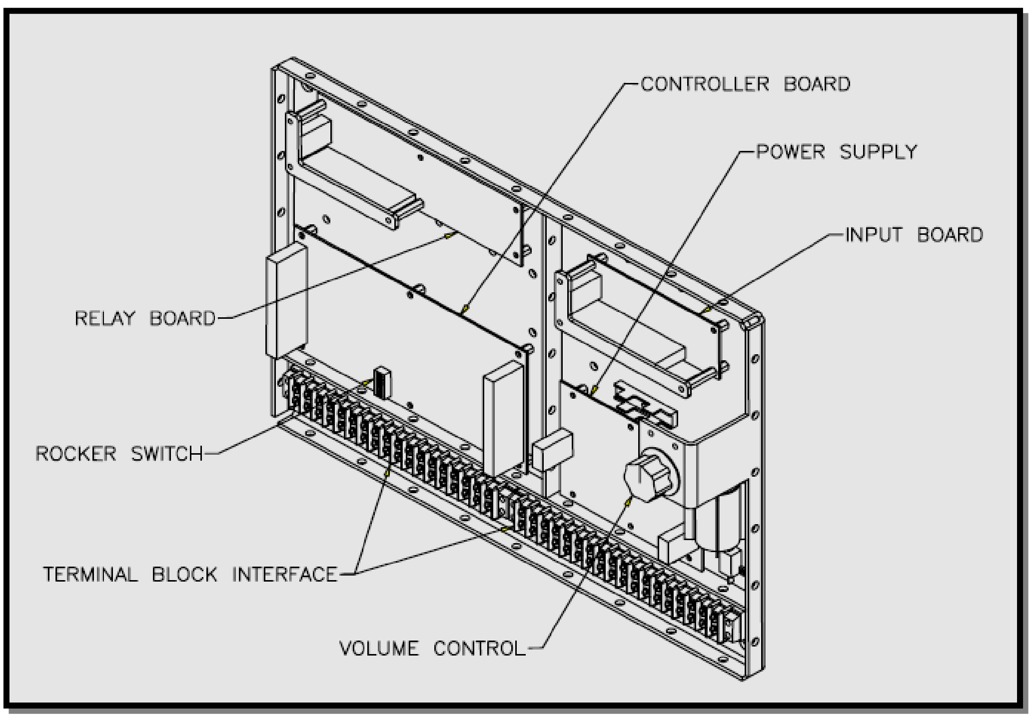


Figure 9-23.— IC/SM 8 Point Alarm Switchboard Internal Panel (EMI Covers Removed).

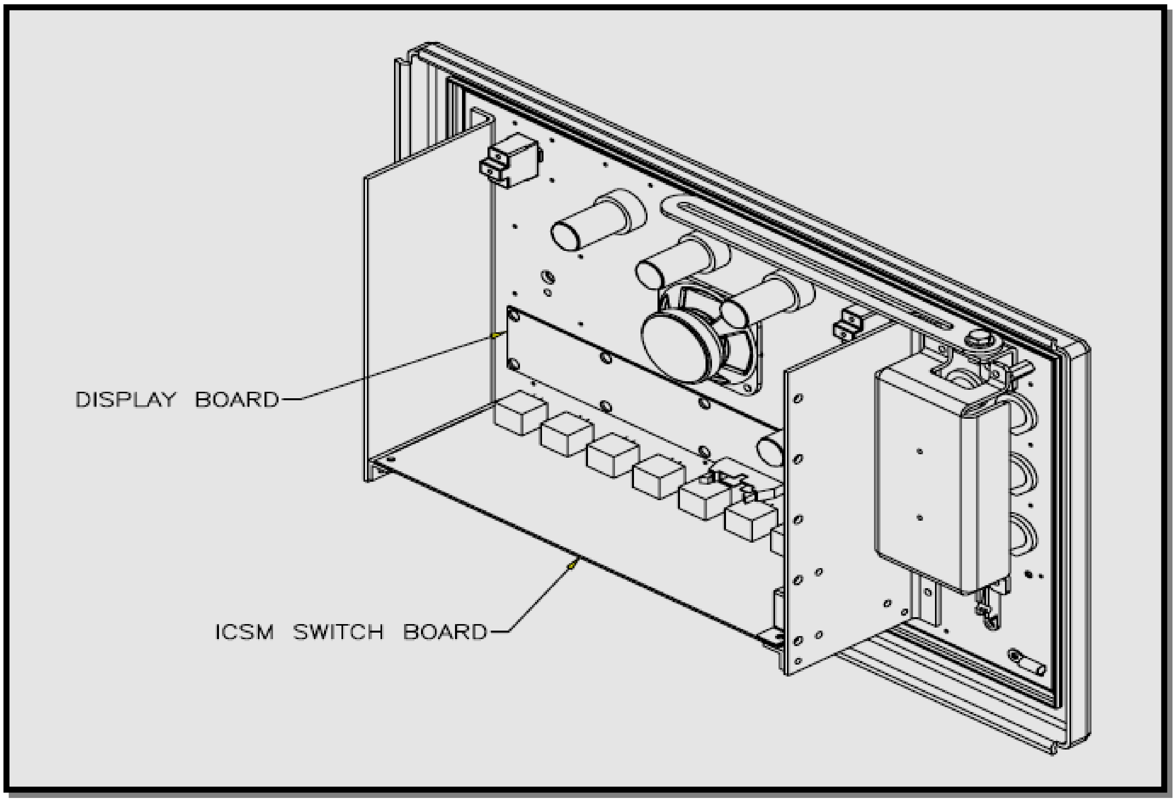


Figure 9-24.— IC/SM 8 Point Alarm Switchboard Internal Components - Rear of Hinged Front Panel.

a. Input Board – Each Input Board provides connections for eight alarm channel inputs (two wires per input).

b. Relay Board – Alarm Channel relay outputs. Each Relay Board provides connections for eight alarm channels.

c. Display Board - Alarm Channel Indicators. Each board provides indicators for eight alarm channels.

d. Switch Board - Data collection and signal routing board for alarm channel data (alarm input status, selector switch position, indicator lights). An Input Board, Relay Board, and Display Board connect to this board via flat ribbon cables. Each board provides signal routing and data collection for eight input channels.

e. Controller Board - Collects data from switch boards, performs all logic operations for every channel, controls front panel indicators, generates necessary sounds for various status conditions, and controls external signal outputs. These functions are performed by a single chip micro controller and supporting hardware. All switch boards in an alarm panel connect to the Controller Board daisy chain fashion via a flat ribbon cable.

f. Power Supply - Provides DC power to all circuit boards.

g. Battery - Provides DC Power to Controller Board when AC Power is disconnected or when the Power Switch is in the "Off" position (not shown).

h. Volume Control - Controls the volume of the speaker. Provides up to 16dB of attenuation.

i. Terminal Block Interface – Connection point for AC power, external signal power, summary relay outputs and serial communications.

Interface

The IC/SM Alarm Panel interfaces to external components via wires routed through the bottom of its enclosure. The different types of signals that can be interconnected are described here.

a. Individual Alarm Channel Input Signals (two wires per channel) - Connected to the 16 point terminal block (TB2) on the appropriate input board.

b. Individual Alarm Channel Relay Output (two wires per channel) - Connected to the 16 point terminal block (TB2) on the appropriate relay board.

c. External Signal Power (Alarm Summary) - 110VAC output. Energized whenever an alarm condition is present at any channel. 1 amp max per channel.

d. External Signal Power (Supervisory Summary) - 110VAC output. Energized whenever a supervisory condition is present at any channel. 1 amp max per channel.

e. Alarm Contact (Alarm Summary) – Single Pole Double Throw (SPDT) solid state relay contact. Energized whenever an alarm condition is present at any channel. 110VAC, 0.17A max.

f. Supervisory Contact (Supervisory Summary) - SPDT solid state relay contact. Energized whenever a supervisory condition is present at any channel. 110VAC, 0.17A max.

g. External Power Indication - 110VAC output used to indicate presence of power to Alarm Switchboard. 1A, max.

h. External Speaker Connection - provides a means of connecting an external speaker to the Alarm Switchboard. 8 ohms minimum impedance.

i. Serial Communications – Redundant serial communications lines (two wire differential). The serial communications link is electrically isolated from the rest of the circuitry, therefore, a communications ground line (provided on the terminal interface) must be connected.

Installation

All three types of alarm switchboards are designed for wall mounting. They are secured via two mounting holes at the top of the enclosure and two slotted holes at the bottom of the enclosure.

Stand-Alone Operation

Stand-Alone Operation is defined as operation of the Alarm Switchboard with no serial communications hookup to an external component or another Alarm Switchboard. If it is not desired to disable any of the channels, no software configuration is necessary when the switchboard is used in this manner.

Alarm Switchboard Power Up and Power Down

To power up the Alarm Switchboard, place the Power Switch in the "On" position. To power down the Alarm Switchboard, place the Power Switch in the "Off" position. When the Alarm Switchboard is powered down, the controller card will still have power applied to it from the battery and the software on the controller card will cause a pulsating sound to be emitted from the speaker. To completely power down the Alarm Switchboard, it is necessary to place the Power Switch in the "Off" position and disconnect the battery.

CAUTION:

Always put the Power Switch in the "Off" position and disconnect the battery when performing maintenance on the Alarm Switchboard.

Individual Channel Operation

Individual channels on the Alarm Switchboard utilize a combination of a four position selector switch and two indicators (upper and lower) for alarm indication, acknowledgement, maintenance and self check. The following sequences illustrate the different scenarios that can occur. Each sequence details the normal sequence of events that occur and the expected responses from the operator:

Alarm Detection

a. Selector switch in "norm" position, alarm condition cleared. Upper indicator illuminated, lower indicator extinguished. No sound.

b. Alarm Switchboard detects an alarm condition at the channel inputs.

c. Upper Indicator flashes, lower indicator extinguished. Wailing sound.

d. Operator places selector switch in the "stby" position.

e. Upper and lower indicators illuminate steadily. No sound.

f. Alarm Switchboard detects an alarm clear condition.

g. Upper indicator illuminated. Lower indicator flashes. Wailing sound.

h. Operator moves selector switch to "norm" position.

i. Upper indicator illuminated. Lower indicator extinguished. No sound.

Transient Alarm Detection

a. Selector switch in "norm" position, alarm condition cleared. Upper indicator illuminated, lower indicator extinguished. No sound.

b. Alarm Switchboard detects an alarm condition at the channel inputs. Alarm condition returns to normal before being acknowledged.

c. Upper indicator flashes, lower indicator extinguished. Wailing sound.

d. Operator places selector switch in the "stby" position.

e. Upper indicator illuminated. Lower indicator flashes. Wailing sound.

f. Operator moves selector switch to "norm" position.

g. Upper indicator illuminated. Lower indicator extinguished. No sound.

Supervisory Detection

a. Selector switch in "norm" position, alarm condition cleared. Upper indicator illuminated, lower indicator extinguished. No sound.

b. Alarm Switchboard detects a supervisory (open circuit) condition at alarm inputs.

c. Upper indicator extinguishes. Lower indicator illuminates. Continuous sound.

d. Operator places selector switch of affected channel in "cutout" position.

e. Lower indicator illuminated. Upper indicator extinguished. No sound.

f. Operator notifies maintenance of faulty condition.

Channel Disable for Maintenance

a. Selector switch in "norm" position, alarm condition cleared. Upper indicator illuminated, lower indicator extinguished. No sound.

b. Operator places selector switch in "cutout" position.

c. Lower indicator illuminated. Upper indicator extinguished. No sound.

d. Maintenance performs required work on channel wiring.

e. Operator places selector switch in "norm" position.

f. Upper indicator illuminated, lower indicator extinguished. No sound.

Channel Self Check

a. Selector switch in any position other than "test".

b. Operator places selector switch in "test" position.

c. Upper indicator flashes. Lower indicator extinguished. Wailing sound.

d. Operator places selector switch in any position other than test.

e. State of indicators determined by position of selector switch and alarm channel input condition.

Alarm Channel Relay Contact Operation

Each alarm channel is furnished with a solid state relay contact (normally open). The relay energizes under the following conditions:

a. Whenever an alarm condition is present.

b. If an alarm occurs and returns to normal before being acknowledged, the relay will remain energized until the operator places the selector switch in the "stby" position.

Front Panel Operation Under Alarm and Fault Conditions

The operation of the front panel controls and indicators was briefly outlined in the description of front panel controls, however, the behavior of certain indicators under alarm and fault conditions warrants more detail.

Alarm Indicator

The Alarm Indicator illuminates under the following conditions:

a. Whenever an alarm condition is present at any channel.

b. If an alarm occurs at any channel and returns to normal before being acknowledged, the Alarm Indicator will remain energized until the operator places the selector switch in the "stby" position.

Positive and Negative Ground Indicator Lights

The chassis of the IC/SM Alarm Switchboard is electrically isolated from the positive and negative DC power lines. Should either one of these lines become shorted to the chassis or either of the external channel alarm wires become shorted to the hull of the ship, one of these indicators will illuminate.

The Positive Ground Indicator will illuminate if the positive DC power line becomes shorted to the switchboard chassis or if the positive excitation wire for the alarm channel becomes shorted to the ship's hull. The Negative Ground Indicator will illuminate if the negative DC power line becomes shorted to the switchboard chassis or if the negative excitation wire from the alarm channel becomes shorted to the ship's hull.

Should both the positive and negative excitation wire for the alarm channel become shorted to the chassis, the Positive Ground Indicator will illuminate and the channel will indicate an alarm condition.

Configuration

In Stand alone mode, configuration is only necessary if it is desired to disable one or more channels in the Alarm Switchboard (Alarm Switchboards are shipped with all channels enabled by default). A disabled channel will not recognize alarm conditions, not respond to self-test, and will illuminate neither of its indicators.

To disable a channel or enable a previously disabled channel requires the use of a Lap-top Computer, RS-485 interface cable with adapter, and the IC/SM Configuration Software.

To enable or disable a channel, perform the following:

a. Connect the Serial Interface cable, RS-485 adapter, and Lap-top Computer to the Alarm Switchboard.

b. Run the IC/SM Configuration Software.

c. Select the "Channel Enable" option.

d. Wait approximately 5 seconds to allow the Program to download data from the Alarm Switchboard.

e. 40 buttons will be displayed on the screen (one for each channel). Any button displaying a green color indicates an enabled channel. Any button displaying a red color indicates a disabled channel. Clicking on a given button will toggle its color, thereby changing its state.

f. After making any desired changes, click the "Update" button.

g. Wait approximately 45 seconds. During this time, the IC/SM Configuration Program will write the configuration information to the Alarm Switchboard, then read it back and confirm the correct information was written. Any errors will be reported to the screen. A message box will be displayed confirming the operation.

h. If no errors are reported, the operation is complete. If any errors are reported, repeat this procedure (click the "refresh" button before proceeding).

i. If repeated attempts fail to produce the desired results, refer to the technical manual.

Multi-Unit Operation

The features provided by Single-Unit operation are also available in Multi-Unit Operation. This section will detail additional features available when units are connected together via the serial interface.

Two possible configurations can be used in Multi-Unit Operation:

Switchboards, designated slaves, can be connected together through the serial interface to a computer running a data acquisition program, designated the master. The master can request data from the slaves using the Modbus Protocol. Data can then be displayed on the screen.

b. Alarm Switchboard Poll - Up to 31 Alarm Switchboards, designated slaves, can be connected together through the serial interface to another Alarm Switchboard, designated the master. The master can then be configured to poll the other switchboards, collecting summary alarm information and displaying the information on one or more channels.

Serial Cable Topology

Regardless of the type of polling configuration, two different topologies may be used to interconnect the Alarm Switchboards:

a. Star - This topology routes a serial cable from each slave directly to the master. Maximum reliability is achieved by this topology, however, it may be difficult to implement depending on the physical location of the slave units.

b. Bus - This topology routes a cable daisy chain fashion starting at the master and then to each slave. To improve reliability, a cable is also routed from the last slave in the chain back to the master although this is not necessary from a functionality standpoint.

Redundancy

The serial interface on the Alarm Switchboard is implemented as two independent physical connections designated channel A and channel B. When an Alarm Switchboard is used as the master; it will switch communication channels in the event communications is lost. When an external computer is used as the polling device, it is recommended that the same method be implemented for maximum reliability.

Both channels do not have to be connected from an operational standpoint, however, it is highly recommended.

Configuration

In order to use the serial interface for summary alarms, the Alarm Switchboard must be configured. The type of configuration depends on whether the unit is to be used as a master or a slave.

Slave Configuration

To configure the Alarm Switchboard for slave operation, perform the following:

a. Turn off the power to the Alarm Switchboard.

b. Open the front cover of the Alarm Switchboard.

c. Disconnect the battery wires.

d. Remove the metal cover from the Controller Board. The cover is attached with screws and washers in six (6) places.

e. Locate the eight position rocker switch on the Controller Board (Figure 9-23 and Figure 9-25).

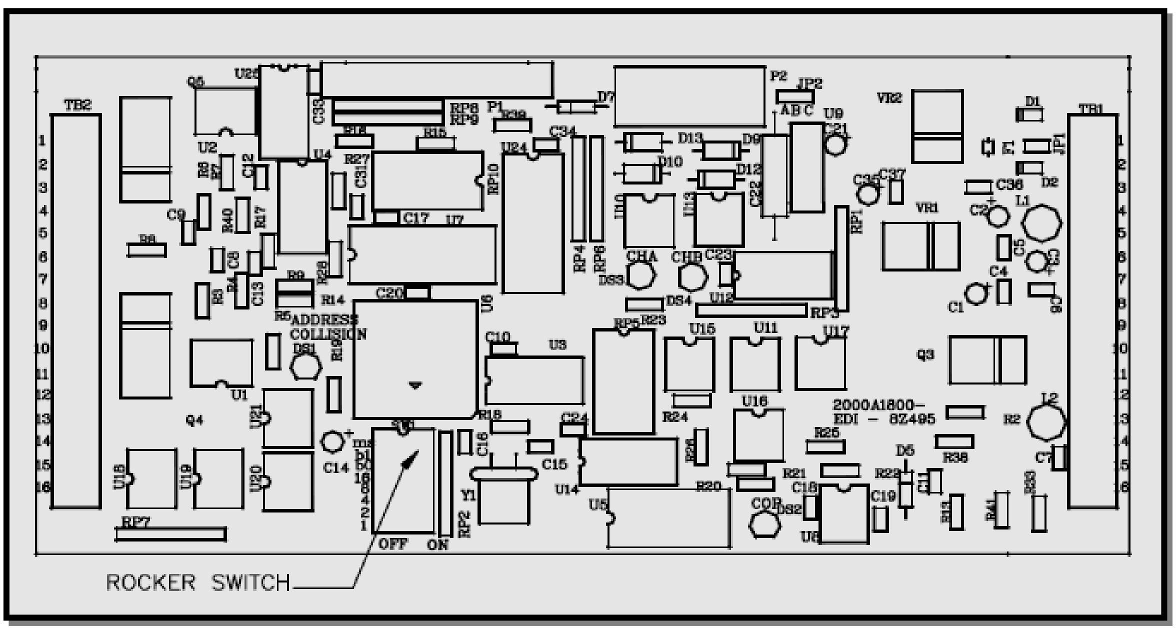


Figure 9-25.— IC/SM Controller Board.

f. The switches labeled 1, 2, 4, 8, 16 will be used to set the slave address.

g. Using Table 9-3, determine the switch settings for the desired slave address.

h. Set the switches to the desired slave address.

i. Locate the switch labeled "M/S" and set it to off. (Slave =OFF; Master= ON)

j. Install the metal cover on the Controller Board.

k. Reconnect the Battery wires.

l. Close the front cover of the Alarm Switchboard.

m. Turn on the power to the Alarm Switchboard.

NOTE:
Slave Address 31 should be reserved for use with the unit acting as master.

ADDRESS	16	8	4	2	1
1	Off	Off	Off	Off	On
2	Off	Off	Off	On	Off
3	Off	Off	Off	On	On
4	Off	Off	On	Off	Off
5	Off	Off	On	Off	On
6	Off	Off	On	On	Off
7	Off	Off	On	On	On
8	Off	On	Off	Off	Off
9	Off	On	Off	Off	On
10	Off	On	Off	On	Off
11	Off	On	Off	On	On
12	Off	On	On	Off	Off
13	Off	On	On	Off	On
14	Off	On	On	On	Off
15	Off	On	On	On	On
16	On	Off	Off	Off	Off
17	On	Off	Off	Off	On
18	On	Off	Off	Off	On
19	On	Off	Off	On	On
20	On	Off	On	Off	Off
21	On	Off	On	Off	On
22	On	Off	On	On	Off

Table 9-3.— Controller Board Slave Switch Settings.

ADDRESS	16	8	4	2	1
23	On	Off	On	On	On
24	On	On	Off	Off	Off
25	On	On	Off	Off	On
26	On	On	Off	On	Off
27	On	On	Off	On	On
28	On	On	On	Off	Off
29	On	On	On	Off	On
30	On	On	On	On	Off
31	On	On	On	On	On

Table 9-3 (Cont).— Controller Board Slave Switch Settings.

Master Configuration

To configure the Alarm Switchboard as a master, perform the following:

a. Turn off the power to the Alarm Switchboard.

b. Open the front door of the Alarm Switchboard.

c. Disconnect the battery wires.

d. Remove the metal cover from the Controller Board.

e. Locate the eight position rocker switch on the Controller Board.

f. Locate the switch labeled "M/S" and set it to On. (Master = ON; Slave = OFF).

g. Install the metal cover on the Controller Board.

h. Reconnect the Battery wires.

i. Close the front door of the Alarm Switchboard.

j. Turn on the power to the Alarm Switchboard.

Configuring Summary Alarms

Configuration of summary alarms requires the use of the IC/SM Configuration Program.

To configure a set of Alarm Switchboards for summary alarm operation, each slave must be configured to detect desired summary alarm conditions. The master must be configured to poll the slaves for the summary alarm conditions and display them on one of the master's channel indicators. The IC/SM Configuration Program provides a user interface to enter this data and write it to non-volatile storage on each Alarm Switchboard to be configured. When configuring the Alarm Switchboards using this program, the unit designated as the master must temporarily be configured as a slave to allow it to be configured by the IC/SM Configuration Program.

Each slave can be configured with up to 16 different summary alarm conditions or "SACs". Each SAC contains the following information:

a. Channel numbers on the Alarm Switchboard to be included in the summary condition.

b. Type of Summary (Alarm, Supervisory, or Alarm and Supervisory).

c. Channel on the master to display the SAC (this is only required if an Alarm switchboard is acting as the master).

To configure the Alarm Switchboards for summary operation, perform the following for each Alarm Switchboard to be configured:

a. Temporarily set the Alarm Switchboard that will act as a master for slave operation. Set the slave address for this unit as 31.

b. Power up all units that are to be configured (including the master).

c. Run the IC/SM Configuration Program.

d. Set the address of the Alarm Switchboard that is to be configured by typing the number in the text box labeled "Modbus Address".

e. Verify the IC/SM Configuration Program is communicating with the Alarm Switchboard.

f. Click the "Summary Config" button on the configuration program display screen.

g. After a short delay, a screen displaying 17 buttons will be displayed on the configuration program display screen. 16 of these buttons represent the SACs that may be configured. They are labeled "SAC 1", "SAC 2" etc. Buttons that are red in color indicate SACs that have previously been configured. Buttons that are white in color indicate SACs that are not currently configured.

h. Click the button representing the SAC that is to be configured.

i. A screen displaying 45 buttons will be displayed on the Configuration Program Display Screen. 40 of these buttons (numbered 1 through 40) represent the channels that will generate a summary condition. A Red Button indicates it is in the summary group (if an alarm occurs in this channel a summary condition will be generated). A white button indicates it is not in the summary group.

j. Set the desired configuration by clicking the buttons to toggle their color to the desired value (The button labeled "Clear All" will set all buttons to White. The button labeled "Set All" will set all buttons to Red).

k. The two buttons labeled "Alarm" and "Supervisory" indicate whether a summary condition will be generated for an alarm or supervisory state occurring at any of the selected channels. A red color indicates the specified state will generate a summary condition. At least one of these must be red. Click the buttons to toggle their color.

l. In the text box labeled "Display Channel", enter the channel number on the Alarm Switchboard acting as master to display the SAC. If an Alarm Switchboard is not to be used to display the SAC, this text box should be empty.

m. When the SAC has been configured, click the "Done" button. The screen outlined in step g will be displayed.

n. Repeat step g - step m until all SACs have been configured as desired.

o. Once all SACs have been configured, click the "Write Configuration" button (This button is displayed on the screen outlined in step g). All SAC configurations will be written to the Alarm Switchboard. A message box will be displayed confirming the operation when complete. It may take up to several minutes to complete depending on the number of SACs that have been configured.

Front Panel Controls

The 4581 and 4434 differ in their operation as well as the number and function of the front panel controls. The front panel controls are detailed here.

4581 Front Panel Controls

The 4581 Intrusion Alarm front panel controls and indicators are illustrated in Figure 9-26 and described below.

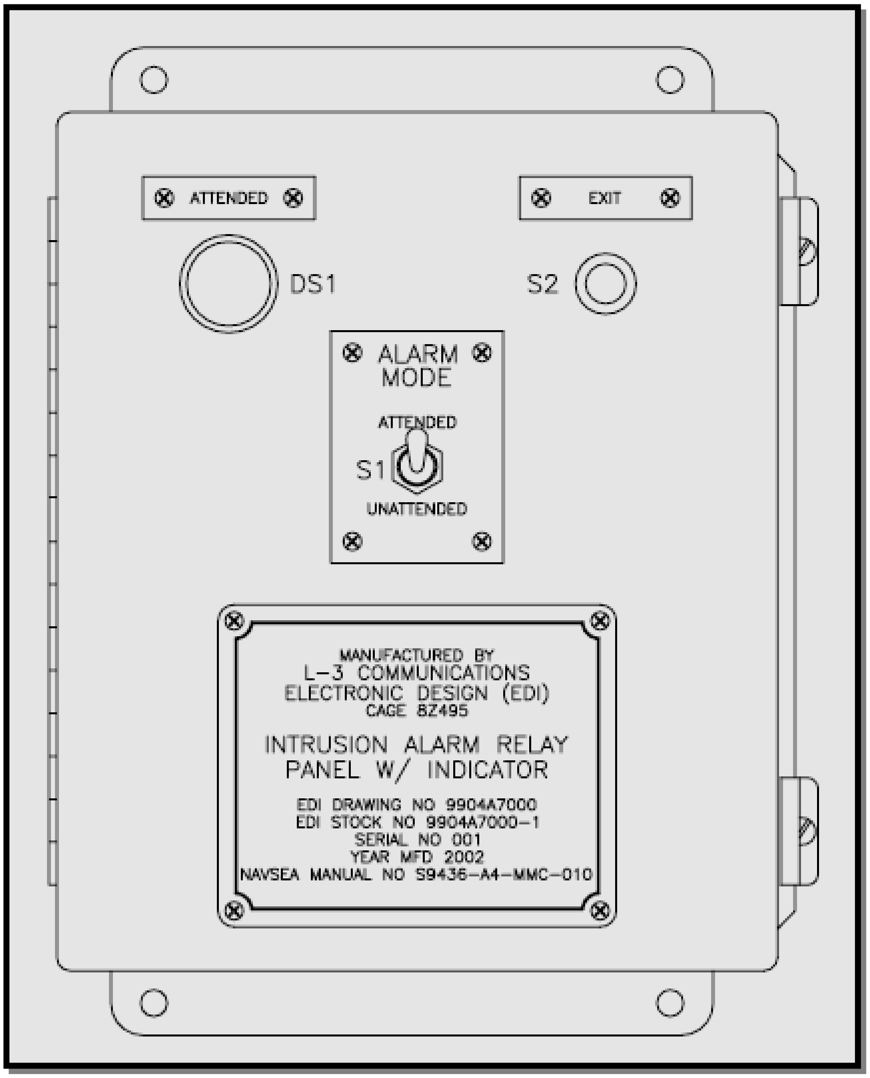


Figure 9-26.— 4581 Intrusion Alarm Panel Control and Indicators.

a. Alarm Mode Switch - When in the "Unattended" position the Intrusion Alarm is "active" and will detect un-authorized intrusions. When in the "Attended" position the Intrusion Alarm is "inactive" and will not detect un-authorized intrusions.

b. Attended Indicator - When illuminated, indicates the Alarm Mode Switch is in the "Attended" position.

c. Exit Button - Disables intrusion detection for 60 seconds. This button also disables the "tamper detection" feature.

4434 Front Panel Controls

The 4434 Intrusion Alarm front panel controls are illustrated in Figure 9-27 and described below.

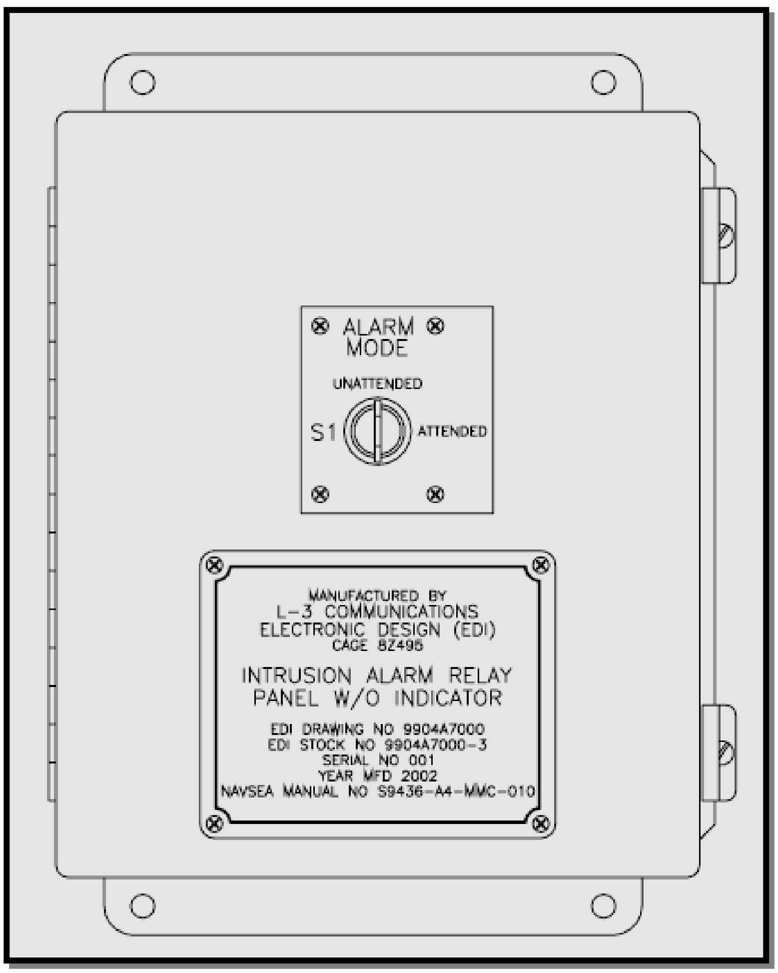


Figure 9-27.— 4434 Intrusion Alarm Panel Controls.

The front panel has only one Front Panel Control:

a. Alarm Mode Switch - When in the "Unattended" position, the Intrusion Alarm is "active" and will detect un-authorized intrusions. When in the "Attended" position, the Intrusion Alarm is "inactive" and will not detect un-authorized intrusions. When the Alarm Mode Switch is switched from the "Attended" position to the "Un-Attended" position, intrusion detection will be disabled for 60 seconds.

Internal Components

In both the 4581 and 4434 Intrusion Alarms, all functionality is provided by a single circuit board mounted inside of the enclosure. All internal wiring and all external interface wiring connects to two terminal blocks mounted on the circuit board. An 8 position rocker switch mounted on the circuit board provides a means to configure the board for either 4581 or 4434 operation. In addition, the 4581 has a cover switch (tamper resistant feature) installed near the cover of the enclosure. Refer to Figure 9-28 for an illustration of the internal components.

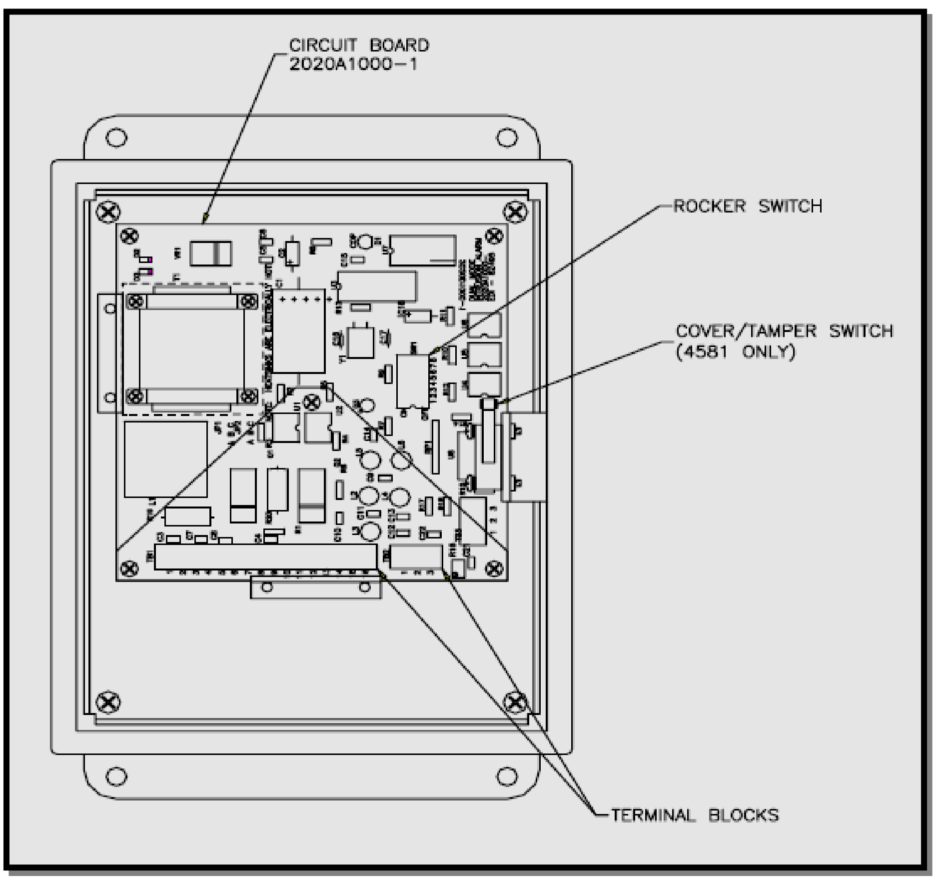


Figure 9-28.— 4581/4434 Intrusion Alarm Internal Components.

Installation

The two types of Intrusion Alarm are designed for wall mounting. They are secured via two mounting holes at the top of the enclosure and two mounting holes at the bottom of the enclosure.

Power Up / Down – Operational Sequences

The 4581 and 4434 intrusion alarms detect an intrusion condition by sensing a closed circuit on the door switch inputs providing the Intrusion Alarm is in un-attended mode and the sixty second bypass timer has not been activated. The 4581 has a tamper detection circuit that will generate an alarm if the cover to the intrusion alarm is opened provided the sixty second bypass timer has not been activated. The sixty second bypass timer is activated by pressing the "Exit" button on the 4581 or moving the "Alarm Mode" switch from the "Attended" to the "Un-Attended" position on the 4434.

9.4.0 PROGRAMMABLE LOGIC CONTROLLERS (PLC)

The last decade has seen significant advances in control system automation onboard U.S. Navy ships. The majority of which have been made possible by the advent of the Programmable Logic Controller (PLC). The PLC replaces legacy automated control systems that utilize hundreds of relays and cam timers which have been proven over time to be cost prohibitive and maintenance intensive. In conjunction with current Fleet Modernization Programs, the Navy’s focus has, and will continue to be, on upgrading and automating legacy platform control systems. The PLC represents the introduction of a new type of control system to the Fleet and the engineering training community.

There are very few similarities between the PLC and the legacy mechanical and relay-based control systems being used in the Fleet. Accordingly, there is limited PLC instruction available in existing formal training pipelines.

Control of various engineering systems has evolved over time. In the 1940-60’s human physical action was the primary method for controlling propulsion or auxiliary systems. More recently, electricity and electro-mechanical processes have been used for control. Early electrical control was primarily based on relays. The development of low cost, more reliable computers has brought about the most recent device to ships, the Programmable Logic Controller (PLC).

As recently as five years ago, the prediction was that Personal Computers (PCs) were going to replace traditional PLC applications. This hasn’t happened because PLCs have continued be an effective, low-cost control option. Both PCs and PLCs have their place in contemporary control systems, and in many cases they work as a team. PLCs will probably remain the predominant control system for some time due to the many advantages that they offer:

- Cost effective for controlling complex systems.
- Flexible and can be reapplied to control other systems quickly and easily.
- Computational abilities allow more sophisticated control.
- Troubleshooting aids make programming easier and reduce downtime.
- Reliable components make PLCs likely to operate for years without failure.

The PLC was installed on the Standard Cargo/Weapons Elevator (SC/WE) Land Based Test Site (LBTS) and recommended as a replacement for the CVN 71 through 75 Cutler Hammer Standard Electronic Module (SEM) controllers. The legacy SEM controller was problematic, and many components were no longer parts supportable. The LBTS was configured to mimic the USS Theodore Roosevelt (CVN 71) Lower Stage Weapons Elevator (LSWE) 3 system; testing validated the control system design and PLC program against possible failure modes. A significant effort was undertaken to develop condition-based maintenance, diagnostics, troubleshooting, and repair programming. The end result was a real reduction in maintenance as several maintenance requirement cards were modified to utilize data from the PLC as an indicator to perform corrective or preventive maintenance. Troubleshooting time was also significantly reduced as a result of the visual monitoring and diagnostic capabilities available from the PLC. The USS Theodore Roosevelt (CVN 71) was the first ship to receive a PLC on her LSWE; feedback from the ship indicates significant savings in maintenance cost and troubleshooting time as a result of the PLC installation.

In addition to cargo/weapons elevator systems, the Navy has utilized the PLCs automation capabilities in many other areas, some of which include:

- Shipboard laundry systems
- Low pressure air compressors
- Oil pollution abatement systems
- Plastic waste processors
- Tank level monitoring systems
- Ship control systems

In June of 1998, the USS Devastator (MCM-6) was the first ship of its class to have the Integrated Ship Control System (ISCS) installed. The ISCS is a distributed client-server system used to control and monitor the shipboard propulsion, electrical and auxiliary machinery systems. This system was designed in response to class-wide problems associated with the aging MCM control console, which was a constant source of grounds, shorts, and other faults. There were also logistics problems associated with the legacy system due to the lack of spare parts availability.

The major hardware components of the ISCS consists of five Intel processor-based user interface consoles, 11 Allen-Bradley PLCs and four Xylan Async Transfer Mode switching hub-based Fiber Optic Local Area Networks (LANs). Each PLC contains a processor and interface circuit cards that are connected to other elements of the propulsion plant equipment. The PLC processor contains signal processing and machinery logic necessary to control the machinery.

Another more recent application of PLC technology onboard naval ships is the Naval Sea Systems Command (NAVSEA) MCM Mine Sweeping Handling Gear Modernization of Controls and Drives program. Under this program, NAVSEA will replace the existing problematic hydraulic pumps/motors and electro-hydraulic controls, with electric motors and control panels which incorporate PLCs. The expected benefits include:

- Reduced maintenance/repair time
- Increased system reliability
- Decreased cost of operation
- 7700 pounds of weight reduction
- Online monitoring and diagnostics
- Improved distance support from land based technical support

The first installation of MCM Mine Sweeping Handling Gear Modernization of Controls and Drives alteration is scheduled to take place in July 2007 onboard the USS Devastator (MCM-6).
In September of 2002, the Navy embarked on the Smart Carrier (SC) program. The project is a Programming Executive Office (PEO) Aircraft Carriers and Office of the Chief of Naval Operations (OPNAV) (N88) initiative that is intended to investigate high Return on Investment/Payback of commercially available industrial technologies. The primary goal of this effort will be to reduce shipboard workload and Total Ownership Costs for in-service aircraft carriers. The SC initiative is expected to utilize PLC technology in the following ship alterations:

- List Automation Control
- Aviation Fuels System Automation
- Vertical Package Conveyor
- Hull Mechanical and Electrical (HM&E) Network
- Advanced Damage Control System (ADCS)

The SC alteration integrates ship sensors and control signals through an integrated fiber optic/copper network with the primary installation of this initiative in the Machinery Control System (MCS). The SC MCS replaces the legacy electro-mechanical MCS, which posed numerous maintenance, obsolescence and supportability problems, to provide a MCS with greater functionality and reliability. Rather than upgrade an already outdated control system, NAVSEA PMS312 made a decision to replace the legacy MCS with a new system to update and automate the infrastructure of specific Aircraft Carrier HM&E systems. Figure 1-1 illustrates the primary elements of the new MCS that were installed to replace the legacy consoles.

The PLC Groups, Ethernet LAN or Core Network and Human Machine Interface (HMI) Workstations form the architectural framework for SC MCS signal processing. Together these elements are implemented in an MCS designed for survivability and reliability. The mission of the MCS is to provide consolidation of Interior Communication circuits associated with Interior Communication/Standard Module (IC/SM) alarms, JP-5 system, List Control, Fire main and Collection Holding Tank (CHT) system signals to a fiber optic Ethernet LAN for use by all HMI consoles. The HMI consists of both hardware and software, which together present the operator with the capability to monitor and control the following ship systems:

- JP-5 system
- IC/SM
- Fire Main system
- List Control System
- CHT System

There are twelve PLC groups in the SC MCS system. Each of the twelve groups has a central PLC controller through which all signals to (or from) the HM&E sensors in the group are processed. The PLC controller performs logic functions for controlling ship system equipment. The PLC groups interface directly with ship system equipment through PLC Input-Output (I/O) modules. These convert the electrical signals used to monitor and control the pumps, valves, Tank Level Indicators (TLIs), and alarm panels, to digital I/O signals needed for PLC controller operation. Figure 9-29 shows the type of Allen-Bradley PLC group installed in the SC MCS system. It consists of three Power Supplies, Analog and Digital I/O modules, an Ethernet module, and one Processor module.

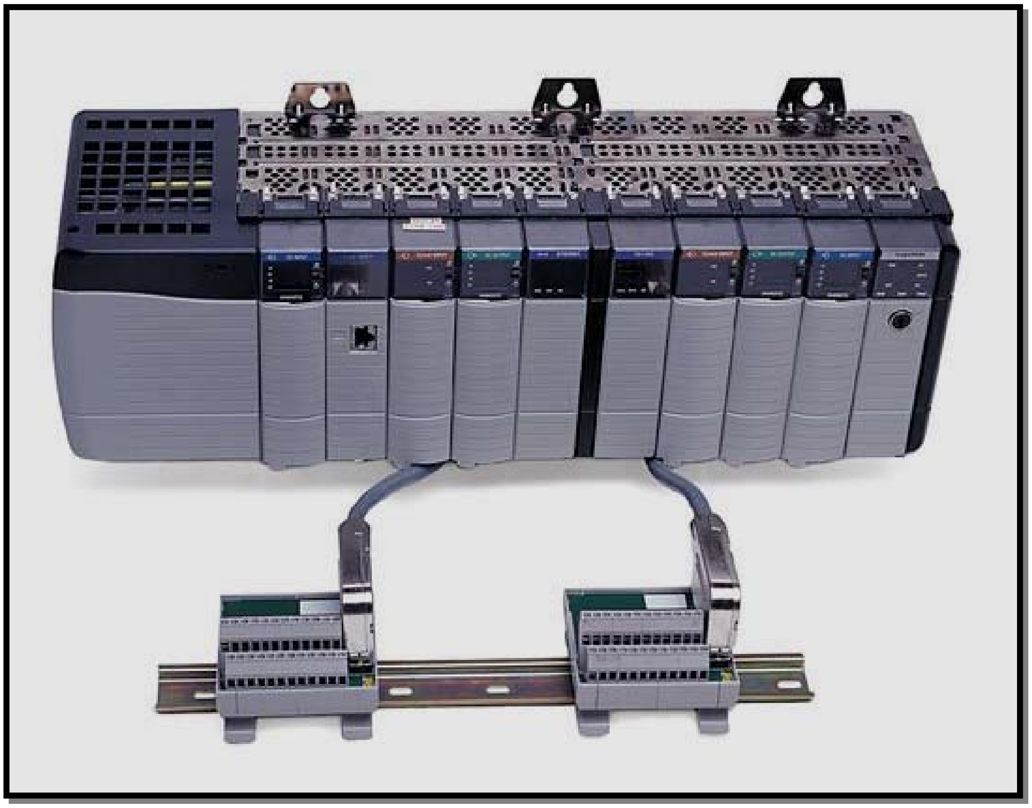


Figure 9-29.— PLC (typical).

There are eight HMI Workstations in SC MCS system. The HMI Workstations are multi-functional operator consoles capable of monitoring and controlling their programmed system as well as displaying the status of other MCS systems. For example, the List Control HMI Workstations can display the JP-5 system status without any control capability. Under normal operation, each console is configured to operate its assigned MCS system.

The SC MCS provides self monitoring and diagnostics of MCS equipment and connected sensors, and also provides signal communication interfaces with the ADCS and Integrated Condition Assessment System (ICAS), supplying information collected by the remote sensors dedicated to their individual control systems.

All equipment in the MCS has been configured to start up in an operational state when energized. Unless the initial configuration of the MCS has changed, or component failure has occurred, no action beyond power-up is required to initialize the system.

With PLC applications becoming more prevalent in the Fleet, due in large part to the Navy's Smart Ship initiatives, deckplate-level knowledge of PLC operation, programming, maintenance, and troubleshooting will become more of a necessity for the personnel that will be responsible for maintaining these systems. With the exception of initial installation training, journeyman-level PLC training is not available for the EM, GSE and IC ratings, which will be responsible for the maintenance of this equipment.

9.5.0 ELECTRICAL ALARM, SAFETY, AND WARNING SYSTEMS
The following sections will describe the various alarm and warning systems that you, as an IC Electrician, will be involved. These interior communication systems provide audible and visible signaling devices to safeguard machinery and personnel.

9.5.1 High-Temperature Alarm System (CKT F)
Circuit F provides a means of detecting and warning of the presence of overtemperature or smoke in compartments requiring continual supervision; that is, ammunition spaces, flammable stowage areas, living spaces, or other spaces designated by ship's design. This system is classified as semivital readiness class 1.

Figure 9-16 illustrates a high-temperature alarm circuit using a mercury thermostat as the sensing device. This system is of the supervisory closed-circuit type, whereby each detector line and associated relay coils on the high-temperature alarm switchboard form a closed circuit, which is under continuous check for grounds, open circuits, low temperature, or the normal function of the system.

The presence of smoke or a rise in the temperature within the compartment to a predetermined temperature (105°F, 125°F, or 150°F) will create a bridge on the line that will actuate an alarm module in the high-temperature alarm switchboard. The nameplate on the alarm signal designates the compartment in which the alarm condition exists.

An extremely low temperature in a compartment or open circuit in the line will result in a failure of the supervisory current, causing a supervisory alarm on the switchboard.

9.5.2 Gas Turbine and Diesel Generator High-Temperature Alarm and Flame Detection System (CKT 1F)
Circuit 1F provides a means for alarm signals to indicate high temperatures and detection of flame within the acoustical module enclosures for gas turbine and diesel generators. This system is classified as semivital readiness class 1.

To serve each gas turbine, two temperature switches are located in the acoustic cell and three flame detectors are located at critical points about the gas turbine. A manual push button is located adjacent to the enclosure access. In addition, door switches are installed at the enclosure access and vent fan control switches are provided at the local operating station and at the propulsion control console (PCC).

To monitor the diesel generators, a temperature switch with a supervisory resistor across its contacts is located in each acoustic cell and three flame detectors are located at critical points about each diesel generator.

At each gas turbine, the photoelectric cells in the flame detectors produce a signal when exposed to a flame condition. This signal operates a local contact closure. This closure is transmitted to the local operating station, where it energizes an alarm indicator mounted on the adjacent instrument panel. The signal is also transmitted to the PCC, where it energizes a second alarm indicator. This circuit is supplemented by a push button, mounted at the enclosure access, operation of which also energizes both of these alarms. Push buttons at the console and the local operating station provide a means for shutting down the engine room ventilation supply and exhaust fans. The status of the enclosure door is displayed at the console.

When the temperature in the acoustic cell reaches a predetermined level, the contacts of one or both temperature switches close and complete the circuit to a console alarm indicator.

At each diesel generator, photoelectric cells in the flame detectors produce a signal when exposed to a flame condition. This signal is transmitted to flame signal conditioner. The conditioner transmits the alarm signal to the electric plant control console.

When temperature in the acoustic cell reaches a predetermined limit, the contacts of the temperature switch close and complete the circuit to a module of the local alarm switchboard with an extension signal to a vent fan shutdown relay assembly. The energized relays disconnect power to the machinery room, supply, and exhaust fans.

Checkout procedures for the gas turbine high temperature and flame detector circuit are contained in the *Electric Plant Control Console Technical Manual.* Checkout procedures for the diesel generator high-temperature alarm circuit are contained in the *Electric Plant Control Console Technical Manual.*

Power for all gas turbine circuits is taken from the PCC. Power supply for the diesel generator flame detector circuit is taken from a local 120 Vac distribution box, while the power supply for the diesel generator high-temperature circuit is taken from the alarm switchboard.

Maintenance should be accomplished according to the applicable technical manual and maintenance requirement cards (MRCs).

9.5.3 Sprinkling Alarm System (CKT FH)

Circuit FH is classified as semivital readiness class 1. This circuit provides a means of indicating leakage or flow of water in the sprinkling system lines for various protected spaces.

This system has four water switches and two pressure switches. Abnormal conditions are displayed on the circuit FH modules in the damage control area of the central control station (CCS).

Any leakage or flow of water in the lines to the small arms magazine, the trash disposal room, the torpedo magazine, or the 76mm ammunition magazine will actuate the switch and provide alarm indication on the associated module in the circuit F alarm switchboard in the damage control area of the CCS. The switches for the small arms magazine and trash disposal room are equipped with supervisory resistors. Since the torpedo magazine and the 76mm ammunition magazine use common alarm modules for circuits FD and FH, the water switches for the sprinkling system in these areas are not fitted with supervisory resistors since the resistors are in the level switches of circuit FD.

Individual extension alarms are provided via the supplemental relay of circuit F to the damage control console and common extension alarms to the alarm switchboard at the officer of the deck (OOD) station and to the alarm switchboard in the ship control console. Circuitry of the alarm switchboards and associated connections may be verified by means of switchboard test procedures. Power for each alarm circuit is provided from the alarm switchboard.

9.5.4 Propulsion Machinery Lubricating Oil Low-Pressure Alarm System (CKT 1EC)

Circuit 1EC provides a means of indicating low oil pressure in the lubricating oil supply lines to the propulsion engines, reduction gear bearings, and associated equipment. This system is classified as semivital readiness class 2.

Pressure transducers of the pressure-to-current type are provided in the lubricating oil supply lines, the lubricating oil scavenge lines, the reduction gear bearing circuit, and the lubricating oil pump discharge lines. Pressure switches are provided in the coastdown circuit and the reduction gear bearing alarm circuit.

Each transducer transmits a signal, proportional to the lubricating oil pressure, to a signal conditioner at the local operating station for display at the local operating station, at the PCC, or as a digital readout at the console.

Each pressure switch transmits a signal to an alarm indicator at the local operating station or at the console.

The signal representing lubricating oil supply pressure is generated at the freestanding electronics enclosure. Pressure is displayed on meters at the local operating station and at the console alarm indicator. The transducer signal, representing lubricating oil scavenge pressure, is applied to the demand circuitry for a digital readout at the console. Internal circuitry generates both high- and low-pressure alarms at the console.

The pressure switch in the coastdown pump air supply is actuated when pressure drops to its low limit, and transmits a signal to a console alarm indicator. In addition, when the pump is operating, it provides a signal to a console pump running indicator.

The transducer signal, representing reduction gear bearing lubricating oil pressure, is transmitted to drive pressure meters at the local operating station and at the console. The associated pressure switch closes when pressure drops to its low limit, and transmits a signal to alarm indicators at the local operating station and at the console. In addition, when the pressure is established, it transmits a signal to a console GEAR LUBE OIL ON indicator.

The transducer signal, representing lubricating oil pump discharge pressure, is routed directly to the console where it is used as a demand digital checkout.

System checkout procedures for the lubricating oil pressure circuits can be found in the *Propulsion Control System Technical Manual.*

Power for the lubricating oil pressure circuits is taken from the PCC.

9.5.5 Auxiliary Machinery Lubricating Oil Low-Pressure Alarm System (CKT 2EC)
Circuit 2EC is a semivital readiness class 1 circuit. This circuit provides a means of indicating low oil pressure in the lubricating oil lines to bearings of the ship's service diesel generators. This is done through the use of pressure transducers and pressure-type switches provided in the lubricating oil lines to the ship's service diesel generators.

A pressure transducer is installed in the lubricating oil supply line to each diesel generator. The transducer generates a signal proportional to supply line pressure that is applied to the console circuitry to drive a pressure meter and to generate an alarm signal when pressure drops to a predetermined low value.

A pressure switch is installed in the lubricating oil supply line to each diesel generator. Alarm modules on the IC/SM switchboards in each machinery room are actuated by these pressure switches to indicate a low-pressure condition at any of the supply lines.

Circuitry of the alarm switchboards and associated connections may be verified by test procedures previously described.

Checkout procedures for the console alarm circuit can be found in the *Electric Plant Control Console Technical Manual.*

Power supply for the circuits associated with the IC/SM alarm switchboard is from these switchboards.

The power for the console alarm circuits is taken from the console.

9.5.6 Auxiliary Machinery Circulating Water Temperature Indicating and Alarm System (CKT 2EW)

Circuit 2EW provides a means for indicating high temperatures in the ship's service diesel generators engine circulating water. This system is classified as semivital readiness class 1.

Sensors of the resistive-thermal-device (RTD) type are installed in the circulating water line of each diesel generator. High-temperature switches, fitted with supervisory resistors across the contacts, are also provided in the circulating water line.

Each RTD in the circulating water line provides a signal to an RTD conditioner in the electric plant operating console. Temperature is displayed continuously on a temperature meter and as a demand digital display. If circulating water temperature rises to a predetermined limit, an alarm signal is generated that energizes visual and audible alarm indicators at the type IC/SM alarm panel associated with the generator.

Checkout procedures for this circuit can be found in the *Electric Plant Control Console Technical Manual.* Switchboards and associated connections can be checked out as described previously.

Power supply for the circulating water indicating and alarm circuits associated with the electric plant control console is taken from the console. Power for the alarm circuits associated with the alarm switchboards is taken from the switchboard.

9.5.7 Generator Air Temperature Indicating and Alarm System (CKT 1ED)

Circuit 1ED provides a means of indicating high temperature of the cooling air exhaust of the ship's service diesel generators. This circuit is classified as semivital readiness class 1.

A sensor of the RTD type is installed in the cooling air exhaust of each diesel generator. In addition, a high-temperature switch is installed adjacent to the sensor.

The RTD in the cooling air exhaust provides a signal to an RTD conditioner in the electric plant control console. Temperature data is available at the demand digital display. In the event the temperature exceeds a predetermined value, an alarm indicator is energized.

The high-temperature switches in the cooling air exhaust, which operates when temperature reaches a predetermined limit, actuates visual and audible alarm indicators on the type IC/SM alarm panel associated with the generator.

Circuitry of the alarm switchboards and associated connections may be verified using the procedures previously described. Checkout procedures for the console circuits can be found in the *Electric Plant Control Console Technical Manual.*

Power for each alarm switchboard circuit is taken from the associated alarm switchboard. Power for the console circuits is taken from the console.

9.5.8 Generator Bearing and Stator Temperature Indicating and Alarm System (CKT EF)

Circuit EF provides a means for indicating high temperature in bearings and stators of ship's service diesel generators. This circuit is classified as semivital readiness class 1.

A sensor of the RTD type is installed so that it is in contact with the bearing or the stator. A high temperature switch is also installed so that it is in contact with the bearing.

The RTD at a bearing sends a signal to an RTD conditioner in the electric plant control console. Temperature is displayed on a demand digital readout. In the event the temperature exceeds a predetermined value, visual and audible alarms are energized.

An increase in the temperature at the bearing to a predetermined temperature causes the temperature switch to operate, actuating a visual and audible indication at the type IC/SM alarm panel associated with the generator. Operation of the circuits of this switchboard has been previously described.

The RTDs at the generator stators provide signals to an RTD conditioner in the electric plant control console. Temperature for each phase is continuously available through a selector switch for display on a temperature meter.

Checkout procedures for the bearing and stator circuits can be found in the *Electric Plant Control Console Technical Manual.* Alarm switchboard circuitry may be verified with its test circuit, as previously described.

Power supplies for the bearing and stator indicating and alarm circuit associated with the electric plant control console are taken from the console. Power supply for the circuits associated with the IC/SM alarm switchboards is taken from these switchboards.

9.5.9 Carbon Dioxide and Halon Gas Release (CKT FR)

Circuit FR provides a means of indicating when carbon dioxide or Halon gas is released in compartments protected by a fixed-gas, fire-extinguishing system. This system is classified as nonvital readiness class 1.

Two dial lamp indicators with red lens or white lens are installed at the access to each compartment that is to be monitored and at the local actuating stations for machinery spaces and the gas turbine enclosures.

Single lamp-type indicators (red HALON RLSE lens) are installed at the local actuating station for all of the diesel enclosures, the flammable liquid storeroom, and the paint mixing and issue room.

Bells, types IC/B2S4 (EXP) and IC/B3S4 are installed in the protected spaces.

Rotary flashing red beacons are installed in the machinery spaces to supplement the bells, due to the high noise levels.

Alarm modules of the circuit F-type IC/SM switchboard in the damage control area of the CCS are assigned to this system.

Switches at the PCC activate the Gas Turbine Halon system. Switches at the turbine enclosure energize a Halon ready indicator at the console.

A separate installation is provided for each compartment protected. The protected compartments are magazines, auxiliary machinery rooms No. 1, 2, and 3, SS diesel generator enclosures No. 1, 2, 3, and 4, the engine room, the flammable liquids storeroom, the gas cylinder storeroom, and the paint mixing and issue room.

For each machinery space, auxiliary machinery room, and the engine room, a pressure switch (manual reset) is installed in the Halon actuating line at the remote actuating station in the CCS. This switch actuates the following:

- An alarm module on the circuit F alarm switchboard in the damage control area of the CCS, operation of which has been previously described
- Audible alarms, type IC/B3S4 bells, in the machinery space protected
- A rotating red beacon in the space protected
- A two-dial lamp-type indicator (red ALARM and white POWER-ON lenses) outside each access to the protected space

A rotary snap switch is installed at each local Halon actuating station that will silence the audible signals and maintain the red light at each access until reset.

Pressure switches, one each in the discharge lines of the primary and reserve banks of Halon cylinders, energize a two-dial lamp-type indicator (two red lenses—HALON RLS PRI and HALON RLS RSV) located at each local actuating station and on the damage control console in the CCS.

The installation for each ship's service diesel generator enclosure consists of a pressure-operated switch (manual reset) in the Halon actuating line in the CCS, which energizes the following when the gas is released:

- Alarm signals on the alarm switchboard for circuit F in the damage control area of CCS
- A type IC/BS4(EXP) bell within the space
- A two-dial lamp-type indicator (red ALARM lens and white POWER-ON lens) installed outside of each access to the protected space

A rotary snap switch is installed at the local Halon actuating station to de-energize the audible alarm within the space while retaining the red light at the access.

A pressure switch in the discharge line of the Halon bank energizes a single dial (red HALON RLS lens) lamp-type indicator at the local Halon actuating station and an indicator on the damage control console.

The installation for each gas turbine module consists of a pressure-operated switch (manual reset) in the Halon actuating line in the CCS, which energizes the following when the gas is released:

- Alarm signals on the alarm switchboard specified for circuit F in the damage control area of CCS
- An explosion-proof bell, IC/B2S4(EXP), installed within the space
- A two-dial lamp-type (red ALARM lens and white POWER-ON lens) installed outside of each access to the protected spaces

A rotary snap switch in the discharge line of the Halon bank energizes a single-dial (red HALON RLS lens) lamp-type indicator at the local Halon actuating station and indicators on the damage control console.

Supervisory resistors are provided in all pressure switches used to actuate alarm modules on the circuit F alarm switchboard, which has been previously described.

Individual extension alarms are provided from all circuit FR alarm modules to the damage control console.

When the Halon flood switch at the PCC is set, the circuit is closed to a solenoid valve to actuate the Halon system within the gas turbine enclosure. A manual Halon inhibit switch at the enclosure in the open position closes the circuit to a console Halon ready indicator.

Circuitry for the alarm switchboard and related connections may be verified by switchboard test procedures.

The remaining circuits can only be tested by simulating an alarm condition at each pressure switch.

Power supply for each system can be verified by the white light at each access to each space.

Checkout procedures for the Gas Turbine Halon Release System can be found in the *Propulsion Control System Technical Manual.*

9.5.10 Boiler Water Level Alarm System (CKT 1TD)

Circuit 1TD provides a means of indicating alarm signals for each boiler when the steam drum water reaches the highest or lowest permissible operating level. The system consists of a drum water level indicator for each boiler, which energizes audible and visual alarm signals at the associated boiler operating station. Visual indications (red lights) will also be on the CCS indicating board. The water level indicator for each boiler will be provided with electrical contacts at the high- and low-level marks on the drum. Either set of contacts upon closing will energize the alarms.

Where only one alarm is required, the system consists of high- and low-water level contacts that energize a type IC/H8S4 horn through a cutout switch and a four-dial indicator (one lens blank) on the boiler gauge board. The four-dial indicator will have power on indication and red high- and low-water level indication.

For troubleshooting the system, refer to the appropriate technical manual, drawings, and PMS cards for the system applicable to your ship.

9.5.11 Wrong Direction Alarm System (CKT DW)
Circuit DW provides a means of warning personnel at the engine order system (EOS) area of the CCS when the operation of the propeller pitch control mechanism is in the opposite direction to an order acknowledged over the EOS. This circuit is classified as vital readiness class 2.

When actual operation of the EOS does not match the EOS acknowledgement of the ordered propulsion command, the contacts in the propulsion control unit and the EOS close in such combination to transmit a signal to the EOS WRONG DIRECTION indicator at the PCC.

When the propeller shaft watermills after a change in direction has been ordered, a reverse direction contact in the shaft revolution transmitter closes, energizing a relay that, in turn, closes a contact to actuate logic circuitry, which energized the shaft reverse rotation alarm indicator in the PCC.

For troubleshooting and repair of the wrong direction indicating system and the shaft reverse rotation system, refer to the *Propulsion Control System Technical Manual.*

9.5.12 Flooding Alarm System (CKT FD)
Circuit FD provides indication when the water level in the monitored compartments has reached a predetermined level. This circuit is classified as nonvital readiness class 1.

The system consists of magnetically operated liquid switches, which are installed in the lowest level of the monitored compartment. The alarm modules are in the alarm switchboard in the damage control area of the CCS.

The float-type switch in each space is fitted with a supervisory resistor to maintain the supervisory feature of the alarm module. In spaces fitted with more than one switch, the resistor is installed in the one at the end of the line.

Operation of any switch by a rising liquid level will short-circuit the line, initiating an alarm on the alarm switchboard as previously described.

Extension alarms are provided via the supplemental relay of circuit F as follows except for the fire pump room, which has no extension:

- Individual extensions of all alarms to the damage control console except that the extensions for the sonar cooling equipment room and the sonar equipment room are paralleled to activate a common indication at the damage control console.

- Individual extensions of the alarms for engine room, a/c machinery room, auxiliary machinery rooms 1,2, and 3, eductor room, auxiliary propulsion machinery room, and steering gear room to the auxiliary control console.

- Common circuit FD alarms to the alarm switchboards at the OOD station No. 1 and in the pilothouse ship control console (SCC).

Troubleshooting and repair of the system can be accomplished by using the system checkout procedures for testing the circuitry of the alarm switchboards and associated connections by switch- board test procedures and by using applicable Planned Maintenance System (PMS) cards.

Power for each circuit is provided from the alarm switchboard.

9.5.13 Propeller Pitch Control Hydraulic Oil Indicating and Alarm System (CKT 3EG)

Circuit 3EG provides means for indicating and alarming low pressure in the propeller hydraulic oil system at the EOS area of the CCS. This system is classified as semivital readiness class 2.

A pressure transducer of the pressure-to-current type is provided at the hydraulic oil power module. Differential pressure transducers of the pressure-to-current type are provided at the main and standby hydraulic pump suction strainers.

The transducer transmits a dc signal, proportional to pressure, to a signal conditioner located in the local operating station. Hydraulic oil pressure is displayed at the PCC on a pressure meter and on the digital demand display. This pressure is continuously monitored so that if, at any time, pressure drops below a predetermined value, visual and audible alarm indicators are energized at the PCC and at the local operating station.

Each differential pressure transducer transmits a signal proportional to the pressure drop in the pump suction strainers to a signal conditioner in the local operating station. The signal is transmitted to the PCC for conversion to a demand digital display. Internal circuitry provides the signal for visual/audible alarm indicators when differential pressure reaches a predetermined value.

Checkout procedures for this system can be found on the appropriate PMS cards and in the *Propulsion Control System Technical Manual.*

Power for the circuits is furnished by the PCC.

9.5.14 Air Pressure Indicating and Alarm System (CKT EK)
Circuit EK provides a means of indicating the pressure in the compressed air system and indicating when the air pressure drops below a predetermined value. It also provides an indication of emergency shutdown of the compressors. This circuit is classified as nonvital readiness class 1.

Pressure transducers and pressure switches are located in the piping for the system.

Each transducer is a pressure-to-current type that transmits a dc signal, proportional to the pressure, to a signal conditioner in the auxiliary control console. The HP and LP air receiver pressures are displayed on digital demand display. The HP range is 0 to 6000 psig and the LP range is 0 to 200 psig. These pressures are continuously monitored so that if, at any time, the pressure drops below a predetermined value, visual indicators and a bell in the auxiliary control console are energized.

The pressure at the starting air manifold is continuously displayed on an analog indicator on the auxiliary control console with a 0 to 150 psig range.

Each HP and LP compressor is fitted with a safety shutdown feature that closes a contact in its motor controller. This contact, in turn, energizes circuits in the auxiliary control console to display a visual alarm and sound a horn.

In addition to the alarms on the auxiliary control console associated with the air receiver pressures, there is a pressure switch fitted in the piping for each HP and LP air receiver. Alarm modules on the IC/SM switchboards in auxiliary machinery rooms No. 2 and No. 3 actuated by these pressure switches are used to indicate a low-pressure condition at any of the HP or LP air receivers. Alarms for HP and LP receiver No. 1 appear on alarm switchboard No. 2 in auxiliary machinery room No. 2. Alarms for HP and LP air receivers No. 2 appear on alarm switchboard No. 4 in auxiliary machinery room No. 3.

The engine turbocharger pressures are displayed on the digital demand display at the electric plant control console.

Low-pressured conditions, at the brake actuator and at the turbine brake actuator, operate pressure sensitive switches, which transmit signals to alarm indicators at the PCC.

Transducer-controlled signals drive pressure meter displays at the local operating station for gas turbine starting air pressure. Alarm signals, taken from the meter circuitry, are transmitted to the PCC for energizing alarm indicators at the PCC.

The PCC computer calculates gas generator pressure ratios. The output signal is displayed on a console meter and is transmitted to the local operating station instrument panel for display on a second meter.

System checkout procedures for the HP and LP air indicating and alarm circuits can be found in the *Auxiliary Control Console Technical Manual.* The alarm circuitry may be verified with its test circuit as described in the appropriate PMS cards. Checkout procedures for the engine turbocharger indicating system can be found in the *Electric Plant Control Console Technical Manual.* Checkout procedures for the actuator alarm systems, the low starting air pressure alarms, and the gas generator pressure ratio indicating system can be found in the *Propulsion Control System Technical Manual.*

9.15.15 Gas Turbine Lubricating Oil High-Temperature Alarm System (CKT EP)
Circuit EP provides a means for indicating high temperature for the lubricating oil supply to the gas turbine. This system is classified as semivital readiness class 1.

A signal, taken from circuit TM (temperature indicating and alarm system), is used as an input to an alarm control module at the local operating station when the lubricating oil reaches a predetermined temperature. An alarm signal is generated and transmitted from the local operating station to the PCC, where it energizes visual and audible alarm indicators.

Checkout procedures for this circuit can be found in the *Propulsion Control System Technical Manual.*

Power supply for this circuit is taken from the PCC.

9.15.16 Steering Emergency Alarm System (CKT LB)
Circuit LB provides a means of signaling that a steering casualty has occurred. This system is classified as vital readiness class 2.

In the event of a casualty to the steering control system, the operator at the SCC operates the steering alarm switch on the console. One pole of this switch closes the circuit to the siren in the steering gear room. A plate installed at the siren reads "WHEN THIS SIREN SOUNDS, AFTER STEERING STATION TAKE CONTROL." The second pole of the switch on the SCC is bridged with a supervisory resistor and is connected to an alarm module of the alarm switchboard in the machinery control area of CCS. Thus, operation of the switch alerts CCS of the steering control casualty.

System checkout can be performed by operation of the switch on the SCC. Circuit checkout of the signal in CCS is available at the alarm switchboard.

9.15.17 Power Failure Alarm System (CKT PF)
Circuit PF provides an indication to a remote station when power input to the main IC switchboard has failed. This circuit is classified as semivital readiness class 1.

One 400-Hz and one 60-Hz relay is provided as integral units of the main IC switchboard. Two modules on the IC/SM alarm switchboard in the machinery control area of CCS function in this alarm circuit.

Each of the relays on the main IC switchboard is normally held energized by the bus voltage. Failure of the bus voltage permits the relay to assume the normal (de-energized) position, shorting the supervisory resistor by closing the alarm contacts to the associated module in the type IC/SM alarm switchboard in the machinery control area of CCS. Operation of the bus failure alarm signal at the main IC switchboard is also controlled by two bus relays and is described in the technical manual for the switchboards.

9.15.18 Security Alarm System (CKT FZ)
The purpose and use of the security alarm system is confidential. During normal ship operations, testing and maintenance of the system and its monitored areas should follow the two-man rule; that is, a minimum of two authorized personnel capable of detecting incorrect or unauthorized procedures with respect to the task to be performed and familiar with applicable safety and security procedures must be present. All keys to the switchboard door locks, terminal box padlocks, and so on, are to be handled as SECRET material, and should remain in the possession of designated ship's security personnel. If either a lock or its key is lost, both must be replaced immediately.

Refer to NAVSHIPS 401-4539661, Security *Alarm System Circuit FZ Elementary and Isometric Wiring Diagram (CONFIDENTIAL)*, for equipment description, operation, and location. Because of the confidentiality involved, you will have to refer to the NAVSHIPS 401-4538943 and applicable PMS cards for procedures to troubleshoot and repair the system.

9.15.19 Indicator and Alarm System, Airflow IC/ASE-1

The Airflow Indicator and Alarm System, Type IC/ASE-1 (Circuit HF), provides a means of monitoring and measuring the velocity of airflow through an exhaust ventilation duct. The system provides audible and visual alarms as well as a remote audible alarm when the airflow in the exhaust duct falls below a predetermined limit. The system also provides audible and visual alarm if the primary power of the equipment fails.

This section will provide personnel with descriptive information and operating procedures.

Equipment Description

The airflow indicator and alarm system is comprised of three units: an indicating and control panel, an airflow sensor unit, and an airflow remote alarm unit (see Figure 9-30).

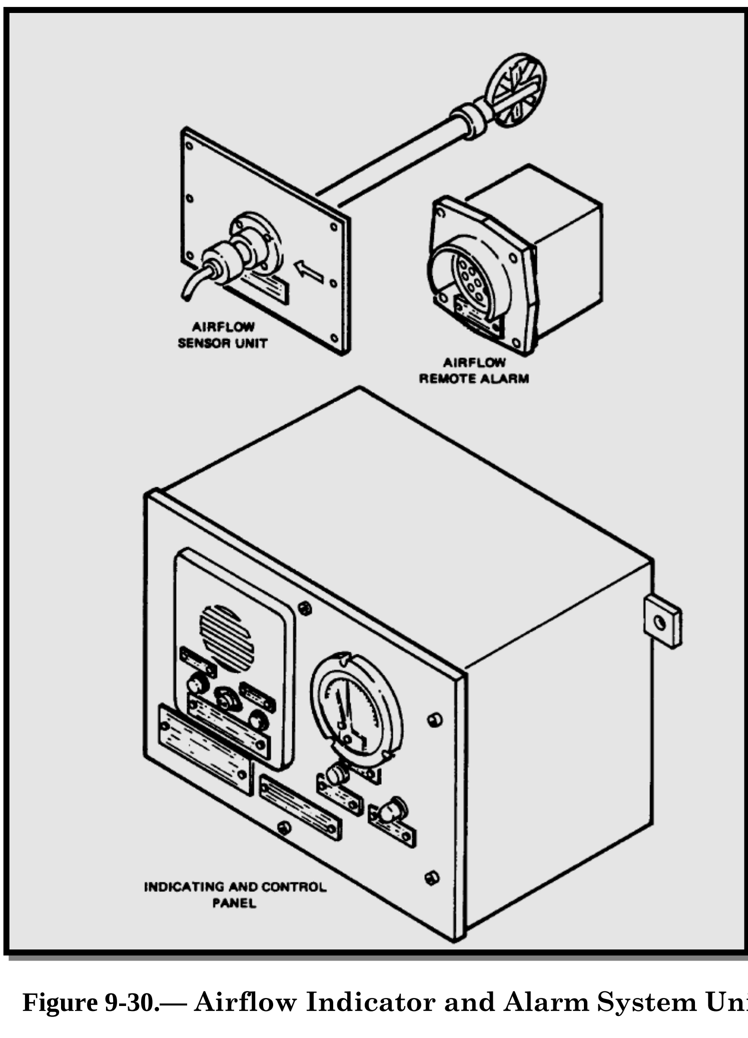


Figure 9-30.— Airflow Indicator and Alarm System Units.

Indicating and Control Panel

The indicating and control panel is of drip proof construction and bulkhead mounted. It houses the controls and indicators necessary to monitor and measure airflow in the exhaust duct, plus it has the means to energize the alarm, both audible and visual, when there is a loss of airflow or primary power.

Airflow Sensor Unit

The airflow sensor unit is a self-contained vane-type rotating sensor that is designed to be mounted into the airsteam of an exhaust duct. Its rotor can be extended into the duct from 2.5 inches to 12 inches by using its inner and outer adjustable sleeves. The unit is electrically connected to the indicating and control panel via a shielded two-wire cable and can be located up to 500 feet away from it.

Airflow Remote Alarm

The airflow remote alarm is of drip proof construction and is designed for either panel or bulkhead mounting. It is normally installed in a location where the audible howler alarm, controlled by the indicating and control panel, is immediately detected.

Controls and Indicators

All controls and indicators for the airflow indicator and alarm system are located on the indicating and control panel with the exception of the audible airflow remote alarm unit. The controls and indicators are illustrated in Figure 9-31 and described in Table 9-4.

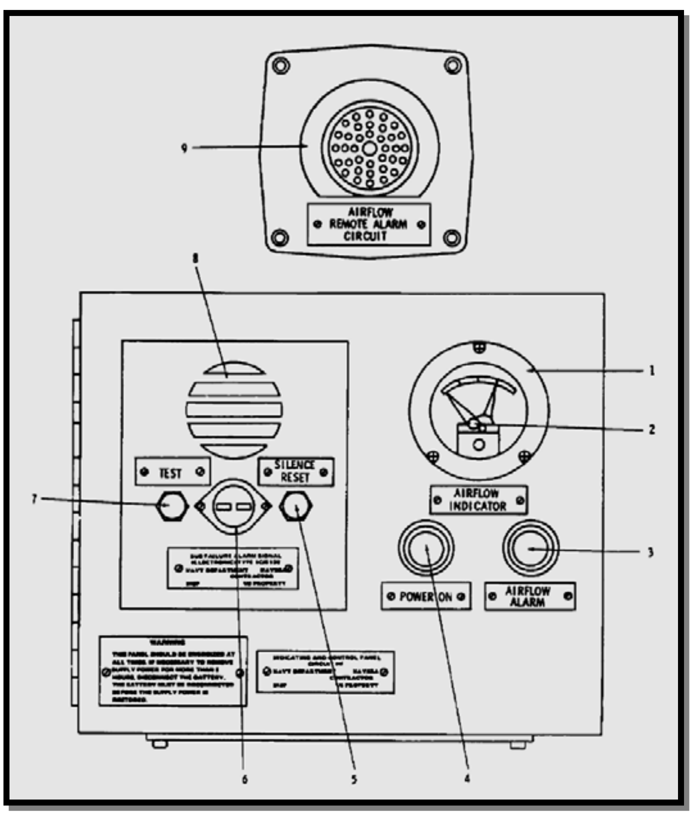


Figure 9-31.— Controls and Indicators.

Figure 9-31 & Index No.	Nomenclature	Function
1	AIRFLOW INDICATOR	Used to monitor the exhaust duct by providing an indication of the airflow velocity within the duct. It measures the velocity (0-1,000 or 0-5,000 fpm) of airflow to within 5%. The velocity of the airflow is shown by the black pointer.
2	AIRFLOW INDICATOR minimum level adj	Provides a means of selecting a minimum acceptable level of exhaust airflow velocity. The red pointer shows the setting of the minimum level.
3	AIRFLOW ALARM light	Lights when the exhaust airflow is equal or less than the preselected minimum acceptable level.
4	POWER ON light	Lights when 115 VAC power is applied to unit.
5	SILENCE RESET pushbutton switch	Pushbutton switch used to silence the audible alarms and reset the FLAG DROP indicator and the airflow monitoring circuits.
6	Flag drop indicator	Two-position indicator that has two colored flags. WHITE indicates system is operating normally, RED shows an alarm condition exists. Some installations contain a GREEN indicator instead of a WHITE indicator.
7	TEST pushbutton switch	Pushbutton switch used to momentarily interrupt input line voltage to test audible alarms and FLAG DROP circuit.
8	Local audible alarm	An audible howler alarm that sounds when a low exhaust airflow exists or there is an equipment primary power failure.
9	Airflow remote alarm	An audible howler alarm that sounds when a low exhaust airflow exists or there is an equipment primary power failure. It is normally located where it can be immediately detected.

Table 9-4.— Controls and Indicators.

General Operation

The airflow indicator and alarm system is designed to provide both visual and audible alarm when the velocity of airflow diminishes below a predetermined value. When an alarm occurs, personnel are required to reset the system and initiate a new operating cycle after correcting the casualty.

Turn-On Procedures

Prior to initiating system operation, ensure that the airflow to be monitored is functioning normally and that the battery in the indicating and control unit has been connected.

To initiate system operation, see Figure 9-31 and proceed as follows:

1. Press the SILENCE RESET pushbutton to cancel the audible alarms.

2. Ensure that the POWER ON light (item 4) is lit.

3. Set the red pointer on the AIRFLOW INDICATOR (item 1) to a position below zero by turning the AIRFLOW INDICATOR minimum level adj (item 2) ccw.

4. Press the SILENCE RESET pushbutton (item 5). This ensures all previous alarm conditions are cleared and initiates system operation.

NOTE:

It may be necessary to push the SILENCE RESET pushbutton more than once to clear the previous alarm conditions.

5. Ensure that the flag drop (item 6) is WHITE or GREEN, AIRFLOW ALARM light (item 3) is out, and the black pointer is showing an airflow rate.

6. Set the red pointer to a predetermined level by adjusting the AIRFLOW INDICATOR minimum level adj (item 2) cw. Ensure that the black pointer is above the red pointer and that no alarm indications are present.

Low Airflow Alarm Condition

(See Figure 9-31.) When a low airflow alarm occurs, airflow indicated by the black pointer is equal to predetermined level set by the AIRFLOW INDICATOR minimum level adj (item 2) (see setting of red pointer) The red and black pointers are locked together and the flag drop indicator (item 6) is RED. The AIRFLOW ALARM light (item 3) is lit and the local audible and airflow remote alarms (items 8 and 9) are energized.

To restore operations, proceed as follows:

1. Press the SILENCE RESET pushbutton (item 5) to silence the audible alarms (items 8 and 9). (All other alarm indications will remain on.)

2. Notify Command about the alarm.

3. After the casualty has been corrected and airflow has been established, follow the procedures to initiate system operation.

Power Failure Alarm Condition

(See Figure 9-31). When the primary power-of the airflow indicator and alarm system fails, a power failure alarm occurs. The AIRFLOW INDICATOR pointer (item 1) indicates normal airflow in the exhaust duct and the AIRFLOW ALARM light (item 3) remains off. The flag drop indicator (item 6) is RED and the local and remote audible alarm (items 8 and 9) are energized. If the POWER ON light is off, this indicates a loss of external power (115 VAC). If it is on, this indicates power failure within the system.

To restore operations, proceed as follows:

1. Press the SILENCE RESET pushbutton (item 5) to silence the audible alarms. The flag drop indicator (item 6) remains RED.

2. Notify Command about the alarm.

NOTE:
The airflow indicator and alarm system will continue to monitor the exhaust duct airflow using battery power. If the exhaust system malfunctions, the AIRFLOW ALARM light will come on but there will be no audible alarms.

3. After the casualty has been corrected, ensure that the POWER ON LIGHT (item 4) is lit. Press the SILENCE RESET pushbutton (item 5). This initiates system operation and resets the flag drop indicator. The system is now fully operational.

System Shutdown

When the system being monitored is to be shut down, adjust the AIRFLOW INDICATOR minimum level adj (item 2) so that the airflow indicator and alarm system alarms will not come on when airflow is lost. If the shutdown is to last more than eight hours and includes securing the power to the airflow indicator and alarm system, the battery must be disconnected from the circuits to prevent it from discharging. When the system is to be restored, reconnect the battery and follow the procedures to place the system in an operational condition.

Setting Alarm Point

The airflow rate setting for actuating the alarm shall be designed as a point midway between the airflow indicator pointer position with supply and exhaust fans operating and the pointer position with supply fans operating and exhaust fan secured. The compartment access must be secured for both conditions.

9.15.20 Airflow Indicator Panel, Model 62413-100

Dynalec AIP illode1 62413-100 monitors the airflow in ducts, displays the absolute airflow in feet per minute (ft/min) on an alphanumeric display and activates alarms if the airflow fails below a user specified setpoint. User adjustable equipment settings are provided for adjusting the unit's functionality for different operating environments. The physical characteristics of the AIP are listed in table 9-5. A list of display functions including the codes which may appear in the alphanumeric display and the associated definitions, is imprinted on the top left of the AIP front panel. The instructions for viewing and changing equipment settings are imprinted on the bottom left of the AIP front panel.

Figure 9-32.— Digital Airflow Indicator and Programmable Alarm System.

Panel Specifications	
Input Power Requirements	115VAC plus or minus 10%, 47 to 440Hz plus or minus 10%, 50W max, externally fused at 2A
Operating Temperature Range	-18 Degrees F to 150 Degrees F
Overall Dimensions	10.16” high X 13.0” wide X 8.0” deep
Weight	18.5 lbs

Table 9-5.— Airflow Indicator Panel Specifications.

Alphanumeric Display
The alphanumeric display is a series of light-emitting diodes (LED) which normally display absolute airflow measurements from the external sensor. The display will show failure messages during a failure condition or equipment settings if the SELECT pushbutton switch is depressed.

Airflow Display
The display of the absolute airflow measurement is the normal display mode and is the default display when the AIP is turned on. The absolute airflow measurement is displayed as a 3-letter code followed by the 4-digit airflow measurement in ft/min.

Failure Message Display
During an alarm condition or a combination of alarm conditions, the display shows each of the failure messages in succession for 1 second each, followed by a 1-second display of the airflow reading. These messages are displayed until the alarm conditions are rectified.

Adjustable Setting
The AIP has a number of user adjustable settings, including the brightness of the LED displays, sensor types in use, and alarm setpoints. These settings can be reviewed by depressing the SELECT pushbutton switch. A different setting is displayed each time the SELECT pushbutton switch is depressed until the display returns to the airflow measurement display.

Bar Graph Display
The bar graph display is a series of nine LEDs (three red, one yellow, and five green). This display gives a quick indication of measured airflow relative to the alarm setpoint. (The alarm setpoint is a specified setting of the minimum desirable airflow in ft/min.) The single yellow LED represents the alarm setpoint. When this LED is illuminated, the measured airflow is exactly at the alarm setpoint. If one or more red LEDs are illuminated, airflow is below the alarm setpoint. If one or more green LEDs are illuminated, airflow is above the alarm setpoint.

Audible and LED Alarms

An audible alarm at the upper right of the AIP front panel emits a loud tone during most alarm conditions. (See figure 9-33.) To turn this alarm off, depress the SILENCE pushbutton switch. Two LEDs, the ALARM LED and the BATTERY LED, are located directly below the audible alarm speaker. The ALARM LED is illuminated during an alarm condition and remains illuminated until alarm conditions are rectified. (The ALARM LED does not turn off when the SILENCE pushbutton switch is depressed.) The BATTERY LED blinks periodically while the equipment is operating on ac power to show that the system is periodically checking the battery. When the BATTERY LED is continuously illuminated rather than blinking, the system is operating on internal battery power.

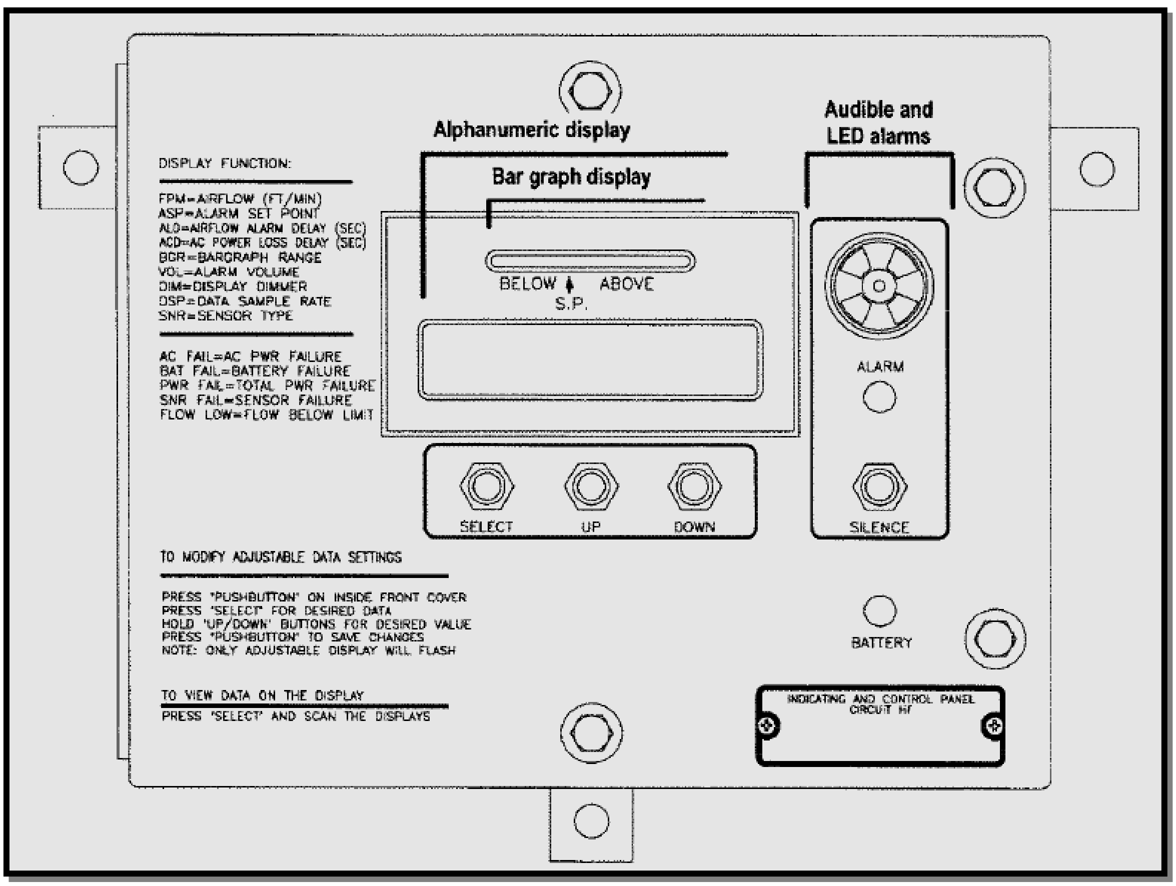


Figure 9-33.— Dynalec Airflow Indicator Panel Model 62413-100.

Front Panel Pushbutton Switches

(See figure 9-33.) Depress the SELECT pushbutton switch to display the user adjustable equipment settings in the alphanumeric display Use the UP and DOWN pushbutton switches to change an equipment setting as it appears in the alphanumeric display. Depress the SILENCE pushbutton switch to silence all audible alarms.

Description of Output Signals

The AIP generates four output signals; the external alarm, ac alarm. Tristate alarm, and analog output signal.

External Audible Alarm

The external audible alarm is a +11 Vdc plus or minus 20 percent signal measured across terminals TB1-3 (positive) and TBI-4. The external audible alarm output signal is 100 mA maximum and is intended to drive an external audible alarm. See figure 9-34.

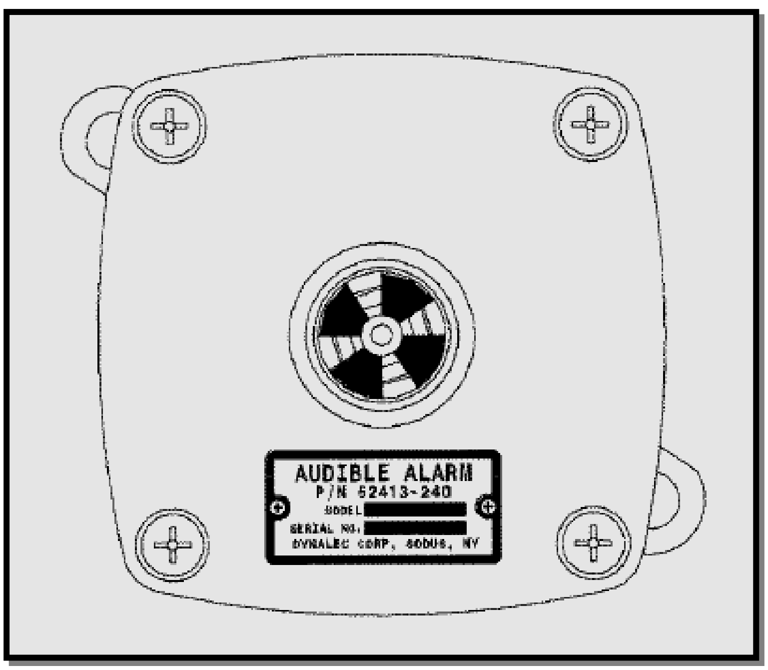


Figure 9-34.— Dynalec External Audible Alarm Model 62413-240.

Alarm

The ac alarm is an 115VAC plus or minus 10 percent signal measured across terminals TBI-6 and TBl-9. The ac alarm output signal is intended to drive an external bell and is fused at 2A by F1 and F2.

Tri-state Alarm

The Tri-state alarm provides alarm status to type IC/SM alarm panels. During normal operation, relay K1 is energized and relay K2 is de-energized. Under these conditions a resistance of 6.8 Kohms plus or minus 10 percent is present across both TB2-8 and TB2-10, and TB2-8 and TB2-9. During alarm conditions listed in table 9-6, K2 is energized and a resistance of less than 1 ohm is present across terminals TB2-8 and TB2-10 and a resistance of greater than 100 Kohms is present across terminals TB2-8 and TB2-9.

ALARM	ALPHANUMERIC DISPLAY	FRONT PANEL AUDIBLE ALARM	ALARM LED	EXTERNAL AUDIBLE ALARM	AC ALARM (EXTERNAL BELL)[1]	TRI-STATE ALARM
Low Airflow Detected	FLOW LOW	**X**	**X**	**X**	**X**	**X**
Sensor Failure	SNR FAIL[2]	**X**	**X**	**X**	**X**	**X**
AC Power Failure	AC FAIL[3]	**X**	**X**	**X**		
Battery Failure	BAT FAIL	**X**	**X**	**X**	**X**	
Total Power Failure[4]	PWR FAIL					**X** (Fault)

[1]The alarm is generated only while the system is on ac power, not on battery power.
[2]RTD input is less than 235 mA, or more than 515 mA.
[3]This message call can be displayed only if the battery is functional; if not, the system will report a total power failure once power is restored.
[4]This alarm is displayed after power is returned to the AIP.

Table 9-6.— Alarms Generated for Each Alarm Condition.

Silence Pushbutton Switch

The SILENCE pushbutton switch is used to silence all audible alarms during an alarm condition. Depressing the SILENCE pushbutton switch will de-energize the front panel alarm, external alarm, and ac power failure alarm. Depressing the SILENCE pushbutton switch does not alter the LED readout nor the Tri-state alarm signal.

Analog Output Signal

The AIP provides an analog output signal which is proportional to the measured airflow. The RTD sensor and the 5-pin (5,000 ft/min) pinwheel sensor each provide an analog signal which varies linearly from 0 to 10 Vdc for airflow measurements of 0 to 5,000 ft/min. See Figures 9-35 and 9-36.

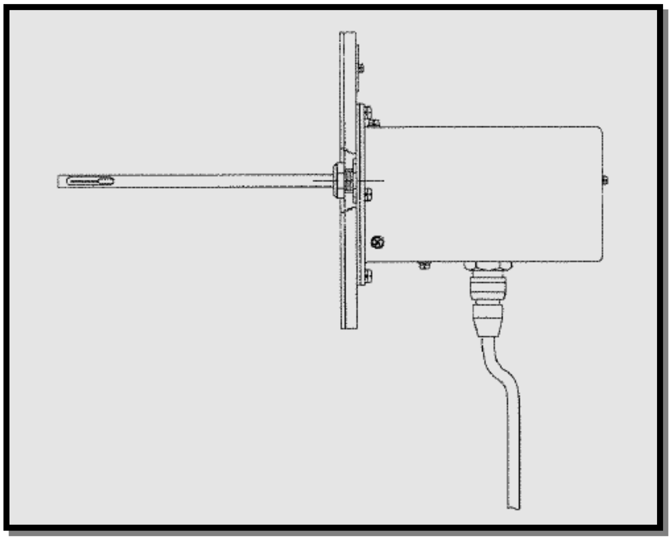


Figure 9-35.— Resistance Temperature Detector.

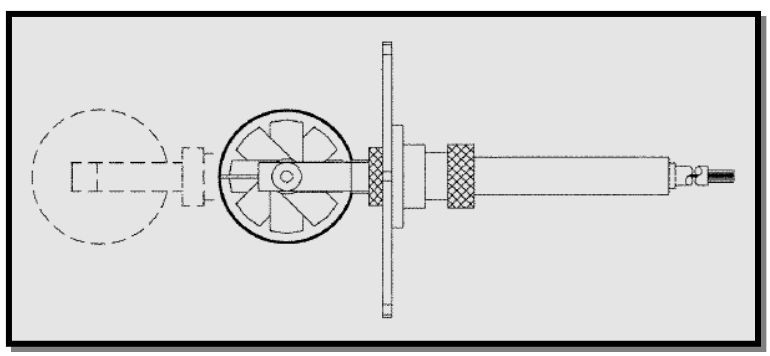


Figure 9-36.— Dynalec Pinwheel Sensor Models 62413-005 and 62413-006.

9.15.21 Monitoring System, Airflow, Model 20-300 (T-AGS 45 Class)

This section contains the instructions required to operate, troubleshoot, perform scheduled and corrective maintenance, and install the Henschel Model 20-300 Airflow Monitoring System. This microprocessor-based system consists of two units:

1) Airflow Panel Assembly (Model 20-300).

2) Sensor Assembly

- a) Resistive Thermal Device (RTD) Sensor
- b) Pinwheel Sensor (1,000 ft/min)
- c) Pinwheel Sensor (5,000 ft/min)

Figure 9-37 shows the three major units of the Model 20-300 Airflow Monitoring System. This illustration shows the Airflow Panel Assembly (Model 20-300), the Model 20-310 RTD Sensor Assembly, and the Pinwheel Sensor Assembly.

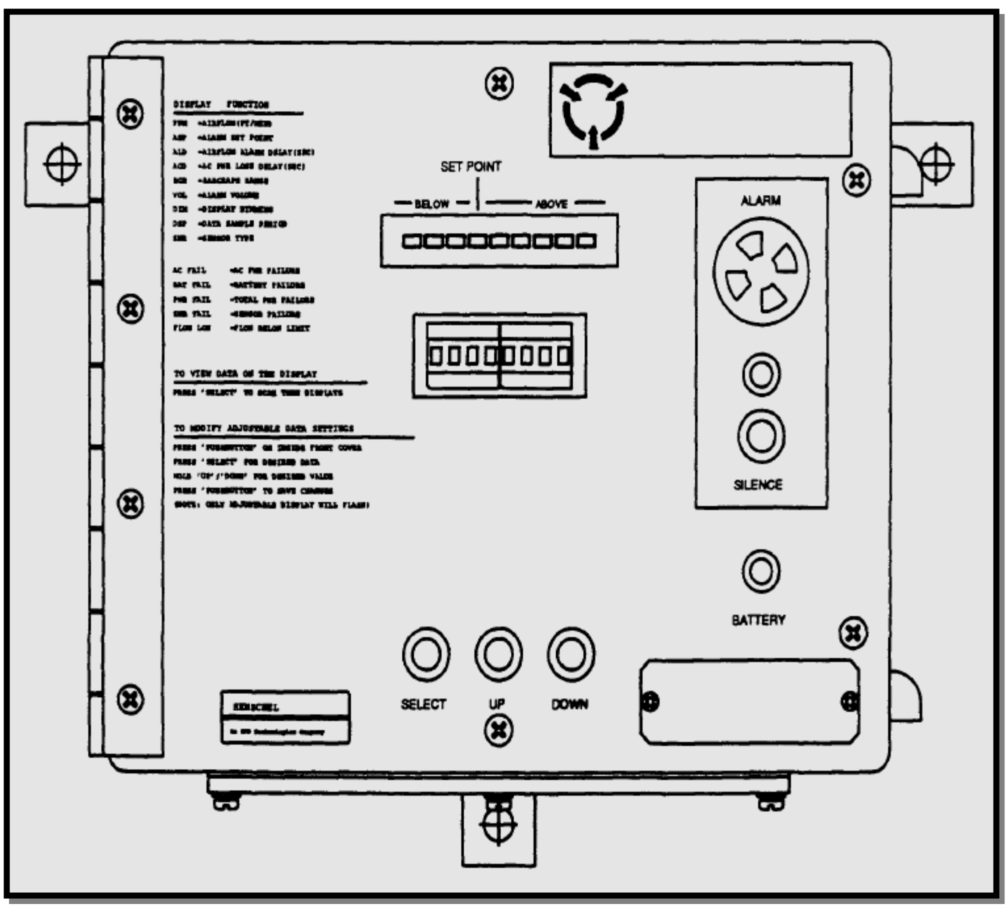


Figure 9-37.— Model 20-300 Airflow Monitoring System (Sheet 1 of 2).

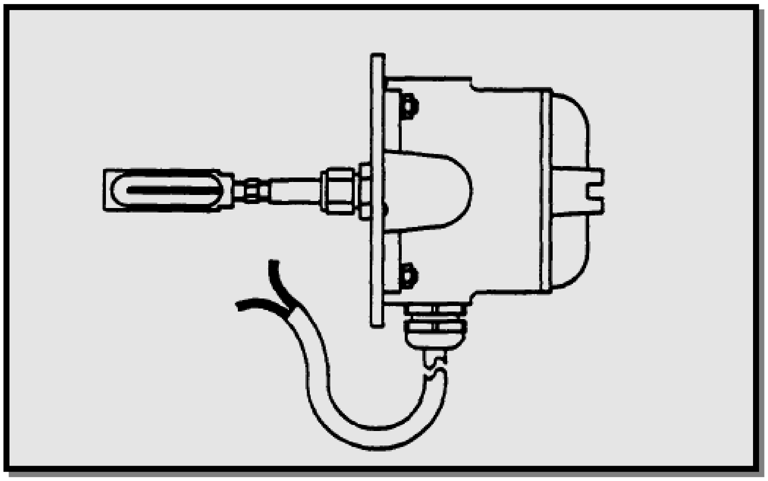
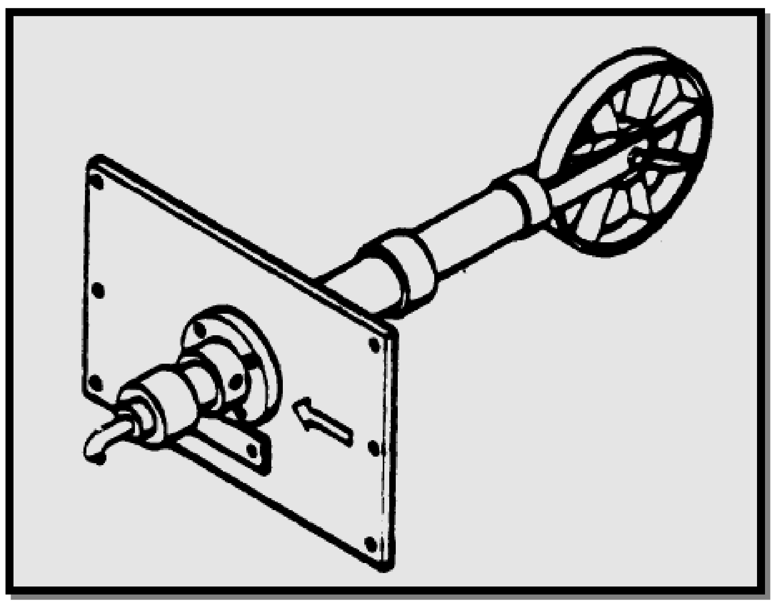


Figure 9-37.— Resistive Thermal Device (RTD) Sensor (Side View) (Sheet 2 of 2).

Figure 9-38.— Pinwheel Sensor.



Purpose and Function

The Model 20-300 Airflow Monitoring System is designed to automatically monitor the airflow in ducts and to activate audible and visual alarms when the rate of air flow monitored by a sensor decreases below a specific level. The system is delivered with preset, factory loaded default parameter settings stored in the ROM (Read Only Memory) of the system's microprocessor. Some settings, such as the alarm set point, are normally determined for each application and can be set by the operator. All of the operator-adjustable parameters are stored in the Electrically Erasable Programmable Memory (EEPROM) of the system's microprocessor. The technician can adjust/modify these settings during the calibration of the system.

The Model 20-300 Airflow Monitoring System's use of microprocessor based technology provides the following system enhancements:

1) Use of alphanumeric displays

2) Use of a "Relative" Bargraph Display

3) Non-Volatile Memory

4) Uninterruptible Power Supply (Rechargeable Lead Acid Battery)

5) AC Power Monitoring

6) Sensor Operation Monitoring

7) Diagnostic Messages

8) Selectable Alarm Thresholds

9) Selectable Alarm Delay Times

10) Volume and Dimming Adjustments

11) Lamp and Input/Output Test

Performance Characteristics
The following paragraphs provide a concise description of the performance characteristics of the Model 20-300 Airflow Monitoring System.

Resistive Thermal Device Sensor The Model 20-300 Airflow Panel Assembly can interface with the Model 20-310 Resistive Thermal Device (RTD) Sensor via a two-wire interface. The RTD sensor measures flow rates between 0 to 5,000 feet per minute (FPM).

Pinwheel Sensor The Model 20-300 Airflow Panel Assembly can interface with a pinwheel sensor via a two-wire interface. Two pinwheel sensors are available - a 1,000 feet per minute pinwheel sensor or a 5,000 feet per minute pinwheel sensor. Depending on which sensor is selected, the system will measure airflow rates between 0 to 1,000 or 0 to 5,000 feet per minute (FPM).

Electrical Power The Airflow Monitoring System is powered by the ship’s 115-VAC supply. The input power must be fused for two (2) amps and is to be attached to the terminal bars located on the Henschel EM-192 Printed Circuit Board (PCB) which is mounted to the internal subassembly of the Model 20-300 Air Flow Panel Assembly.

A redundant backup power supply, provided by a rechargeable lead acid battery, will provide the system with a minimum of 30 minutes back-up power upon the loss of ships power. The yellow Battery Status LED will be illuminated when the system is operating under battery power. The battery will recharge automatically (requires approximately 20 hours) on the resumption of ship’s power. A software controlled automatic disconnect feature has been designed into the system to provide deep discharge protection to the battery.

Airflow Panel Assembly The operation of the Airflow Monitoring System is controlled from the Henschel Model 20-300 Airflow Panel Assembly. This assembly utilizes front panel status indicators (LEDs), analog and digital displays, and audible alarms to keep the operator informed of the functional performance of the system. The operator will use pushbutton switches on the front panel of the assembly and in the interior of the Air Flow Panel Assembly to power up the system, enter or change system parameter values, select parameters for display on both the analog and digital displays, and respond to system alarms and messages.

Alarms The Airflow Monitoring System utilizes both audible and visual alarms. The following list identifies the types of alarms that will be displayed and/or audibly sounded to the operator. Visual Display Alarm Status LED (Red), Digital Display (Relevant error message will be displayed.) Audible Alarms 70 to 120 db signal (Adjustable by the operator).

System Setup Protection

The design of the Model 20-300 Airflow Monitoring System includes a "SAFE SET-UP" feature to prevent the accidental changing of any parameter's setting. To change the data value for a parameter, the operator must gain access to the interior of the Airflow Panel Assembly and then place the system into the Data Entry mode by pressing the "ENTER" pushbutton switch, located on the rear side of the front panel of the assembly.

System Inputs

The Airflow Panel Assembly of the Model 20-300 Airflow Monitoring System receives three input signals:

1) RTD Sensor Input (Air Flow Rate)

2) Pinwheel Sensor Input (Air Flow Rate)

3) 115-VAC Primary Power Input (Ships Power or Battery)

System Outputs

The Airflow Panel Assembly of the Model 20-300 Airflow Monitoring System generates four output signals:

1) Remote Flow Signal (Analog Voltage Signal Proportional to Air Flow Rate)

2) Tri-State Alarm Contact (Indicates alarm/circuit status -- alarm, normal, fault)

3) 115-VAC Alarm Output (60 Hz, 1 Amp)

4) RTD Sensor Power (Power to sensor heater element and resistance temperature detectors.)

System Expansion/Growth
The Model 20-300 Airflow Monitoring System is designed to accommodate and support future growth requirements. The system offers the following expandable features:

1) Support for an External Serial Interface (RS-485).

2) Support for an Internal Serial Bus.

3) Support for a Frequency Input.

4) Support for an Analog Input.

5) Support for Remote Audible Alarm Output

6) Support for External Battery Inputs.

7) A Reprogrammable Microprocessor.

8) Support for Fiber Optic, Voltage, and Frequency Type Inputs.

9.15.22 Refrigerant Monitor Parasense (Model 3300FSV-N)
This section provides personnel with operating instructions, detailed system and component descriptions, and maintenance procedures, for the Parasense Refrigerant Monitor, Model 3300FSV-N. The "N" at the end of the model number indicates that the monitor meets Grade A mechanical shock requirements, and has been modified for shipboard use.

Description
The Parasense 3300 Series monitors are advanced refrigerant leak detection devices utilizing infrared absorption sensors to analyze air samples. The component arrangement of a typical monitor is shown in figure 9-39.

Monitors are available with four or eight individual sampling modules (SAMM), each having their own pump and filter. Typically, each SAMM is connected to the sample area by semi-rigid polyethylene tubing, called "freeways." The specific area can be further subdivided into smaller regions using a manifold with multiple sampling pipes known as a "spur kit". This multiple sampling technique ensures likely sources of refrigerant leakage are specifically targeted.

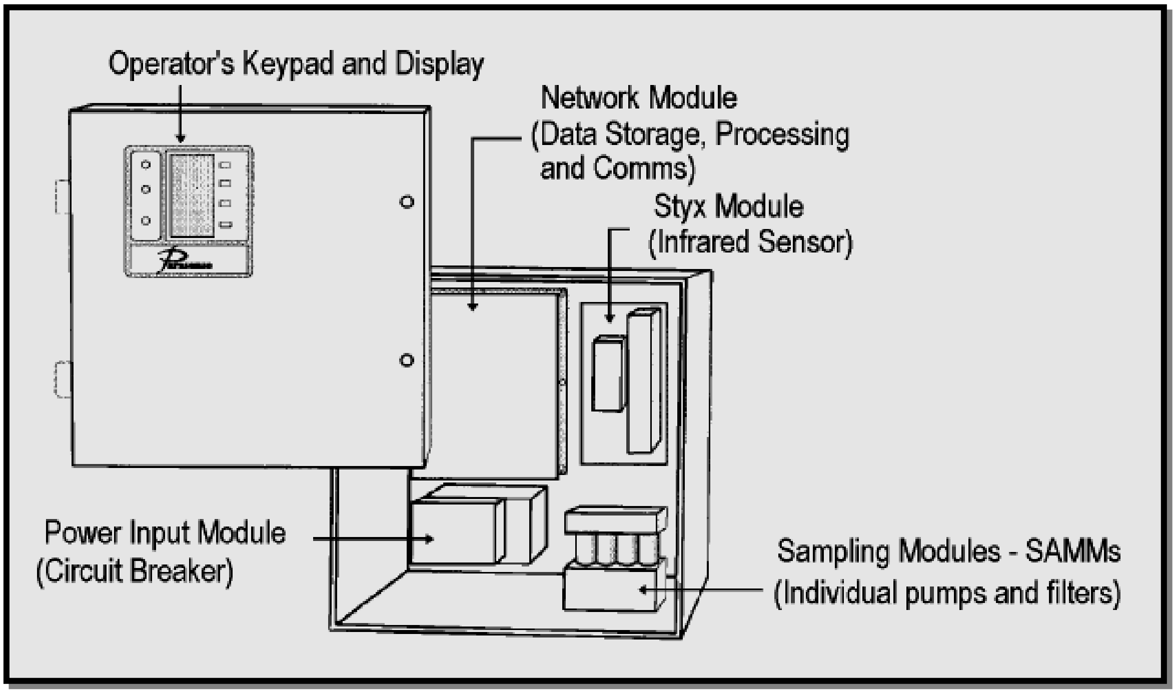


Figure 9-39.— Parasense Monitor.

Alarms can be generated at three different levels described as “Alert,” “Alarm,” and “Critical.” These alarms can be signaled to other devices using the four configurable relays, the two RS-232 communication ports, or the RS-485 communication port. On some ships, the alarm signal is sent to a continuously manned remote location (e.g., Central Control Station or Damage Control Central) to alert supervisory personnel of a refrigerant leak. If the monitor is not mounted within sight of the entrance to the monitored space, a remote beacon sounder can be used to alert personnel that an alarm condition exists. The current alarm status and an analysis of alarms over the preceding 10 days are indicated on the operator’s keypad display (see figure 9-40). Details of system alarms, events, and readings are stored within the monitor and can be accessed via the operator’s keypad. Local and remote access is also available through the RS-232 connection using Parasense SE8000 PC software.

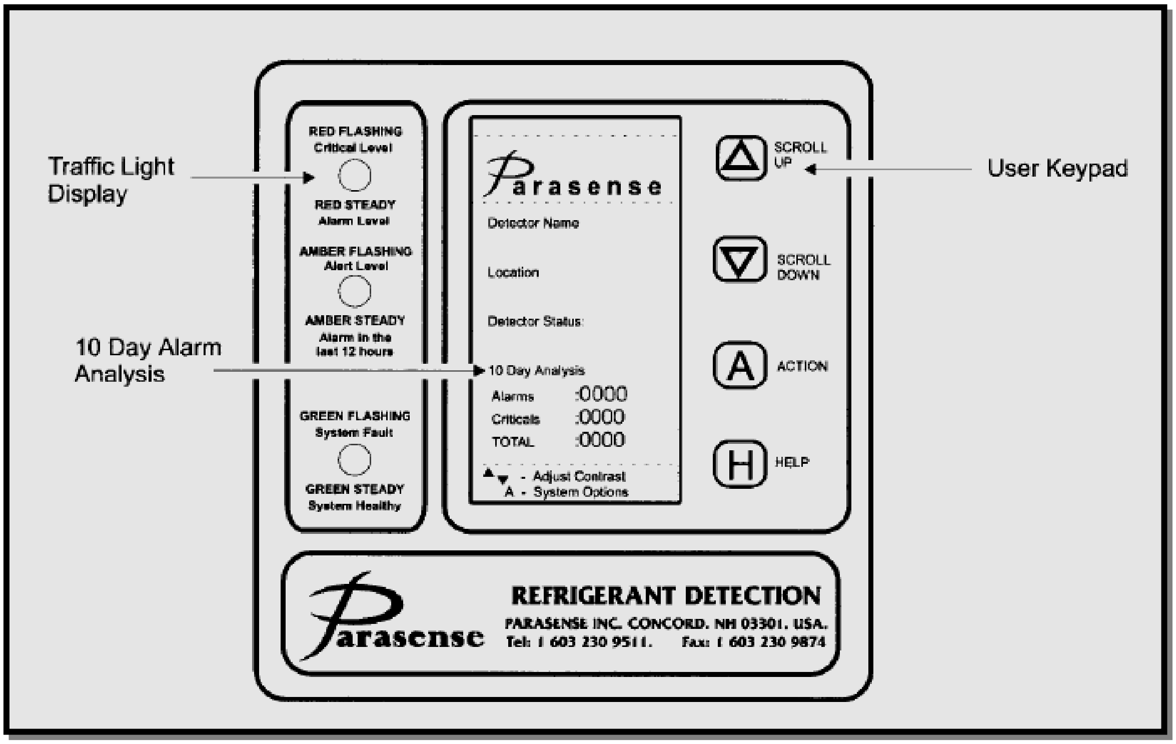


Figure 9-40.— Operator's Keypad Display.

Parasense SE8000 Software

Parasense SE8000 software allows a personal computer (PC) to interface with the monitor via the external RS-232 communication port. This software is provided in the service kit. Although computer interface by ship's personnel is not mandatory, it allows for information download, and faster configuration uploads.

The Parasense SE8000 software must be loaded onto a PC in order to allow interface with the monitor. Two versions of the Parasense SE8000 software are available; one version for Windows '95, '98, Millennium, and XP (provided on two 3.5-inch floppy diskettes); and another version for Windows 2000, and NT (provided on compact disk). Both versions are supplied in the service kit.

a. Follow the instructions provided with the software to load the program onto the PC.

b. Connect the PC to the monitor using the monitor communication lead provided in the service kit.

c. Open the SE8000 program. A picture of the monitor display will appear. To access the setup menu, right click in the black area of the monitor display.

(1) In the setup menu, select “Preferences.” Ensure the correct COMMS port for the PC is selected. Select “Ok.”

(2) In the setup menu, select “Configure.” Verify “Direct local connection” is selected. Verify detector baud rate is selected to “9600.” Select “Ok.”

NOTE:
LKF files are not provided with the SE8000 software. The installing activity should request copies of the LKF files from the Naval Surface Warfare Center Carderock Division (NSWCCD) or the nearest Fleet Technical Support Center (FTSC) representative.

d. To upload an LKF file from the PC to the monitor, proceed as follows:

(1) In the setup menu, select “Open Site.” Locate the specific LKF file and select “Open.”

(2) In the setup menu, select “Connect.”

(3) In the setup menu, select “Transmit” to open the “Leak Detection Transmit Options” menu. Select “Send Site Information,” “Send Relay configuration,” and “Remove unused Samms at the detector” by clicking in the box adjacent to each option. “Choose the SAMMs to send” using a combination of the “check mark” and “right arrow” buttons. After selections are complete, select “Ok.” The red light on the PC will flash while the file is being transmitted. When file transmission is complete, the SE8000 main screen will reappear.

(4) Cycle power to the monitor off and then back on.

(5) After the 60-second self test, all appropriate SAMMs will begin to operate.

(6) Ensure data upload was successful by verifying the information displayed on the monitor agrees with the information displayed on the PC.

e. After interfacing between the PC and the monitor is complete, in the setup menu, select “Disconnect” and exit the SE8000 program.

Standard Screens and Commands

The Parasense 3300 series monitor has a door mounted “traffic light” alarm display, a liquid crystal display (LCD) panel and a 4-button keypad (see figure 9-40). All of the monitor’s features can be accessed or viewed from here by using the keypad functions as described below.

Traffic Light Display and Beacon Sounder

All Parasense refrigerant monitors have identical traffic light alarm displays. The traffic light display gives “at a glance” system status of any of the SAMMs and is interpreted as follows:

Red Flashing: The most recent measurement of refrigerant concentration from one or more of the SAMMs has exceeded the critical level.

Red Steady: The most recent measurement of refrigerant concentration from one or more of the SAMMs has exceeded the alarm level.

Amber Flashing: The most recent measurement of refrigerant concentration from one or more of the SAMMs has exceeded the alert level.

Amber Steady: An alarm has occurred in the last 12 hours.

Green Flashing: A fault exists.

Green Steady: The refrigerant monitor is operating at design specifications; all conditions normal.

WARNING:

When a flashing red light is present on the traffic light display, or any beacon sounder is activated, exit the space immediately and notify supervisory personnel; do not reenter the space without appropriate breathing protection. When a steady red or yellow light is present on the traffic light display, immediately notify supervisory personnel; with proper ventilation, continued occupation of the space is allowed.

For shipboard applications, a beacon sounder is mounted on top of the monitor (see figure 9-41). The beacon sounder provides an audiovisual signal of an unsafe condition, prompting personnel to evacuate the compartment. For extremely large or noisy spaces, installation of additional beacon sounders may be necessary. The beacon sounder is activated by one of the four relays on the network module. The duration of relay activation is determined by the configuration settings. A switch on the front of each beacon sounder will silence its respective sounder; the red beacon remains lit until the associated relay contacts open.

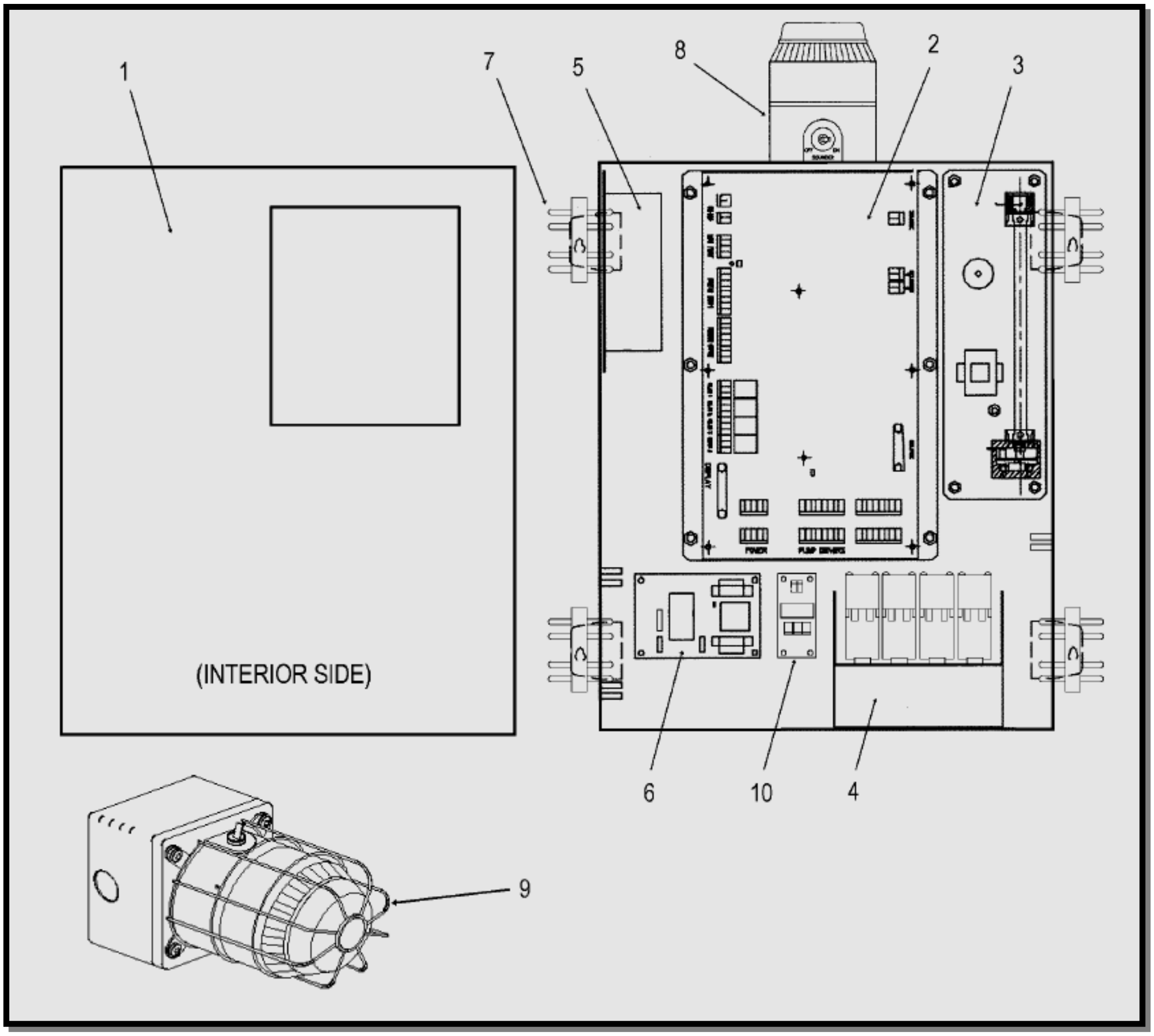


Figure 9-41.— Parasense 3300FSV-N Refrigerant Monitor.

Keypad Functions
See figure 9-40 for keypad location.

The SCROLL UP and SCROLL DOWN keys are used to select a menu option, change a number or character, or scroll a pointer or cursor through a list or graph.

The ACTION key executes the option selected or the parameter adjustment that has been made.

Operating the HELP key will provide instruction in the operation of the detector specific to the function selected. If more than one page of text is available, this may be accessed by using the SCROLL UP and SCROLL DOWN keys to locate more information. Operating the HELP key again will return the screen to the selected menu.

Use the SCROLL UP and SCROLL DOWN keys to select a menu option followed by the ACTION key to execute the option. Use the SCROLL UP and SCROLL DOWN keys to adjust a parameter followed by the ACTION key to execute the adjustment.

Pass Codes
Certain menu selections are protected by a four digit pass code to prevent unauthorized changes in set-up data or detector operation. The pass code is entered by using the SCROLL UP and SCROLL DOWN keys to adjust the first digit of the code followed by the ACTION key to accept that digit. The rest of the code is entered sequentially, in the same manner. To abort the pass code selection at any stage, enter an “X” followed by the ACTION key. If the wrong code is selected after entering the fourth digit, entry will be denied and the previous screen displayed.

Idle Screen
Following application of power, or if the monitor keys have not been used for approximately 5 minutes, the idle screen will appear. The display contrast can be adjusted using the SCROLL UP and SCROLL DOWN keys.

System Options
The “System Options” screen has four functions. See figure 9-42.

1. Samms List: To display a list of the individual SAMMs with their current status, including refrigerant type being detected, alarm set points, and the level in parts per million (ppm) of the most recent reading. This option will also provide entry to the menu screen giving historic data and control to the individual SAMMs.

2. Management: To gain entry to the Management section, refer to Monitor Setup in Technical Manual.

3. Entire System: To provide entry to the menu screens giving historic data and control for the entire system.

4. *BACK*: To return to the idle screen.

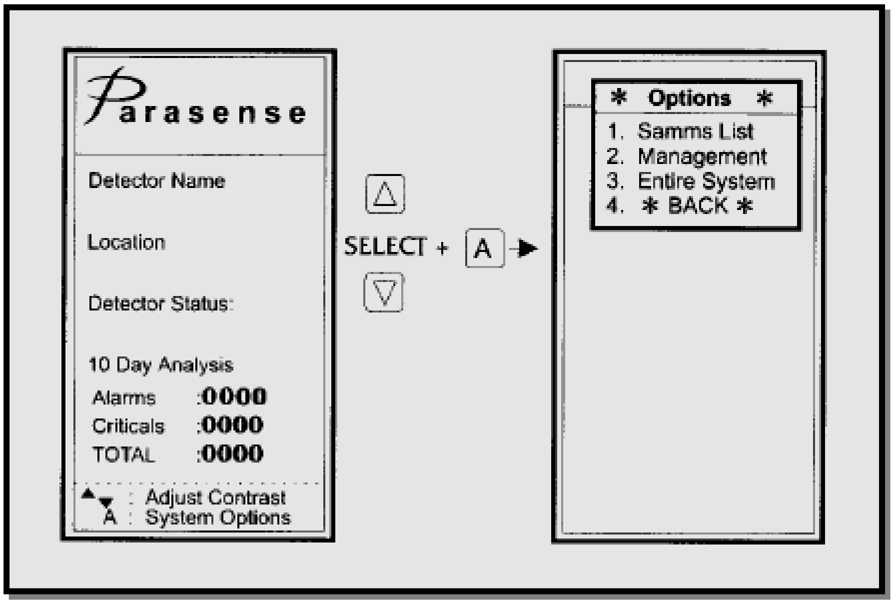


Figure 9-42.— System Options.

<u>Manual Sample</u>

To invoke a manual sample outside of the programmed sequence, select a SAMM from the “Samms List,” followed by the ACTION key. See figure 9-43. Select “Start Sample” followed by the ACTION key. The sample will be taken, the traffic light will operate as applicable and the “Samms List” information will be updated. Manual sample readings will not affect the relays or be recorded in the logs.

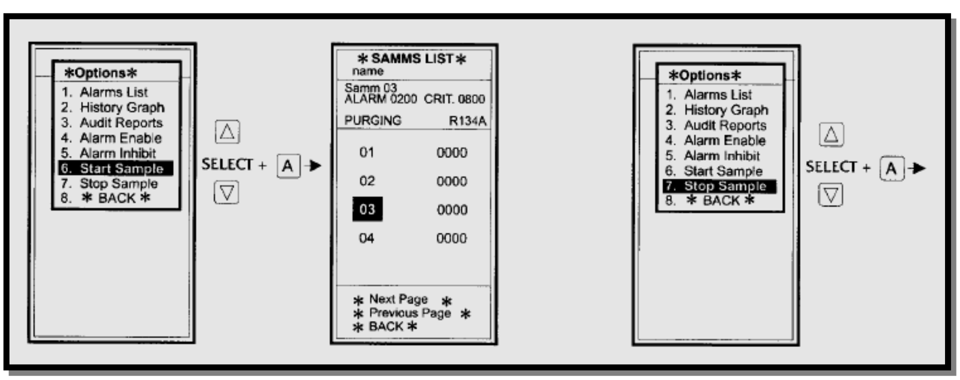


Figure 9-43.— Manual Sample.

Alarm Inhibit/Alarm Enable

Alarms from an individual SAMM can be inhibited by selecting “Alarm Inhibit” followed by the ACTION key. Enter the four digit “user” pass code followed by the ACTION key. Inhibit will remain in effect for a period of 12 hours or until “Alarm Enable” is selected. While a SAMM is inhibited, it will continue to sample, log, and operate the traffic lights.

Alarms from the entire system can be inhibited by selecting “Global Inhibit” and entering the four digit “user” pass code, followed by the ACTION key. After entering the pass code and pressing the ACTION key, the display will return to the idle screen and the SAMMs list will indicate INHIBITED for any SAMM selected. Inhibit will remain in effect for a period of 12 hours or until “Global Enable” is selected. While the system is inhibited, it will continue to sample, log, and operate the traffic lights.

Management Options

If the proper four digit “management” pass code is entered, the Management Option screen will be displayed. Access to the Management Option screen will automatically end if the keypad has not been used for approximately 5 minutes.

The Management Option screen has seven functions.

a. Setup Options: To access the options to configure, modify, or set up the operating data within the monitor.

b. Events List: To display a schedule of management generated events.

c. Faults List: To display a list of system faults.

d. System Test: To invoke a system test. This will cause each channel to take a sample in sequence, starting with channel 1. Following this, sampling will revert to the normal configured times.

e. Calibr. Check: To carry out a calibration check.

f. New Passcode: To input a new four digit management pass code number.

g. *BACK*: To return to the idle screen.

SAMMS Setup

SAMM ID numbers correspond with the pump number on the network module, and the associated pump on the SAMMs. The individual SAMMs are numbered from left to right, with 1-4 towards the rear, and 5-8 towards the front of the enclosure. Other data such as “SAMM Name,” “Alarm Levels,” and “Operation” information will be set to the factory installed Navy configuration but can be adjusted to suit the installation.

Pipe Length

The pipe length is the length of the freeway plus the length of the spur kit (See Figure 9-44) and is used to determine the length of time required to purge airways between sampling. Although actual pipe length may be less, the pipe length setting should always be set to at least 100 feet to allow a minimum 10 second purge time. If more than 100 feet of freeway piping is actually used, adjust “Pipe length” accordingly (up to a maximum of 300 feet).

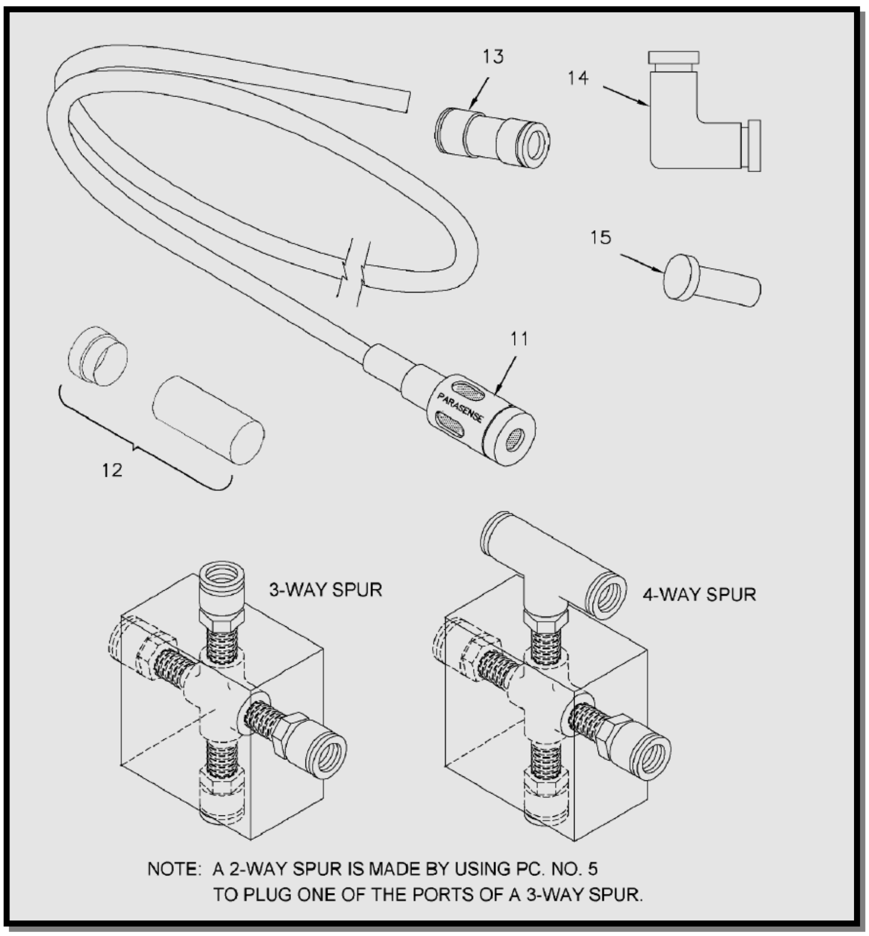


Figure 9-44.— Parasense 3300FSV-N Refrigerant Monitor.

"Cycle time" is the time interval between samples on a particular SAMM. It is entered in whole minutes and is calculated based on purge time and sampling time. Purge time is the time required to clear the freeway of air and to deliver a fresh sample for analysis; this takes approximately 1 second for every 10 feet of 6.0 mm diameter pipe. Sampling time is the time required for the infrared detector to process the air sample and report the concentration; this takes approximately 30 seconds. Therefore, one complete cycle for an 8-channel monitor with 250 feet of freeway on each channel is:

8 x (30 sec + 25 sec) = 440 sec (7.33 minutes)

"Cycle time" should not be set to less than the calculated cycle time. In the previous example, this would require selecting a "Cycle time" of at least 8 minutes (selecting 7 minutes would be less than the 440 seconds calculated).

For simplicity and uniformity, 10 minutes is used in all Navy applications.

Relays

Four separate volt-free changeover relays are provided on the Network Module, rated at 1.0 amp (resistive). External contact voltages should not exceed 30 volts DC. A 24-volt DC 250-mA supply is available adjacent to the relays if required to drive beacons, etc.

System Test

By selecting "START" followed by the ACTION key, a system test will commence. All SAMMs will sample in sequence, updating logs and activating relays if applicable. The system will revert to normal operation after all SAMMs have sampled once or if "STOP" is selected followed by the ACTION key.

Scheduled Maintenance

The Planned Maintenance System (PMS) provides required preventive maintenance procedures to be performed on a scheduled basis. OPNAVINST 4790.4 describes this system and covers departmental and work center record keeping, as well as the Maintenance Index Page (MIP) and Maintenance Requirement Cards (MRCs). MRCs include scheduled maintenance procedures for the equipment covered by the Technical Manual.

Calibration

Calibration is performed by replacing the styx module at intervals specified in PMS. Replacement of the styx module is accomplished when indicated by monitor message “CALIBRATION CHECK REQUIRED” (older software versions), RECALIBRATION” or “SERVICE REQUIRED” (newer software versions). This message will appear automatically after 18 total months of operation. If the styx module cannot be replaced due to ship’s operational commitment, a calibration check should be performed. A calibration check kit, consisting of a gas cylinder, reservoir, and hose, is required for this maintenance. See figure 9-45.

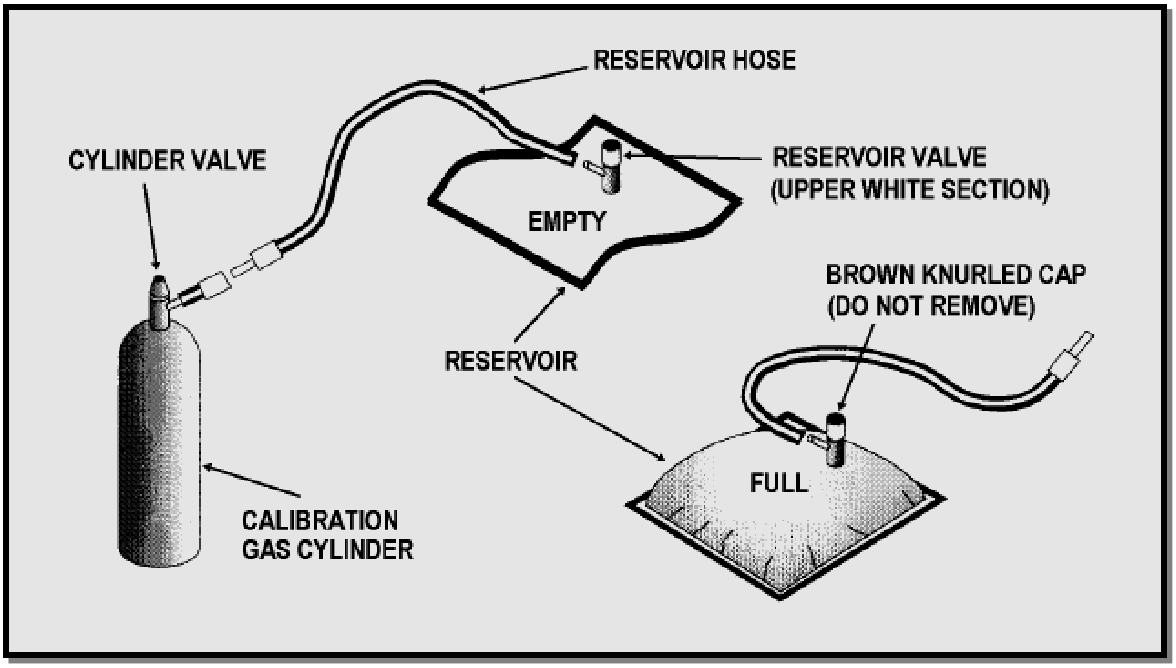


Figure 9-45.— Calibration Gas Cylinder and Reservoir.

9.16.0 SYSTEMS MAINTENANCE

Preventive maintenance of the systems should be done according to the MRCs associated with each system. Preventive maintenance consists of routine cleaning, visual inspection of components, and testing.

Corrective maintenance of the systems is relatively easy to perform. Almost any trouble that will affect system operation gives an audible and/or visual indication.

If an open occurs in one of the systems, an alarm condition cannot be detected. Therefore, the problem should be found and corrected as soon as possible, In some cases, such as open supervisory relay contacts, no indication will be received to indicate a trouble condition.

Shorted switch contacts or relay contacts in one of the systems could result in false alarm conditions or blown fuses. A short in an audible or visual signal will affect the operation of the system only during an alarm condition. The short will cause an increase in current flow and will result in blown fuses.

A ground in one of the systems could also result in false alarms or blown fuses. Grounds can be either single or multiple on the same side of the line or simultaneous on both sides of the line.

Mechanical problems, such as a weak spring on art alarm relay, will also result in a false alarm.

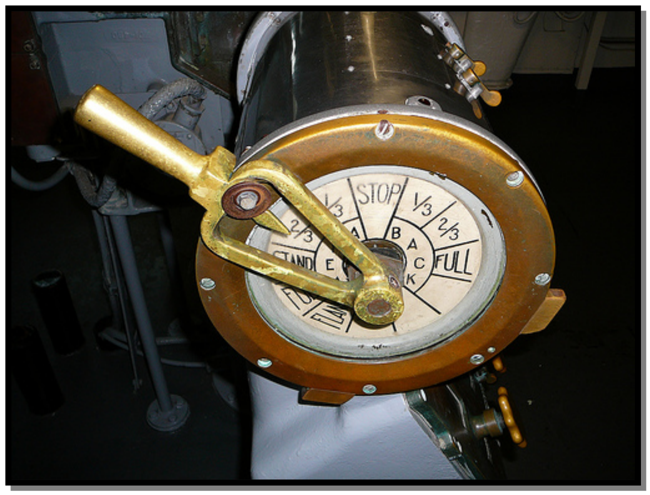
If a complete loss of power occurs in an alarm panel, check the fuses that supply primary power to the panel. If the fuses are good, open the panel and check the incoming line connections with a voltmeter. If power is not present, the problem is in the cable that supplies power to the panel. If power is present, check the power transformer and rectifier. For more information on troubleshooting alarm panels, refer to the applicable manufacturer’s technical manual.

If a complete loss of power occurs in the IC/SM switchboard, check the two main power fuses located on the front of the common alarm. If the fuses are good, open the cabinet and check the incoming line connections of the fuse holder with a voltmeter. If input power is present, check the power transformers and bridge rectifiers. If power is not present, check the fuses that supply primary power to the switchboard. For more information on troubleshooting the IC/SM switchboard, refer to the applicable manufacturer’s technical manual.

9.17.0 SUMMARY

In this chapter, we have discussed how the alarm, safety, and warning systems are used on board ship to alert personnel of dangerous or abnormal conditions. We have identified the principle components of the various alarm, safety, and warning systems and how they operate. We have also briefly described some of the common troubles associated with the systems and the effects they will have on the systems.

10 SHIP'S ORDER INDICATING AND METERING SYSTEMS



Upon completion of this chapter you will be able to do the following:

- Describe the purpose of the ship's order indicating and metering systems.
- Identify the various types of control consoles used with the ship's control order and indicating systems.
- Describe the operation of the ship's control order and indicating systems.
- Describe the operation of some of the various metering and indicating systems installed on Navy ships.
- Describe the function of gears.
- Identify the basic types of gears and their uses.
- Describe the operation of various gear mechanisms.
- Briefly describe the troubleshooting and maintenance procedures for various ships' order indicating and metering systems.

10.0.0 INTRODUCTION

To operate a ship properly, watch personnel require vast quantities of information relative to conditions within and outside the ship. Ship's order indicating and metering systems are installed on ships to measure and transmit this information.

10.1.0 SHIP'S CONTROL ORDER AND INDICATING SYSTEMS

Ship's control order and indicating systems consist of the (1) propeller revolution order system (circuit M), (2) engine order system (circuit MB), (3) rudder angle indicator (circuit N), (4) rudder order (circuit L), and (5) steering emergency alarm signal (circuit LB). On the older ships, the equipment for these circuits is mounted in a ship's control console and a steering control console. On the newer gas turbine ships with automated propulsion systems, the ship's control and steering consoles are combined into one console using state of the art circuitry and equipment. Only the consoles installed on the older ships will be discussed in this training manual. For information on the consoles installed on the newer gas turbine ships, refer to the applicable Ship Information Book.

10.2.0 SHIP'S CONTROL CONSOLE

The ship's control console incorporates, in a single unit, the equipment required to transmit orders relative to the speed of the ship. Figure 10-1 is an illustration of a double engine order ship's control console. The order and indicator systems associated with the console are the propeller revolution order and the engine order. The ship's control console also contains circuits for control of the ship's speed lights. The speed light circuits are maintained by the Electrician's Mates.

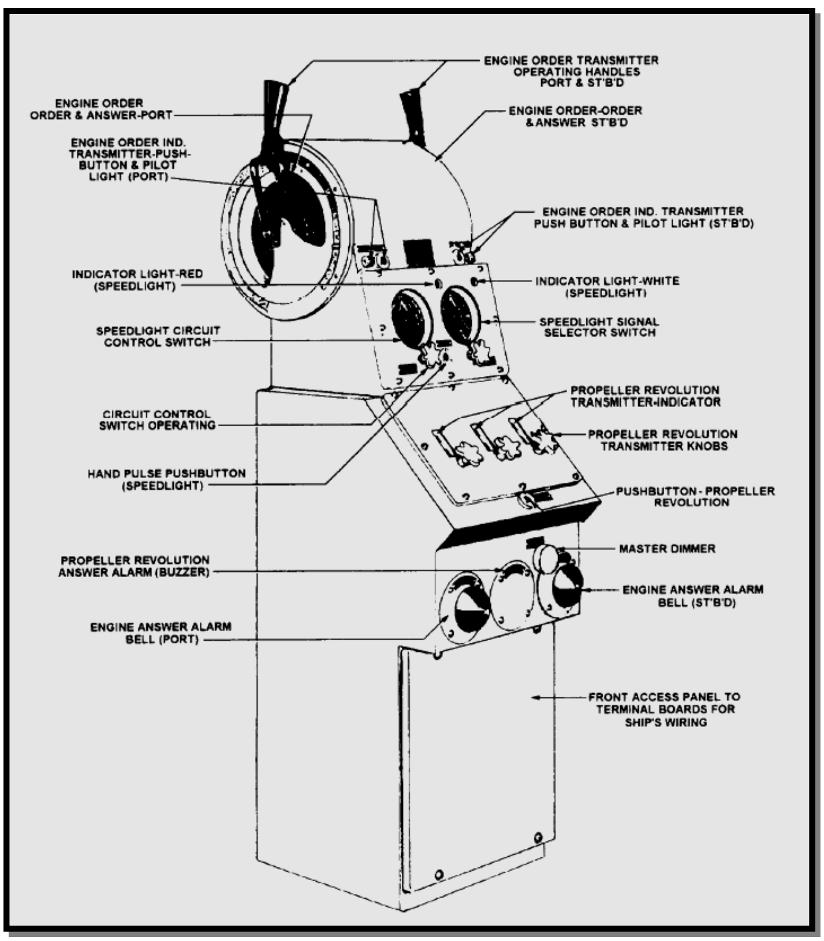


Figure 10-1.—Ship's control console.

10.2.1 Propeller Revolution Order System

The propeller revolution order system (circuit M) transmits the required propeller revolutions per minute (rpm) from the pilothouse to each propulsion gauge board. The control unit (propeller order indicator transmitter) for circuit M is mounted in the ship's control console. It is a self-synchronous control unit, containing three synchro transmitters and three synchro receivers, each of which is coupled to an indicating dial. The transmitters are further coupled to control knobs. The lee helmsman operates the indicator transmitter when a change in propeller revolutions is ordered by the OOD.

A second propeller order indicator-transmitter (fig. 10-2) is mounted on the main gauge board in engine room No. 1. When a change in propeller revolutions is transmitted from the ship's control console, it is received and indicated on this propeller order indicator-transmitter. The throttleman in engine room No, 1 acknowledges the change by transmitting the order back to the propeller order indicator transmitter in the ship's control console. In the event of an engineering casualty or specific test, the throttleman in the engine room can reverse the procedure by requesting specific revolutions per minute.

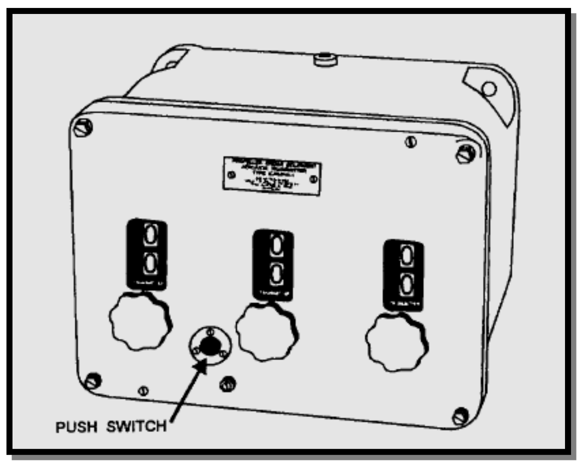


Figure 10-2.—Propeller order indicator-transmitter (circuit M).

A propeller order indicator (fig. 10-3) is mounted on the gauge board of engine room No. 2. This indicator is used to inform the watch in engine room No. 2 that a change in propeller revolutions has been ordered.

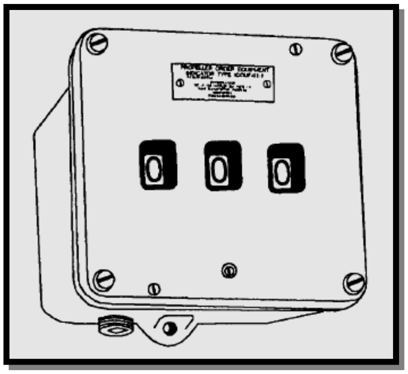


Figure 10-3.—Propeller order indicator (circuit M).

10.2.2 Engine Order System

The engine order system (circuit MB) transmits the required shaft direction orders (ahead/back) and the ordered speed of each shaft from the pilothouse to each propulsion gauge board.

An engine order indicator-transmitter for each shaft (1MB for starboard shaft and 2MB for port shaft) is mounted in the upper section of the ship's control console. An operating handle is attached to each indicator-transmitter. The lee helmsman operates the handles whenever a change in shaft direction or speed is ordered by the OOD. There is also a push button and a bell located on the console for each indicator transmitter. The push buttons are used to alert the appropriate engine room of a change in orders. The bells alert the lee helmsman that the order has been acknowledged by the appropriate engine room.

Each engine room has one indicator-transmitter (fig. 10-4) for its associated shaft. After receiving an engine order, the throttleman acknowledges the order by turning the knob and matching its transmitter to the received order. A push button is located on the indicator-transmitter to energize the appropriate bell on the ship's control console.

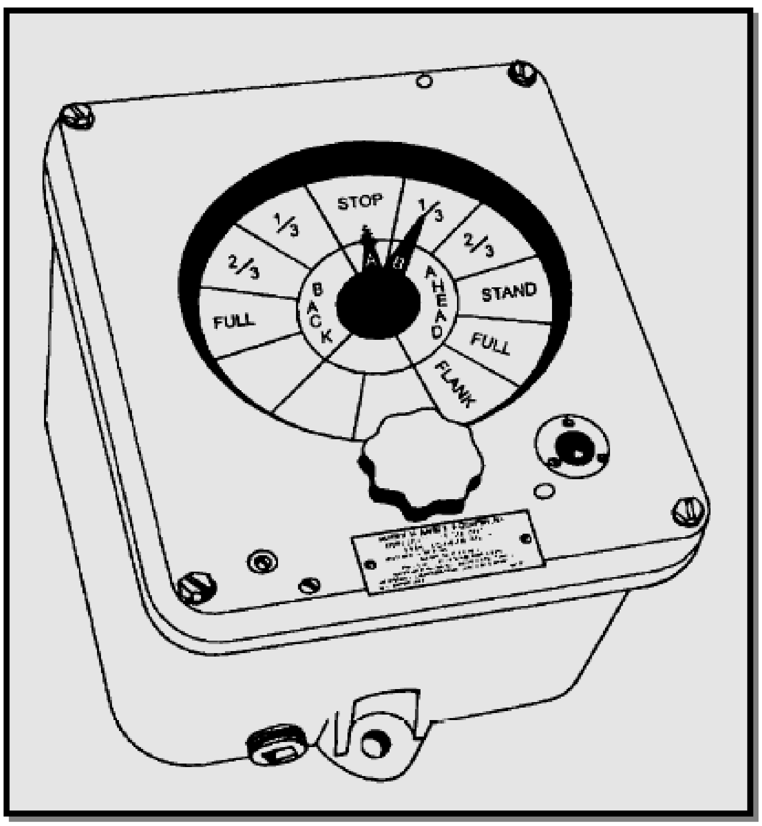


Figure 10-4.—Indicator-transmitter (circuit MB).

Each fireroom has a double engine order indicator (fig. 10-5) to alert the fireroom to changing steam requirements.

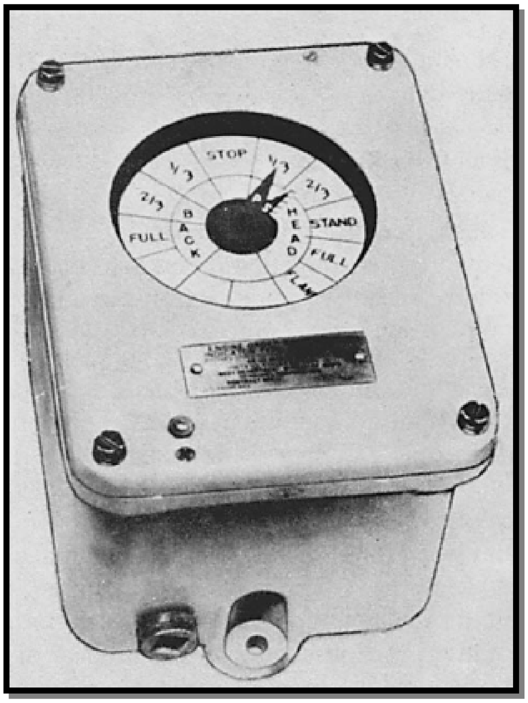


Figure 10-5.—Double indicator (circuit MB).

Engine order indicators are also located in other stations on the ship, such as the combat information center (CIC) and the navigation bridge. Figure 10-6 is an illustration of a single engine order indicator.

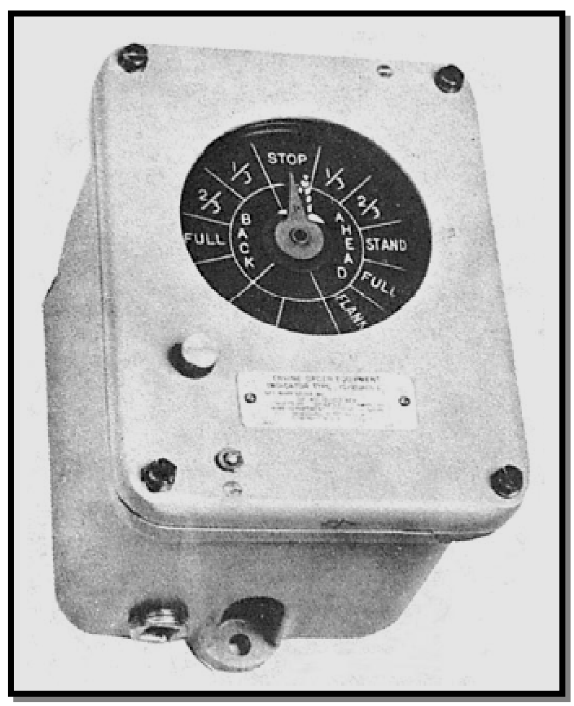


Figure 10-6.—Single engine order indicator (circuit MB).

Figure 10-7 is a block diagram of a typical engine order system, showing the various units and their locations for circuit MB. The associated remote indicator stations are also included in the diagram.

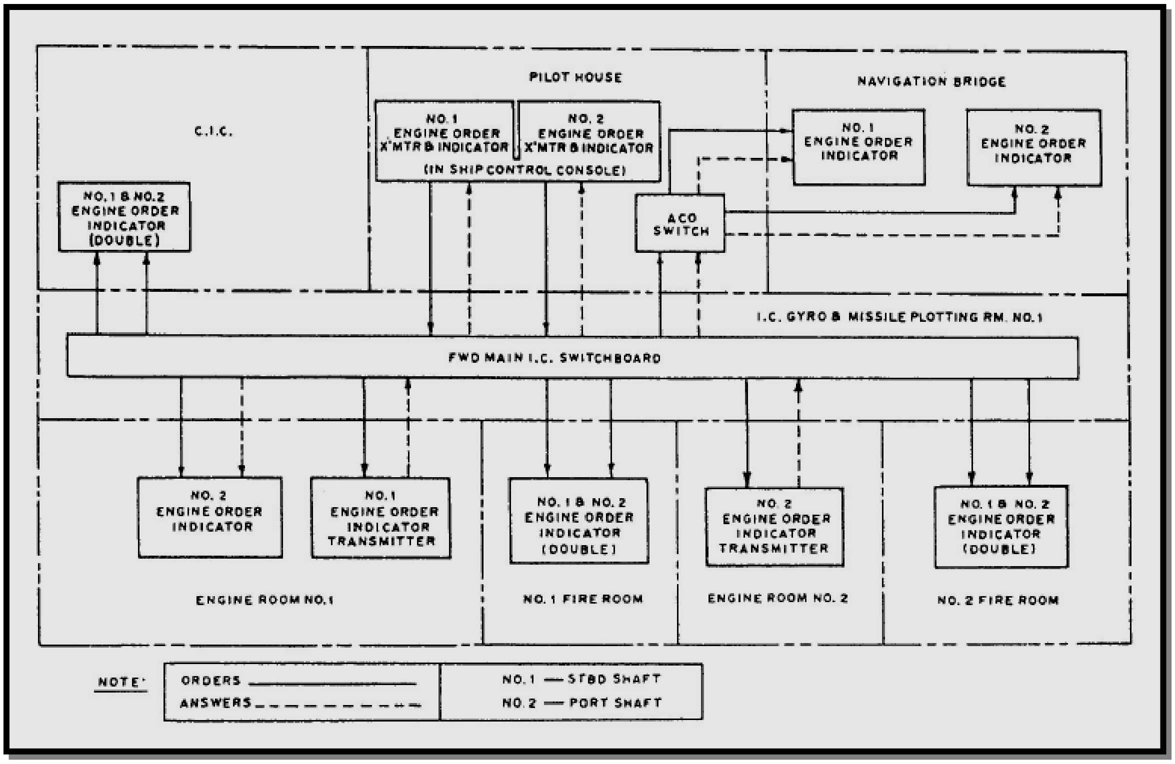


Figure 10-7.—Engine order system (circuit MB).

10.3.0 STEERING CONTROL CONSOLE

The steering control console (fig. 10-8) incorporates, in a single unit, the equipment required to navigate the ship from the pilothouse and to transmit steering orders to the steering gear room. The order and indicating systems associated with this console are the rudder angle indicator, the rudder order, and the steering emergency alarm signal. The steering control console also contains ship's course indicators, a helm angle indicator, and a steering wheel (helm). Some steering control consoles also contain a magnesyn compass repeater.

The helm angle indicator is a synchro receiver that is connected to a synchro transmitter attached to the steering gear. It indicates the mechanical position of the steering gear. The steering wheel (helm) is used to steer the ship. The magnesyn compass repeater is maintained by the ship's Quartermasters.

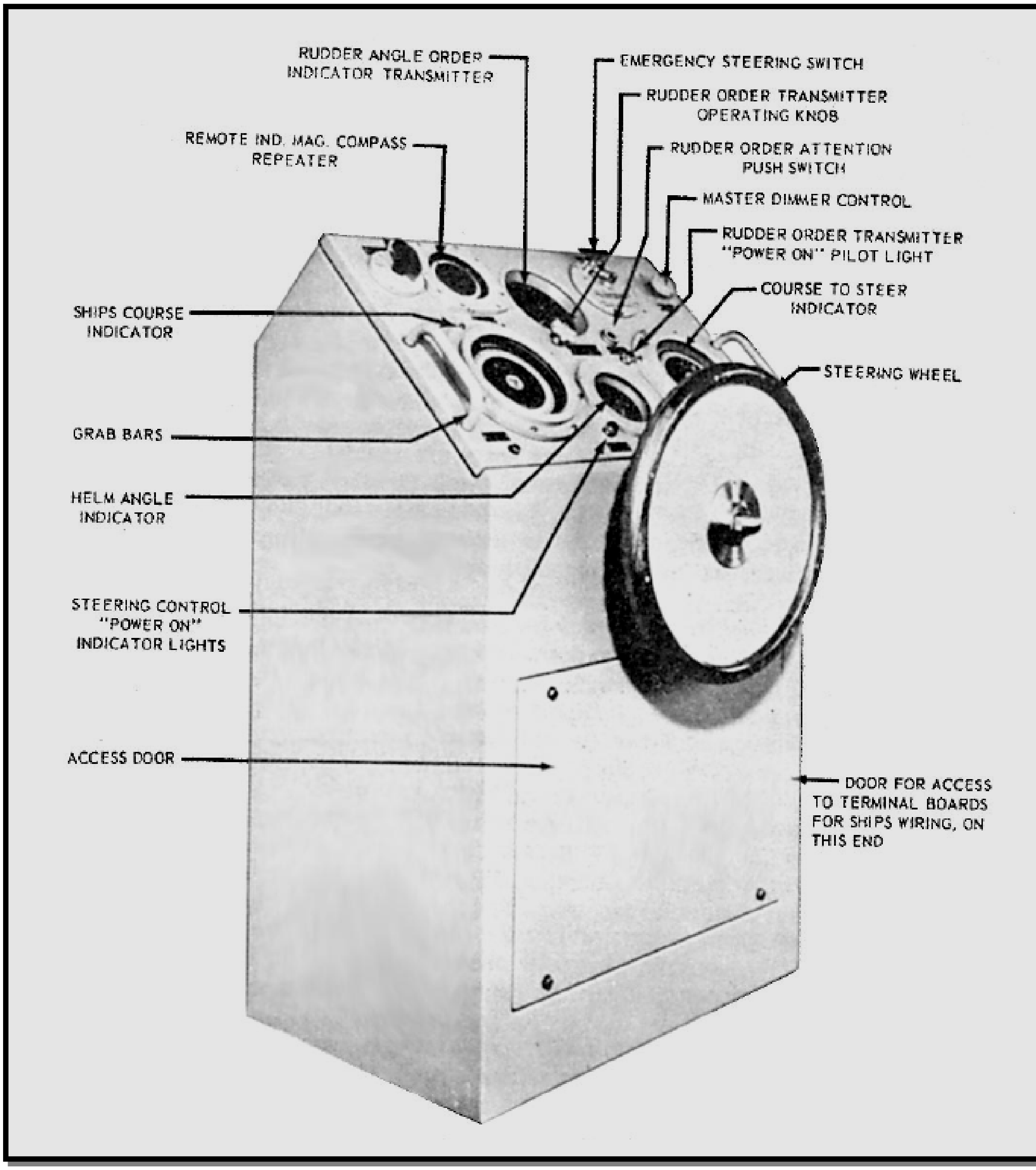


Figure 10-8.—Steering control console.

10.3.1 Rudder Angle Indicator

The rudder angle indicator system (circuit N) provides a means of electrically transmitting the angular position of the ship's rudder at the rudder head to designated stations throughout the ship.

The rudder angle transmitter (fig. 10-9) is located at the rudder head and consists of a synchronous transmitter mechanically linked to the rudder stock in such a manner that its shaft follows the movement of the rudder. It transmits the angular position of the rudder angle to various ship's rudder angle indicators via the action cutout (ACO) section of the steering gear room IC switchboard.

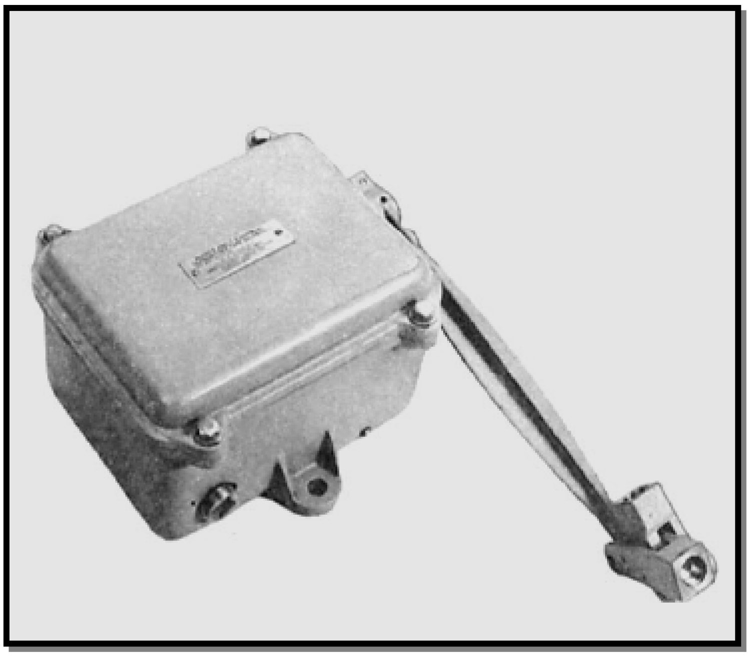


Figure 10-9.—Rudder angle transmitter.

The rudder angle indicator (fig. 10-10) consists of a fixed dial and pointer, which is mounted on the shaft of a synchro receiver. The receiver rotates the pointer to the transmitted angular displacement on the dial face.

Figure 10-10.—Rudder angle indicator (circuit N).

Figure 10-11 is a block diagram of the rudder angle order and rudder angle indicator systems, showing the various units and their locations.

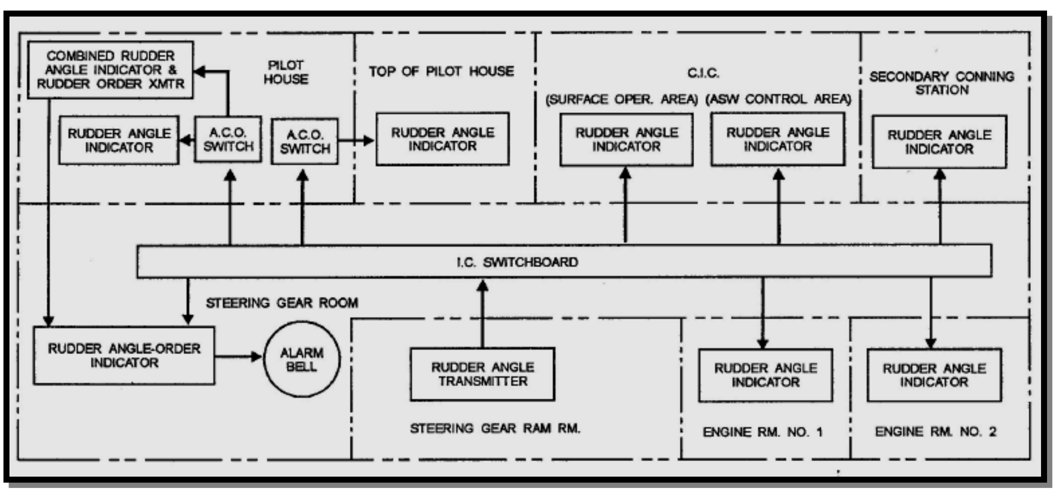


Figure 10-11.—Rudder angle indicator (circuit N) and rudder angle order (circuit L).

A combination rudder angle order indicator (fig. 10-12) is located in the steering gear room in front of the steering gear room trick wheel. The trick wheel is used to steer the ship under emergency steering conditions.

Single rudder angle indicators are located in the engine rooms, bridge wings, CIC, pilothouse, and navigation bridge.

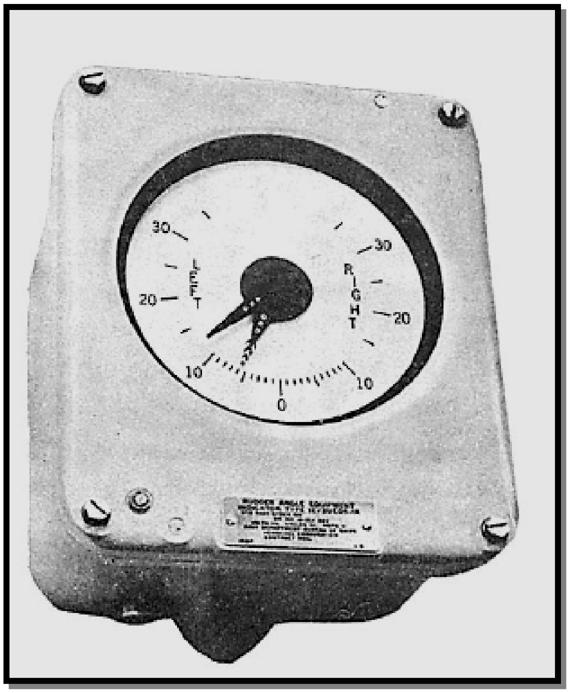


Figure 10-12.—Rudder angle order Indicator (circuits L and N).

10.3.2 Rudder Order

The rudder order system (circuit L) provides a means of electrically transmitting rudder angle orders from the steering control console in the pilothouse to the steering gear room when the ship is being steered from the steering gear room.

The rudder angle order indicator transmitter is located in the steering control console. The helmsman operates the transmitter when a change in rudder angle is ordered by the OOD.

A push button is also provided on the console to ring a bell in the steering gear room so that the steering gear room watch can anticipate a rudder angle order change. When operated, the transmitter sends the desired rudder angle in degrees left or right to the combination rudder angle order indicator in the steering gear room. The steering gear room watch then positions the trick wheel to cause the rudder angle order indicator to match the order.

10.4.0 STEERING EMERGENCY ALARM SIGNAL CIRCUIT

The steering emergency alarm signal circuit (circuit LB) provides a means by which the pilothouse can alert the steering gear room watch that a steering emergency has occurred and that the trick wheel must be used to steer the ship.

A spring return lever switch is located on the steering control console, and a siren is located in the steering gear room. The helmsman operates the switch to energize the siren when normal steering control is lost. When the siren sounds in the steering gear room, the steering gear room watch immediately engages the trick wheel and takes control of steering the ship.

10.5.0 GEARS

Since gears are used in most of the equipment that we are discussing in this chapter for changing the direction or speed of an input, or for converting an electrical input to a mechanical input and vice versa, it is essential that we discuss the different types of gears and their functions.

10.6.0 FUNCTIONS OF GEARS

Gears have three functions: they change the direction of motion; they change the speed of motion; and they change the force by changing the mechanical advantage.

A simple gear system that illustrates all of these functions is the eggbeater (fig. 10-13). There are 32 teeth on gear A, which mesh with 8 teeth on gear B. Notice the direction of rotation. Also notice that as gear B turns in one direction, its teeth mesh with gear C and cause C to revolve in the opposite direction. The rotation of the crank handle has been transmitted by gears A, B, and C to cause the beater blades to rotate.

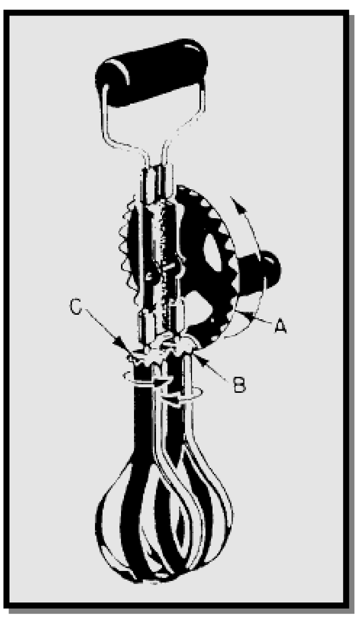


Figure 10-13.—A simple gear arrangement.

Gears also can change the speed of the motion, as was stated previously. Since gear A has 32 teeth and gear B has only 8, one complete revolution of gear A causes four complete revolutions of gear B. Therefore, the ratio between A and B is 1:4. Since gear C also has 8 teeth, the ratio of B to C is 1:1. Therefore, the beater blades revolve four times as fast as the crank handle.

Gears also can change the force of the applied motion. Generally, any time a gear is used to increase the speed of motion, the force at the output of the gear is reduced. Conversely, when the speed is reduced by gears, the force at the output is increased.

10.7.0 TYPES OF GEARS

There are several types of gears used in mechanical assemblies. In the following paragraphs, we will discuss the spur, bevel, and worm gears.

10.7.1 Spur Gears

When two shafts are not lying in the same straight line but are parallel, motion can be transmitted from one to the other by spur gears. This setup is shown in figure 10-14.

Spur gears are wheels with mating teeth cut in their surfaces so that one can turn the other without slippage. When the mating teeth are cut so that they are parallel to the axis of rotation (as shown in fig. 10-14), the gears are called straight spur gears.

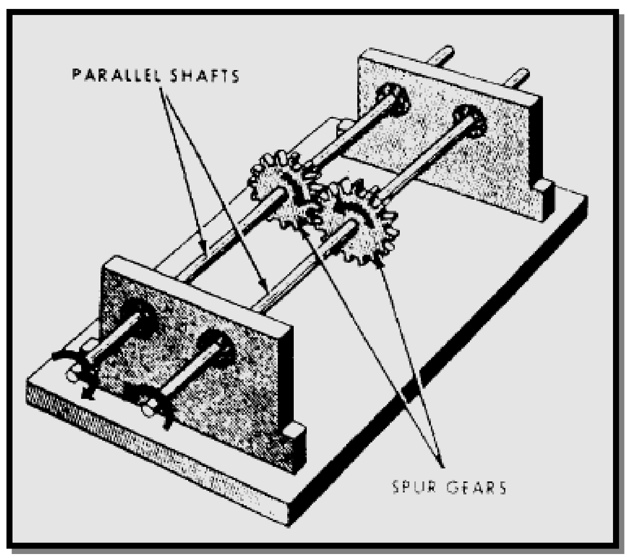


Figure 10-14.—Spur gears coupling two parallel shafts.

When two gears of unequal size are meshed together, the smaller of the two is usually called a pinion. By unequal size, we mean an unequal number of teeth causing one gear to be of a larger diameter than the other. The teeth, themselves, must be of the same size in order to mesh properly.

The most commonly used type of spur gear is the straight spur gear, but quite often you will run across another type of spur gear called the helical spur gear.

In helical gears, the teeth are cut slantwise across the face of the gear. One end of the tooth, therefore, lies ahead of the other. In other words, each tooth has a leading end and a trailing end. A look at these gears in figure 10-15 will show you how they are constructed.

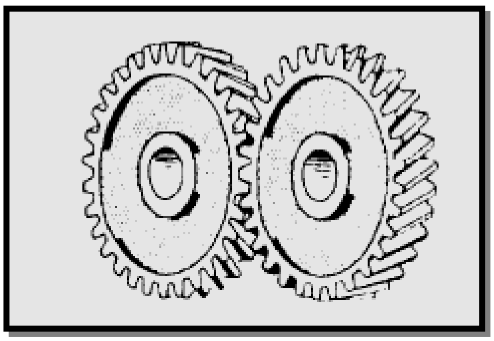


Figure 10-15.—Helical gears.

In the straight spur gears, the whole width of the teeth comes in contact at the same time. But with helical (spiral) gears, contact between two teeth starts first at the leading ends and moves progressively across the gear faces until the trailing ends are in contact. This kind of meshing action keeps the gears in constant contact with one mother; therefore, less lost motion and smoother, quieter action is possible. One disadvantage of this helical spur gear is the tendency of each gear to thrust or push axially on its shaft. A special thrust bearing must be put at the end of the shaft to counteract this thrust.

Thrust bearings are not needed if herringbone gears like those shown in figure 10-16 are used. Since the teeth on each half of the gear are cut in opposite directions, each half of the gear develops a thrust that counterbalances that of the other half. You'll find herringbone gears used mostly on heavy machinery.

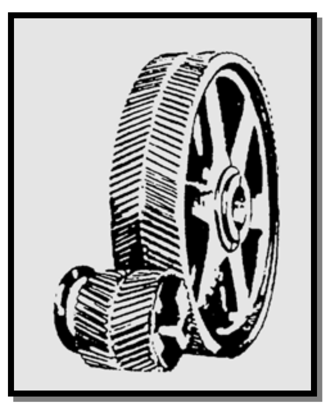


Figure 10-16.—Herringbone gears.

Figure 10-17 shows three other gear arrangements in common use.

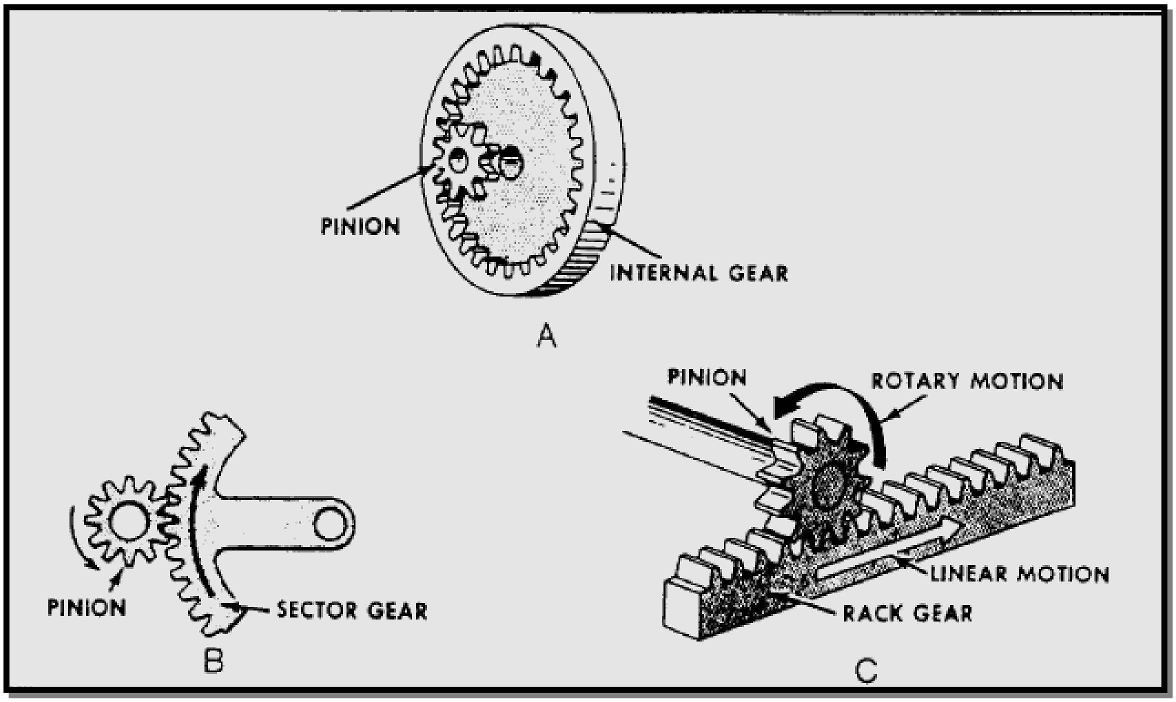


Figure 10-17.—Gear arrangements.

The internal gear in figure 10-17, view A, has teeth on the inside of a ring, pointing inward toward the axis of rotation. An internal gear is always meshed with an external gear, or pinion, whose center is offset from the center of the internal gear. Either the internal or pinion gear can be the driver gear and the gear ratio is calculated the same as for other gears-by counting teeth.

Often only a portion of a gear is needed where the motion of the pinion is limited. In this case, the sector gear (fig. 10-17, view B) is used to save space and material. The rack and pinion in figure 10-17, view C, are both spur gears. The rack may be considered as a piece cut from a gear with an extremely large radius. The rack-and-pinion arrangement is useful in changing rotary motion into linear motion.

10.7.2 Bevel Gears

So far, most of the gears you have learned about transmit motion between parallel shafts. But when shafts are not parallel (at an angle), another type of gear is used—the bevel gear. This type of gear can connect shafts lying at any given angle because they can be beveled to suit the angle.

Figure 10-18, view A, shows a special case of the bevel gear-the miter gear. A pair of miter gears is used to connect shafts having a 90-degree angle, which means the gear faces are beveled at a 45-degree angle.

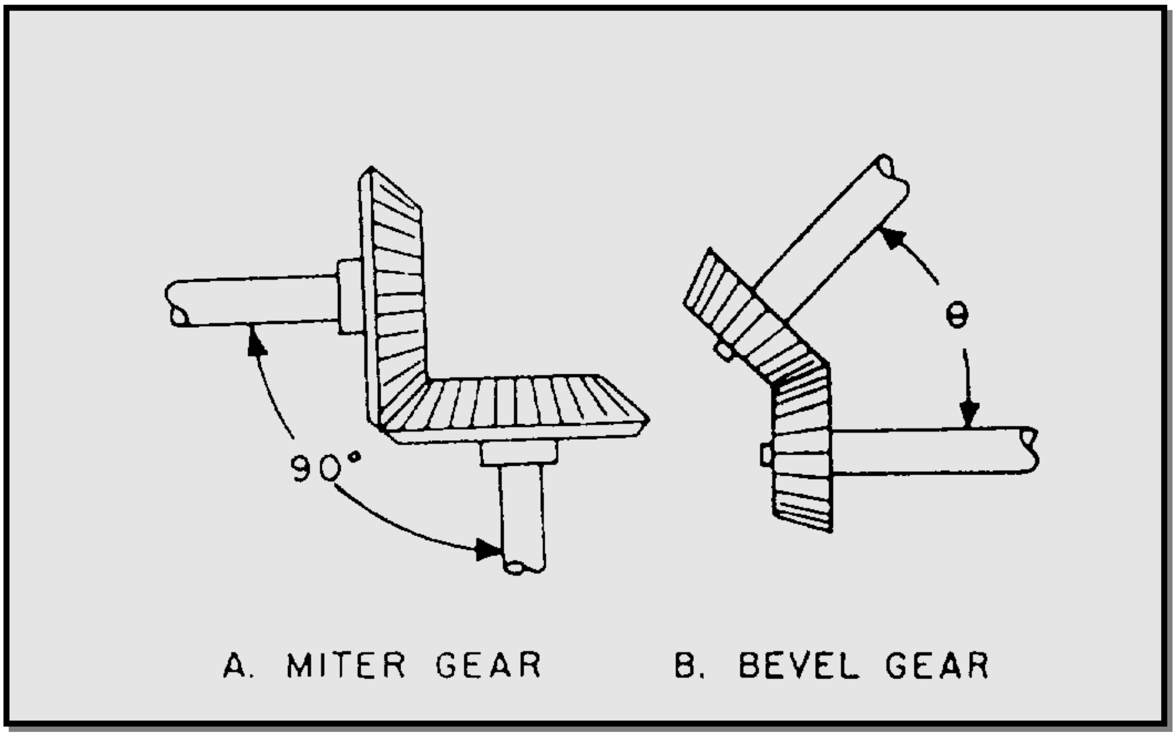


Figure 10-18.—Bevel gears.

You can see in figure 10-18, view B, how bevel gears are designed to join shafts at any angle. Gears cut at any angle other than 45° are called just plain bevel gears.

The gears shown in figure 10-18 are called straight bevel gears because the whole width of each tooth comes in contact with the mating tooth at the same time. However, some spiral level gears have teeth cut so as to have advanced and trailing ends. Figure 10-19 is an illustration of spiral bevel gears. They have the same advantages as other spiral (helical) gears—less lost motion and smoother, quieter operation.

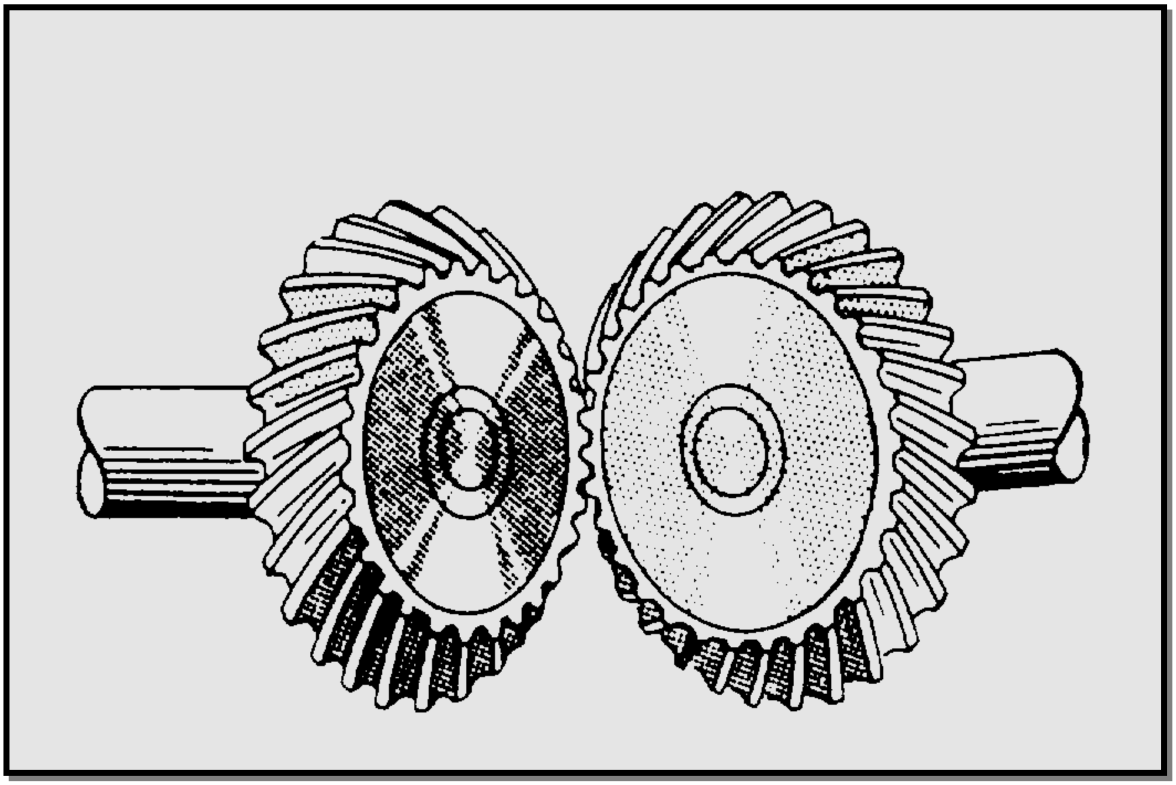


Figure 10-19.—Spiral bevel gears.

10.7.3 Worm Gears

Worm gears and worm gear-worm wheel combinations, like those in figure 10-20, have many uses and advantages. But, it is better to understand their operating theory before learning of their uses and advantages.

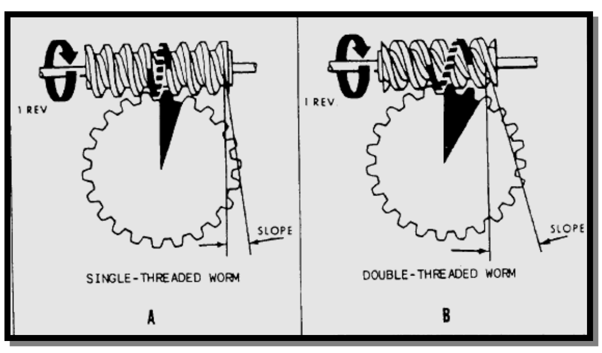


Figure 10-20.—Worm gears.

Figure 10-20, view A, shows the action of a single-threaded worm gear. For each revolution of the worm gear, the worm wheel turns one tooth. Thus, if the worm wheel has 25 teeth, the gear ratio is 25:1.

Figure 10-20, view B, shows the action of a double-threaded worm. For each revolution of the worm gear in this case, the worm wheel turns two teeth. Thus, if the worm wheel has 25 teeth, the gear ratio is 25:2.

Likewise, a triple-threaded worm gear would turn the worm wheel three teeth per revolution of the worm gear.

A worm gear-worm wheel is really a combination of a screw and a spur gear. Tremendous mechanical advantages (M.A.) can be obtained with this arrangement. Worm drives can also be designed so that only the worm gear is the driver—the spur gear cannot drive the worm gear. On a hoist, for example, you can raise or lower the load by pulling on the chain that turns the worm gear. But, if you let go of the chain, the load cannot drive the spur gear and will let the load drop to the deck. This is a non-reversing worm drive.

10.8.0 CHANGING DIRECTION WITH GEARS

No doubt you know that the crankshaft in an automobile engine can turn in only one direction. If you want the car to go backwards, the effect of the engine's rotation must be reversed. This is done by a reversing gear in the transmission, not by reversing the direction in which the crankshaft turns.

A study of figure 10-21 will show you how gears are used to change the direction of motion. This is a schematic diagram of the sight mounts on a Navy gun. If you trunk the range-adjusting handle, A, in a clockwise direction, the gear, B, directly above it, is made to rotate in a counterclockwise direction. This motion causes the two pinions, C and D, on the shaft to turn in the same direction as gear B against the teeth cut in the bottom of the table. The table is tipped in the direction indicated by the arrow.

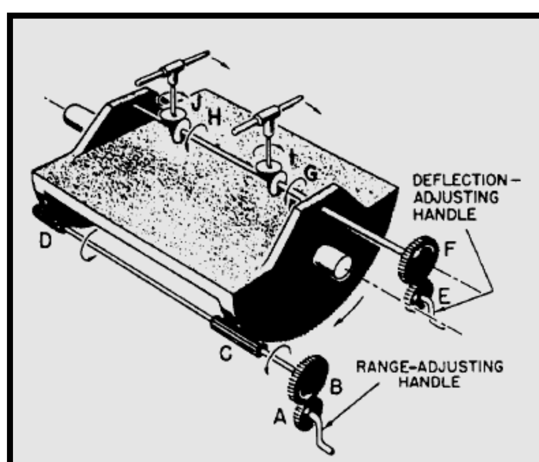


Figure 10-21.—Gears can change the direction of applied motion.

As you turn the deflection-adjusting handle, E, in a clockwise direction, gear F, directly above it, turns in the opposite direction. Since the two bevel gears, G and H, are fixed on the shaft with F, they also turn. These bevel gears, meshing with the horizontal bevel gears, I and J, cause I and J to swing the front ends of the telescopes to the right. Thus, with a simple system of gears, it is possible to keep the two telescopes pointed at a moving target. In this and many other practical applications, gears serve one purpose-they change the direction of motion.

10.9.0 CHANGING SPEED WITH GEARS

As you have already seen in the eggbeater, gears can be used to change the speed of motion. Another example of this use of gears is found in your clock or watch. The mainspring slowly unwinds and causes the hour hand to make one revolution in 12 hours. Through a series, or train, of gears, the minute hand makes one revolution each hour, while the second hand goes around once per minute.

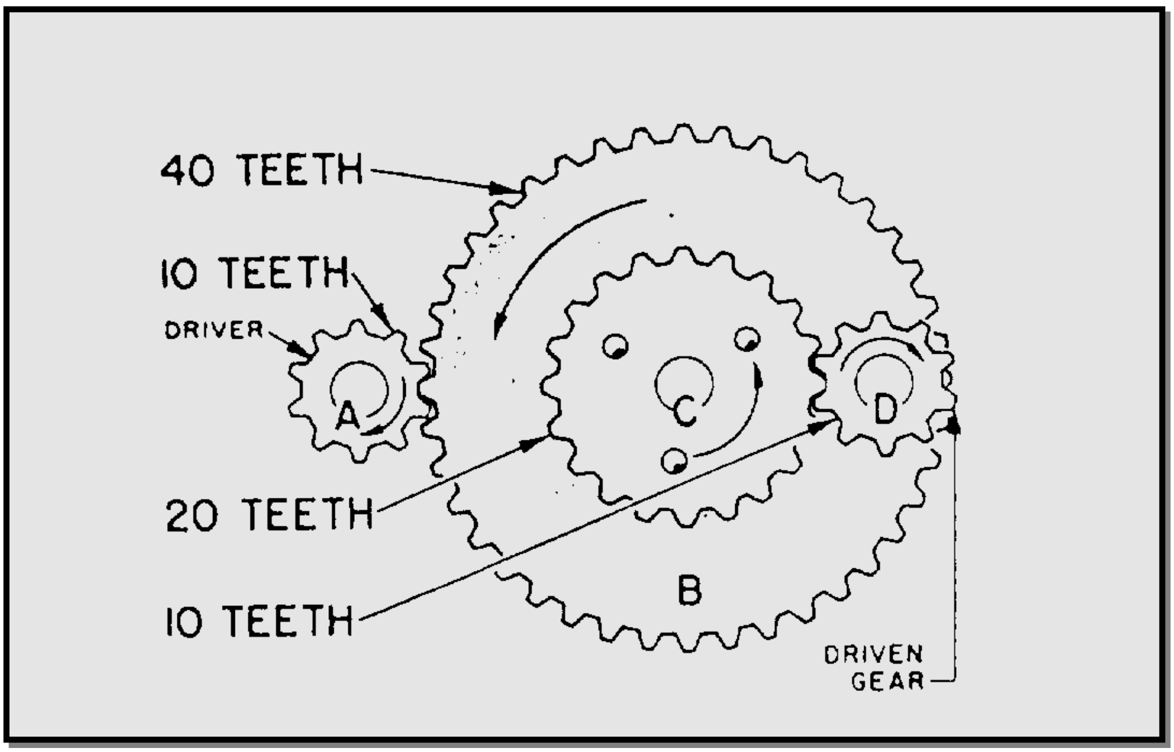


Figure 10-22.—Gears can change the speed of applied motion.

Figure 10-22 will help you understand how speed changes are made possible. Wheel A has 10 teeth, which mesh with the 40 teeth on wheel B. Wheel A will have to rotate four times to cause B to make one revolution. Wheel C is rigidly fixed on the same shaft with B. Thus, C makes the same number of revolutions as B. However, C has 20 teeth and meshes with wheel D, which has only 10 teeth. Hence, wheel D turns twice as fast as wheel C. Now, if you turn A at a speed of four revolutions per second, B will be rotated at one revolution per second. Wheel C also moves at one revolution per second and causes D to turn at two revolutions per second. You get out two revolutions per second after having put in four revolutions per second. Thus, the overall speed reduction is 2/4—or 1/2—which means that you got half the speed out of the last driven wheel that you put into the first driven wheel.

You can solve any gear speed-reduction problem with the following formula:

$$S_2 = S_1 \times \frac{T_1}{T_2}$$

Where:

S_1 = speed of first shaft in train

S_2 = speed of last shaft in train

T_1 = product of teeth on all drivers

T_2 = product of teeth on all driven gears

Now use the formula on the gear train of figure 10-21.

$$S_2 = S_1 \times \frac{T_1}{T_2} = 4 \times \frac{10 \times 20}{40 \times 10} = \frac{800}{400} = 2 \text{ rps}$$

Almost any increase or decrease in speed can be obtained by choosing the correct gears for the job. For example, the turbines on a ship have to turn at high speeds—say 5800 rpm—if they are going to be efficient. But the propellers, or screws, must turn rather slowly—say 195 rpm—to push the ship ahead with maximum efficiency. So, a set of reduction gears is placed between the turbines and the propeller shaft.

When two external gears mesh, they rotate in opposite directions. Often you will want to avoid this. Put a third gear, called an idler, between the driver and the driven gear. But do not let this extra gear confuse you on speeds. Just neglect the idler entirely. It does not change the gear ratio at all, and the formula still applies. The idler merely makes the driver and its driven gear turn in the same direction. Figure 10-23 shows you how this works.

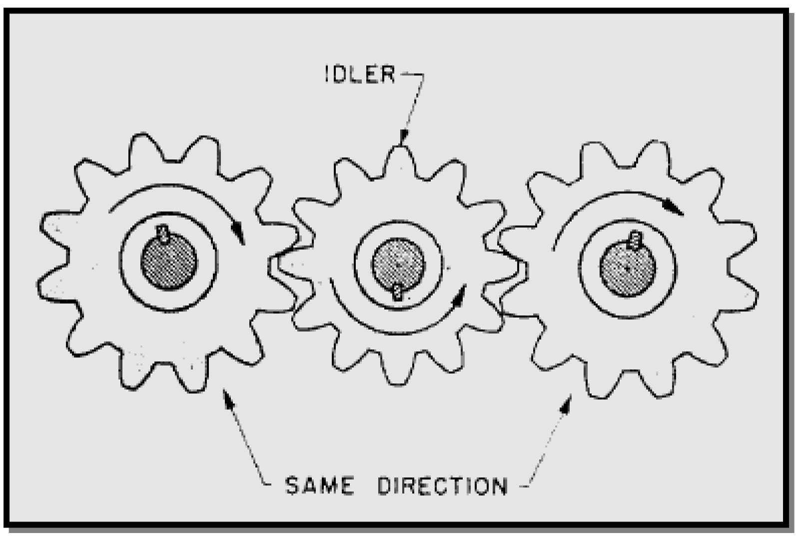


Figure 10-23.—An idler gear.

10.10.0 MAGNIFYING FORCE WITH GEARS

Gear trains are used to increase the M.A. In fact, wherever there is a speed reduction, the effect of the effort you apply is multiplied. Look at the cable winch in figure 10-24. The crank arm is 30 inches long, and the drum on which the cable is wound has a 15-inch radius. The small pinion gear has 10 teeth, which mesh with the 60 teeth on the internal spur gear. You will find it easier to figure the M.A. of this machine if you think of it as two machines.

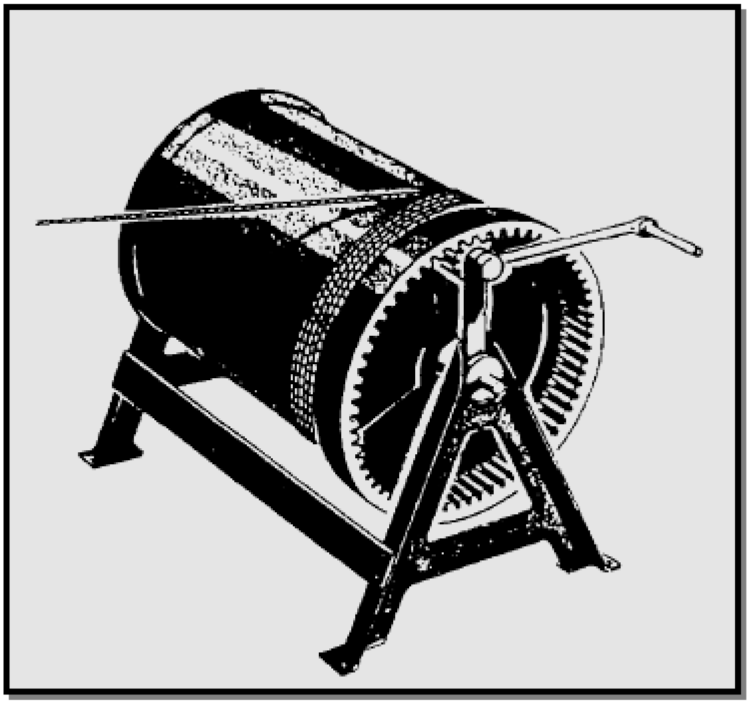


Figure 10-24.—Cable winch.

First, figure out what the gear and pinion do for you. The theoretical M.A. of any arrangement of two meshed gears can be found by using the following formula:

$$\text{M.A.(theoretical)} = \frac{T_o}{T_a}$$

In which,

To= number of teeth on driven gear
Ta= number of teeth on driver gear

In this case,

$$T_o = 60 \text{ and } T_a = 10$$

Then,

$$\text{M.A. (theoretical)} = \frac{T_o}{T_a} = \frac{60}{10} = 6$$

Now, the theoretical arrangement for the other part of the machine, which is a simple wheel-and-axle arrangement consisting of the crank arm and the drum, can be found by dividing the distance the effort moves—2R—in making one complete revolution, by the distance the cable is drawn up in one revolution of the drum—2r.

The total or overall, theoretical M.A. of a compound machine is equal to the product of the M.A. of the several simple machines that make it up. In this case, you considered the winch as being two machines—one having an M.A. of 6 and the other an M.A. of 2. Therefore, the overall theoretical M.A. of the winch is 6 x 2, or 12. Since friction is always present, the actual M.A. may be only 7 or 8. Even so, by applying a force of 100 pounds on the handle, you could lift a load of 700 to 800 pounds.

10.11.0 THE GEAR DIFFERENTIAL

As you have seen, gears have a variety of functions, and as an IC Electrician, you will work with all types of gear trains. One type of gear train that is used extensively is the gear differential. It is capable of adding and subtracting mechanically. The gear differential adds the total revolutions of two shafts, or subtracts the total revolutions of one shaft from the total revolutions of another shaft, and delivers the answer by positioning a third shaft. The gear differential will add or subtract any number of revolutions, or small fractions of revolutions, continuously and accurately.

Figure 10-25 is a cutaway drawing of a bevel gear differential, showing all its parts and how they are related to each other. Grouped around the center of the mechanism are four bevel gears, meshed together. The two bevel gears on either side are called end gears. The two bevel gears above and below are called spider gears. The long shaft running through the end gears and the three spur gears is called the spider shaft. The short shaft running through the spider gears, together with the spider gears themselves, is called the spider.

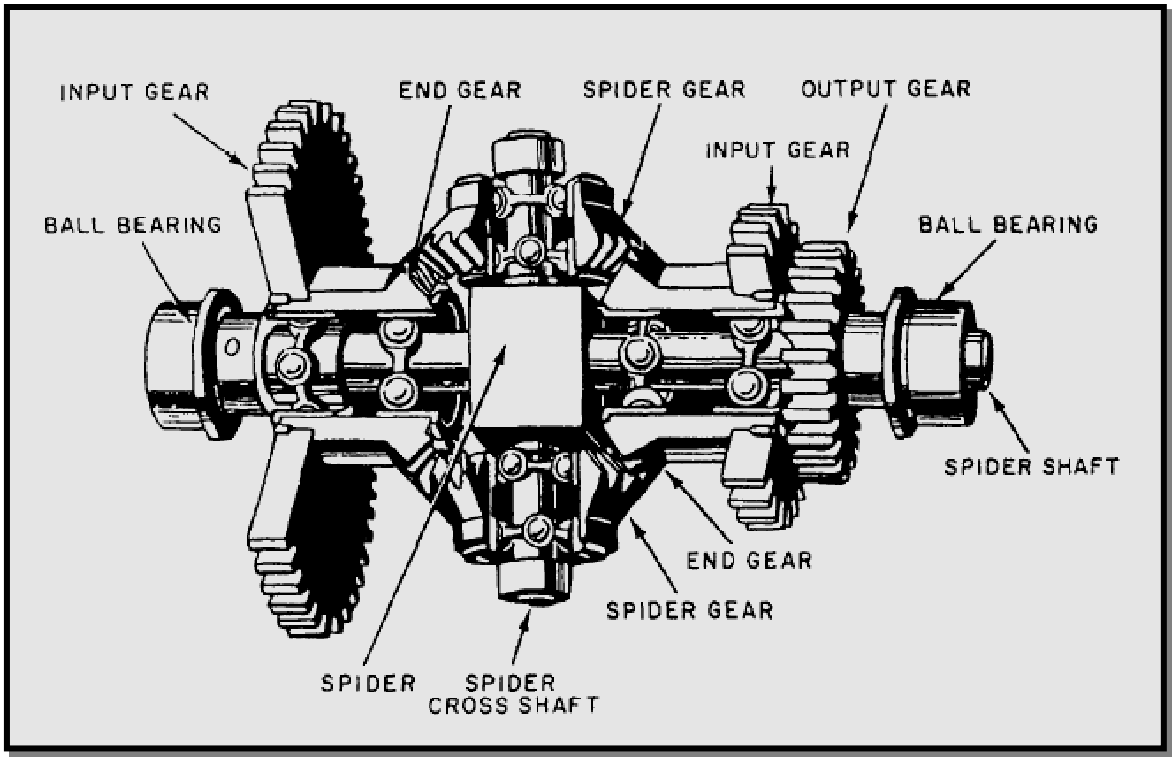


Figure 10-25.—Bevel gear differential.

Each of the spider gears and the end gears are bearing mounted on their shafts and are free to rotate. The spider shaft is rigidly connected with the spider cross shaft at the center block where they intersect. The ends of the spider shaft are secured in flanges or hangers, but they are bearing mounted and the shaft is free to rotate on its axis. It follows then that to rotate the spider shaft, the spider, consisting of the spider cross shaft and the spider gears, must tumble, or spin, on the axis of the spider shaft, inasmuch as the two shafts are rigidly connected.

The three spur gears shown in figure 10-25 connect the two end gears and the spider shaft to other mechanisms. They may be of any convenient size. Each of the two input spur gears is attached to an end gear. An input gear and an end gear together are called a side of a differential. The third gear is the output gear (as designated in fig. 10-25). This is the only gear that is pinned to the spider shaft. All of the other gears, both bevel and spur, in the differential are bearing mounted.

Figure 10-26 is an exploded view of a gear differential showing each of its individual parts, and figure 10-27 is a schematic sketch showing the relationship of the principle parts.

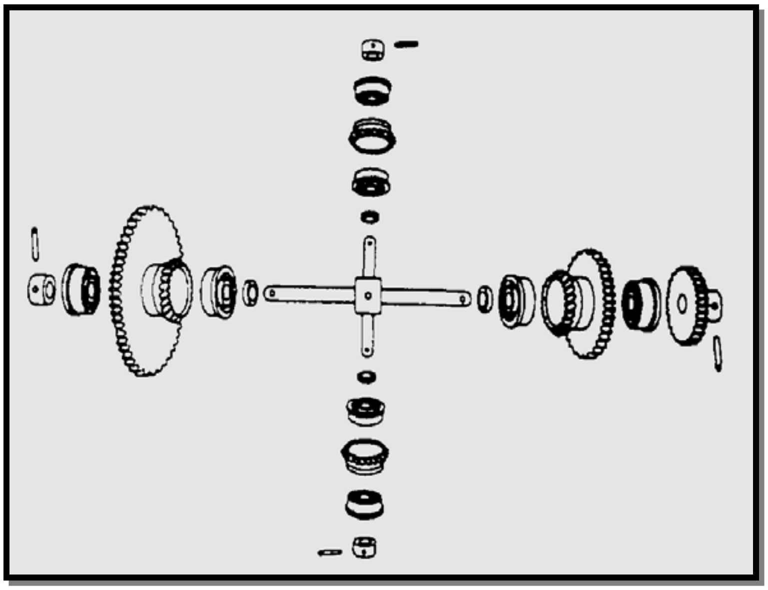


Figure 10-26.—Exploded view of a differential gear system.

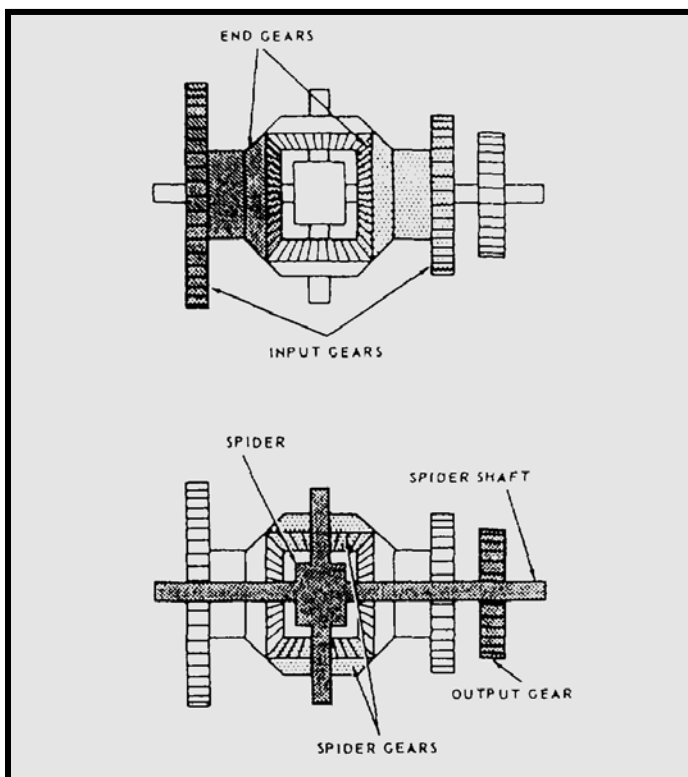


Figure 10-27.—End gears and spider arrangement of a differential.

For the present, we will assume that the two sides are the inputs, and the gear on the spider shaft is the output. Later, it will be shown that any of these three gears can be either an input or an output. Now, look at figure 10-28. In this hookup, the two end gears are positioned by the input shafts, which represent the quantities to be added or subtracted. The spider gears do the actual adding and subtracting. They follow the rotation of the two end gears, turning the spider shaft a number of revolutions proportional to the sum, or difference, of the revolutions of the end gears.

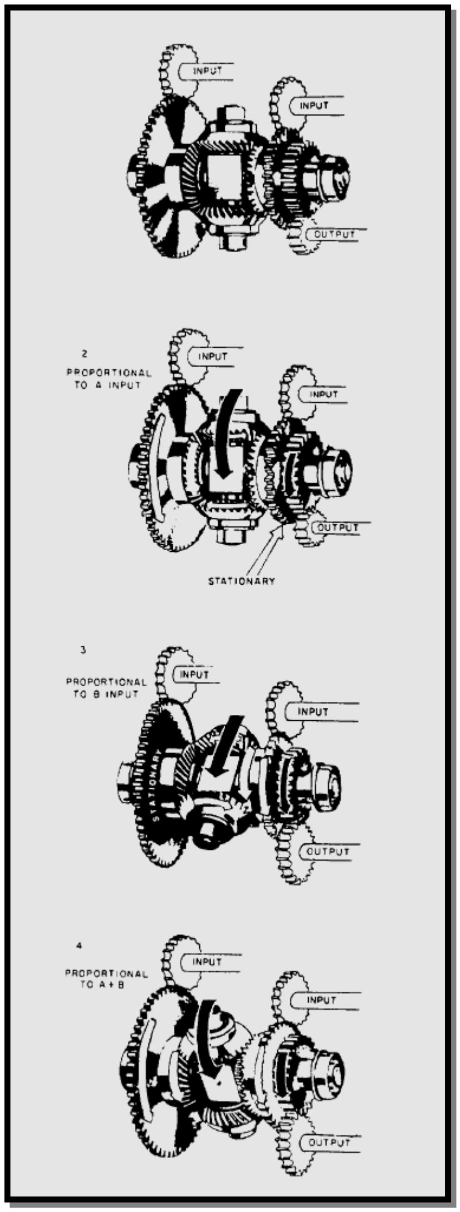


Figure 10-28.—How a differential works.

Suppose the left side of the differential is rotated while the other remains stationary (as in block 2 of fig. 10-28). The moving end gear will drive the spider gears, making them roll on the stationary right end gear. This motion will turn the spider in the same direction as the input and, through the spider shaft and output gear, the output shaft. The output shaft will turn a number of revolutions proportional to the input.

If the right side is now rotated and the left side held stationary (as in block 3 of fig. 10-28), the same thing will happen. If both input sides of the differential are turned in the same direction at the same time, the spider will be turned by both at once (as in block 4 of fig. 10-28). The output will be proportional to the sum of the two inputs. Actually, the spider makes only half as many revolutions as the sum of the revolutions of the end gears, because the spider gears are free to roll between the end gears. To understand this better, look at figure 10-29.

Here a cylindrical drinking glass is rolled along a table top by pushing a ruler across its upper side. The glass will roll only half as far as the ruler travels. The spider gears in the differential roll against the end gears in exactly the same way. Of course, the answer can be corrected by using a 2:1 gear ratio between the gear on the spider shaft and the gear for the output shaft. Very often, for design purposes, this gear ratio will be found to be different.

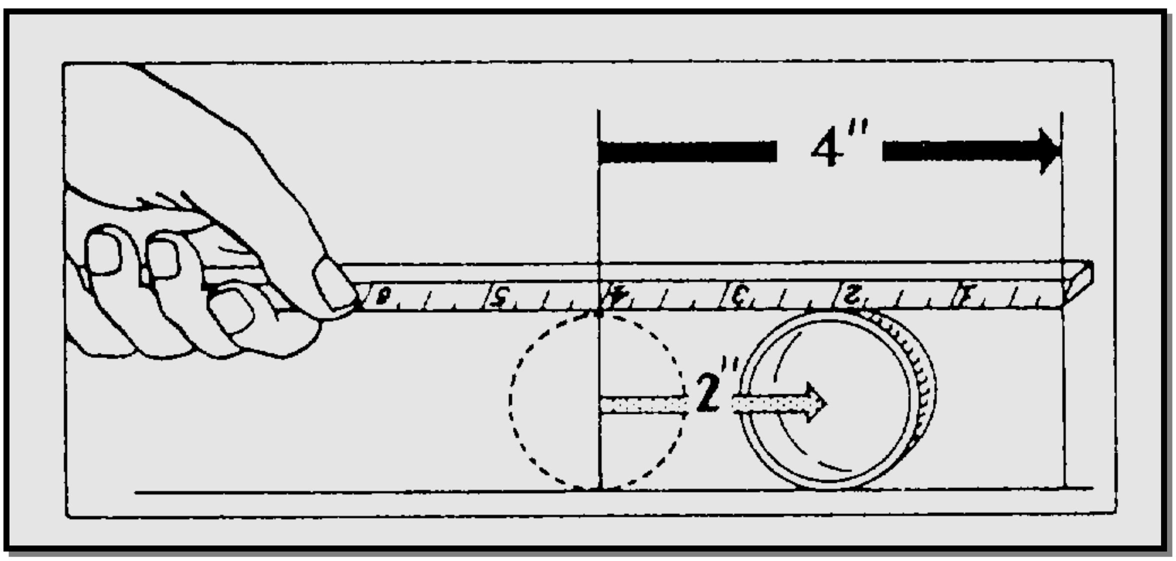


Figure 10-29.—The spider makes only half as many revolutions.

When the two sides of the differential move in opposite directions, the output of the spider shaft is proportional to the difference of the revolutions of the two inputs. This is because the spider gears are free to turn and are driven in opposite directions by the two inputs. If the two inputs are equal and opposite, the spider gears will turn, but there will be no movement of the spider shaft. If the two inputs turn in opposite directions for an unequal number of revolutions, the spider gears roll on the end gear that makes the lesser number of revolutions, rotating the spider in the direction of the input making the greater number of revolutions. The motion of the spider shaft will be equal to half the difference between the revolutions of the two inputs. A change in the gear ratio to the output shaft can then give us any proportional answer we wish.

We have thus far been describing a hookup wherein the two sides are inputs and the spider shaft the output, as long as it is recognized that the spider follows the end gears for half the sum, or difference, of their revolutions. However, it is not necessary to always use this type of hookup. The spider shaft may be used as one input and either of the sides used as the other. The other side will then become the output. This fact permits three different hookups for any given differential (as is illustrated in fig. 10-30). Whichever proves the most convenient mechanically may be used.

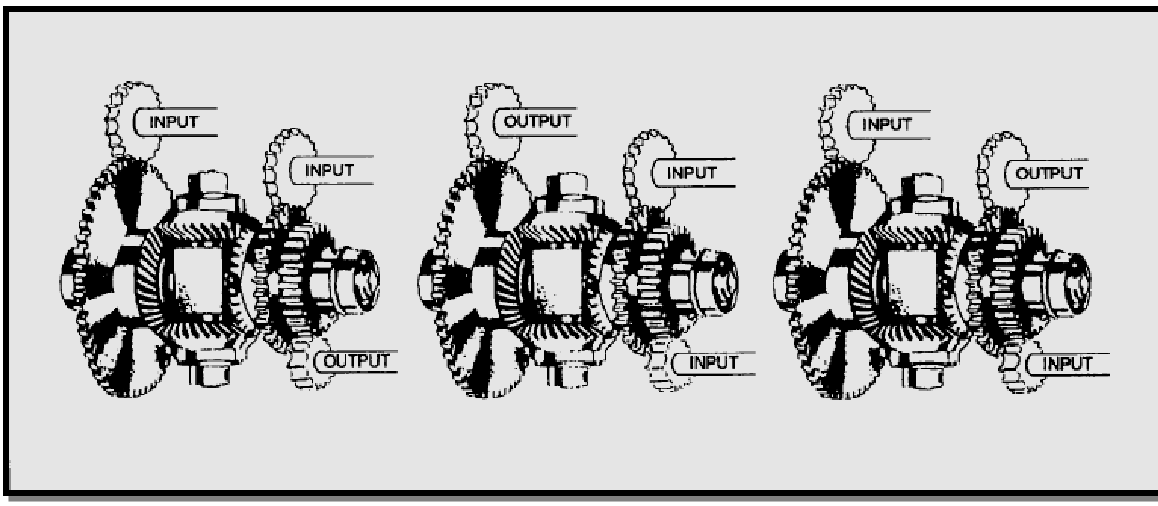


Figure 10-30.—Differentia1 hookups.

10.12.0 BASIC COMPUTER MECHANISMS

So far, we have discussed the various gears and what they can accomplish, and the gear differential, which is a simple analog computer. Next, we will discuss basic computer mechanisms. As in all complex machines, focus on the simple mechanisms that comprise the complex machine. An understanding of the simple mechanisms will enable you to understand how they enable the complex machine to perform its function.

The differentials used in analog computers are gear differentials similar to those we discussed previously, unlike the automotive differential, which receives two inputs and combines them to provide a single output. Most differentials used in computers are quite small, between 2 inches x 2 1/2 inches in size, and are designed for relatively light loads. Figure 10-31 illustrates the symbol used to indicate the differential in schematic drawings.

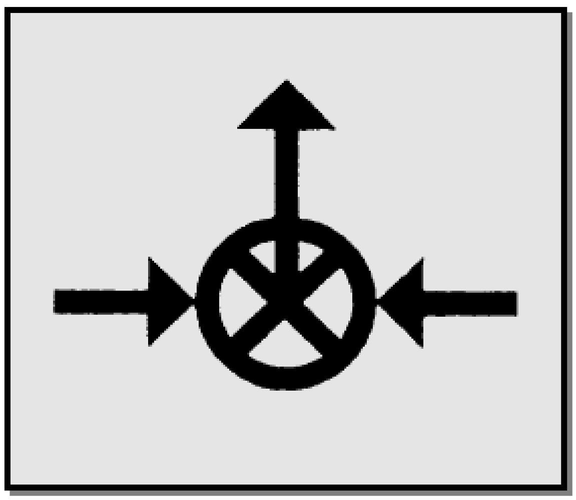


Figure 10-31.—Schematic drawing symbol for a differential.

Figure 10-32 shows one of the many applications of the gear differential in a computer. In this case, the differential is being used as an integral part of a follow-up control. Computing mechanisms are not designed to drive heavy loads. The outputs from such mechanisms often merely control the action of servomotors. The motors do the actual driving of the loads to be handled. The device that makes it possible for the comparatively weak output from a computing mechanism to control the action of a servomotor is called a follow-up control. In this device, the differential is used to measure the difference, or error, in position between the input and the output. The input is geared to one side of the differential. The servo output is used to do two things: (1) to position whatever mechanism is being handled, and (2) to drive the other side of the differential. This second operation is known as the servo response.

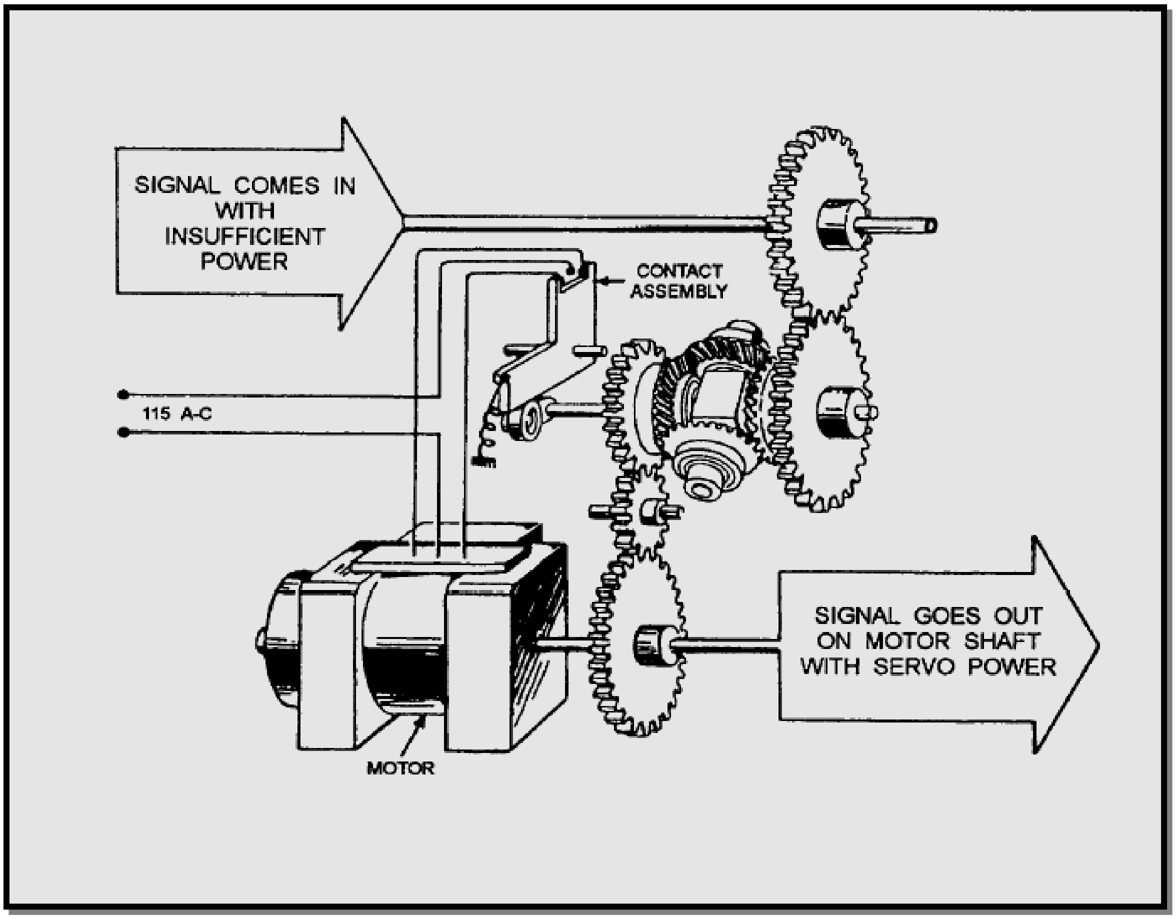


Figure 10-32.—Simplified sketch of a follow-up control showing application of a gear differential.

When there is a difference between the input and the output, the spider of the differential turns. As this happens, the spider shaft operates a set of controls which control the action of the servomotor in such a way that the motor drives its side of the differential in a direction opposite to that taken by the input. That is, the servo always drives to reduce the difference, or error, to zero.

While you may not work specifically with mechanical computers as an IC Electrician, you will see the various gears and linkages in many IC circuits. When working with mechanical gear trains, it will help to look for the simple machines within the equipment; this will help in the understanding of the whole complex machine and will enable you to more quickly isolate trouble areas.

10.13.0 METERING AND INDICATING SYSTEMS

Metering and indicating systems provide continuous information from remote sensors on the position, status, or condition of a particular system. The sensors used in metering and indicating systems include switches, salinity cells, mechanical linkages, synchros, pressure sensors, and various types of temperature sensors. Indicator panels used with the systems include meters, dials, lamps, and other indicators that provide a readout of the desired information. Some systems include alarms, which are actuated when predetermined conditions exist.

The operation of some of the various metering and indicating systems will be discussed in the following paragraphs.

10.13.1 Propeller Revolution Indicator System

The propeller revolution indicator system (circuit K) is used to indicate instantaneously and continuously the revolutions per minute, direction of rotation, and total revolutions of the individual propeller shafts. The information is indicated in the engine rooms, pilothouse, and other required locations.

There are two types of propeller revolution indicator systems, the synchro system and the magneto-voltmeter system. The synchro system is installed in large combatant ships and in many newly constructed small ships. The magneto-voltmeter system is less complicated and is installed in small ships. Only the synchro system will be discussed in this training manual.

A representative synchro-type propeller revolution indicator system installed in a DDG is discussed in the following paragraphs. The system consists of transmitters, indicator-transmitters, and indicators.

Transmitters

The transmitters, one for each propeller shaft, indicate the revolutions of the propeller shaft. They also transmit the speed and direction of rotation of the propeller shaft to the associated indicator-transmitter. The transmitters are installed on the actual propeller shaft usually near the reduction gear. They are electrically connected to indicator-transmitters located in their respective throttle stations.

Figure 10-33 is the gearing diagram of a transmitter. The transmitter consists of a running synchro transmitter, revolution counter, and contact assembly. These components, which are actuated by suitable gearing, are mounted in a watertight housing. The transmitter is either gear driven from the propeller shaft or is directly coupled to the end of a stub shaft of the propulsion machinery, as required by the particular installation. The synchro transmitter is always driven at twice the propeller speed in a constant clockwise direction.

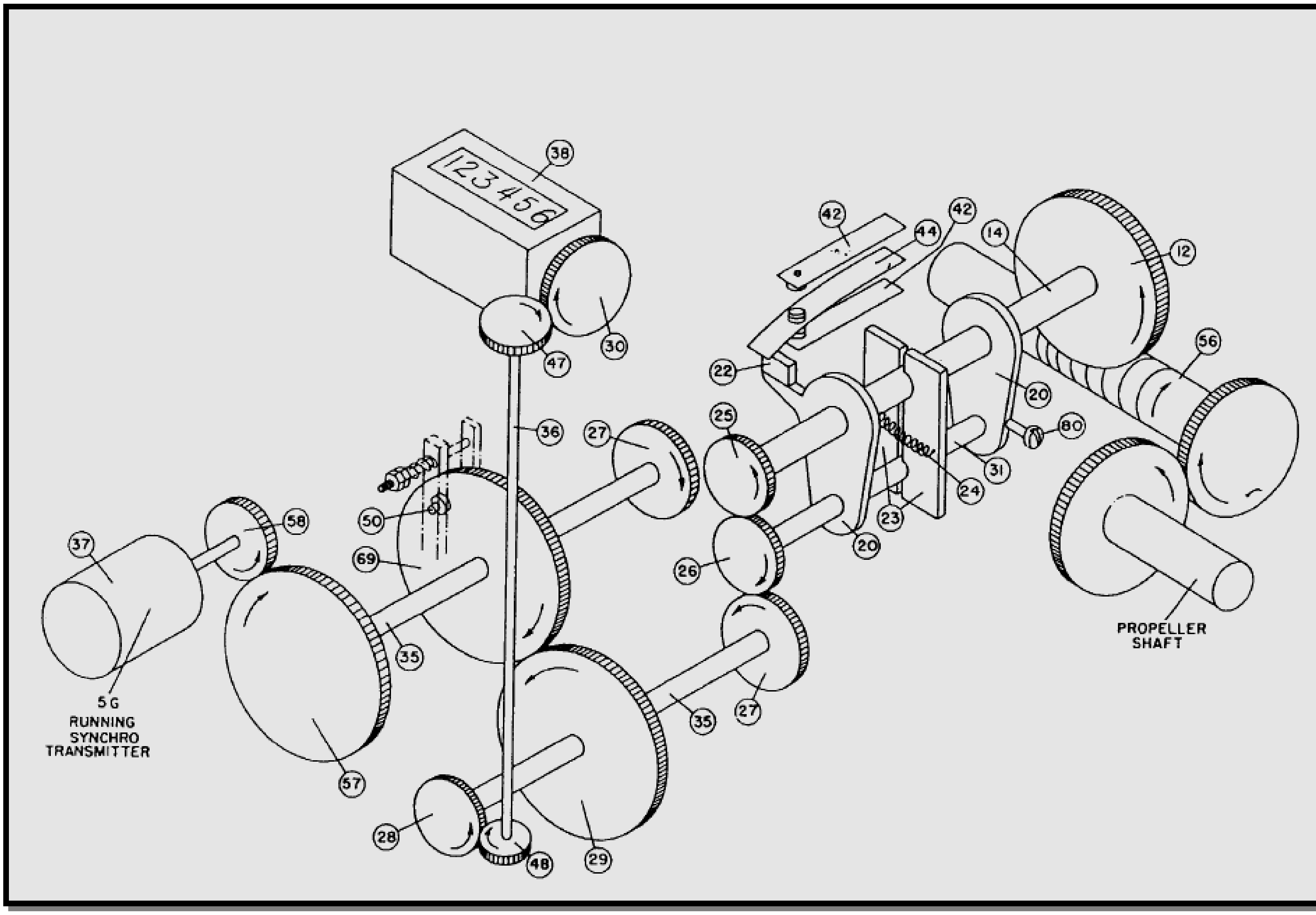


Figure 10-33.—Gearing diagram of a propeller revolution shaft transmitter

A drive worm, cut integral with shaft 56, meshes with worm gear 12, which is secured to shaft 14. The ratio is such that shaft 14 is driven at exactly one-tenth the propeller speed. Gear 25 is attached to shaft 14, and links 20 are free to swing on the shaft. The lower ends of links 20 support swinging shaft 31. Gear 26 is attached to shaft 31. Friction blocks 23 are held in contact with the hubs of gears 25 and 26 by spring 24. The friction blocks restrain the rotation of gears 25 and 26 and swing the links assembly, including shaft 31 and gear 26, in the direction of rotation of gear 25. This action engages gear 26 with one of the two gears 27, the selection depending on the direction of rotation of gear 25. Screws 80 limit the angular swing of the links assembly.

Gears 27 are secured to respective side shafts 35, which also carry gears 29 and 69. These gears are meshed and drive each other alternately, depending on which one of the two gears 27 is engaged with the swinging idler gear 26. Gears 29 and 69 do not reverse when the propeller shaft reverses because idler gear 26 reverses rotation each time it swings from side to side. The same is true for gears 28 and 57 because they are mounted on the hubs of gears 29 and 69, respectively. Gear 57 engages gear 58, which is mounted directly on the shaft of synchro transmitter 37. The overall gear ratio between transmitter shaft 56 and the shaft of the synchro transmitter is such that the synchro shaft is always driven at twice the propeller speed in a constant clockwise direction.

Revolution counter 38, which is driven at one-tenth the propeller speed, is driven through helical gears 28, 48, 47, and 30. The reading is directly in terms of propeller revolutions because each revolution of the counter shaft registers a count of 10. Brake shoes 50 prevent synchro transmitter 37 from driving counter 38 backward during brief periods of rapid speed reduction.

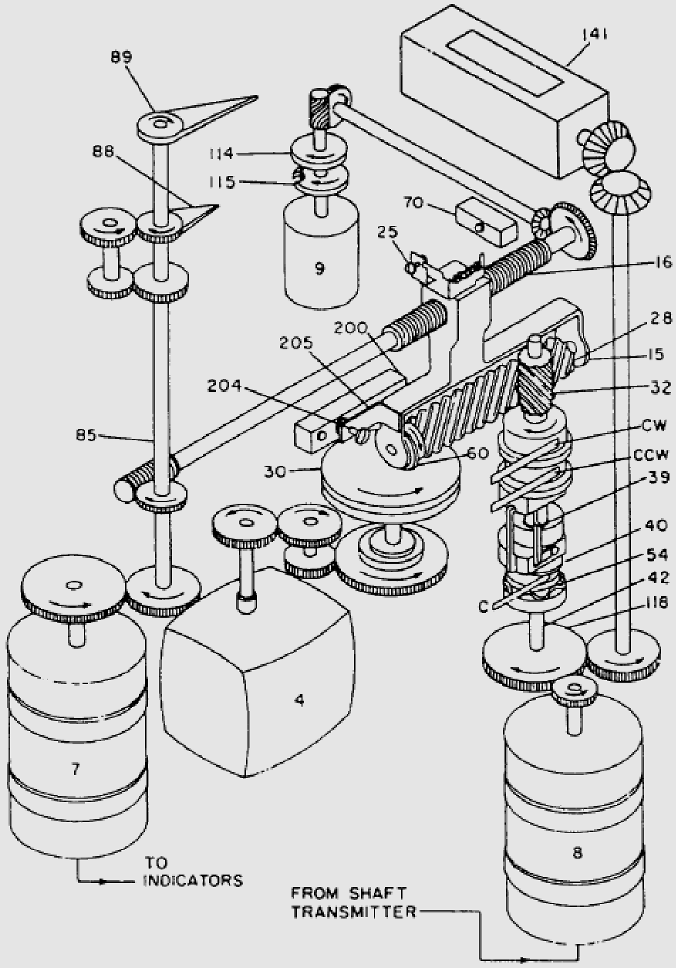
The contact assembly is actuated by small insulating block 22, attached to one of the swinging links 20. The block moves up and down as the link swings with reversals of driving rotation. This action moves center spring contact 44 from the bottom to the top stationary contact 42, and vice versa. The center contact and one of the stationary contacts energize the signal lights in the remote indicator when the propeller shaft rotates in the astern direction.

Indicator-Transmitters

The indicator-transmitter installed in each throttle station is used to convert the running speeds received from the associated shaft transmitters into angular synchro displacements, which are transmitted to the various indicators.

Figure 10-34 is the gearing diagram of an indicator-transmitter. The indicator-transmitter consists of a running synchro receiver, a speed-measuring mechanism, a positioning synchro transmitter, a revolution counter, two pointers, a dial, and a backing signal.

The two concentric revolving pointers indicate on a dual-marked fixed dial the output in rpm of the speed-measuring mechanism. The inner scale, marked for each 100 rpm only, is indexed by short pointer 88. The outer scale, calibrated from zero to 100 rpm with numerals for each 5 rpm, is indexed by long pointer 89. Positioning synchro transmitter 7 and pointers 88 and 89 are geared to friction roller 60 and follow-up motor 9. Long pointer 89 makes one complete revolution every 100 rpm, and short pointer 88 makes one complete revolution for full-scale indication. The relative direction of the speed is indicated by the backing signal indicator, which is lighted only when the propeller shaft rotates in the astern direction.



4 – Synchronous Motor
7 – Positioning Synchro Transmitter
8 – Running Synchro Receiver
9 – Followup Motor
15 – Traveling Yoke
16 – Lead Screw
25 – Switch Operating Screw
28 – Helical Gear
30 – Friction Disk
32 – Helical Gear
39 – Slip Ring and Contact Assembly
40 – Hub Assembly
42 – Input Shaft
54 – Spring Washer
60 – Friction Roller
70 – Limit Switch
85 – Pointer Shaft
88 – Inner Pointer
89 – Outer Pointer
114 – Driven Disk
115 – Drive Disk
118 – Input Gear
141 – Mechanical Counter
200 – Speed Signal Switch
204 – Actuator Screw
205 – Bracket

Figure 10-34.—Gearing diagram of an indicator-transmitter.

Running synchro receiver 8 is driven electrically by the associated shaft transmitter at a speed exactly one-tenth that of the propeller shaft. The running synchro drives the input shaft of the speed-measuring mechanism through gear 118. The speed-measuring mechanism converts the rotary motions into proportional angular displacements, Running synchro 8 also drives revolution counter 141 through gears at a speed exactly one-tenth that of the propeller speed. The revolution counter registers the total propeller revolutions directly, irrespective of the direction of rotation.

Positioning synchro transmitter 7 receives the angular displacement from the speed-measuring mechanism and transmits these displacements to the remotely located indicators.

The speed-measuring mechanism operates on the friction disk and roller assembly principle; that is, if a disk is driven by a synchronous motor supplied with a controlled frequency, the disk will run at a constant speed irrespective of fluctuations of the ship's supply frequency. A roller placed in the center of the rotating disk will not turn.

However, if the roller is moved out from the center of the disk, the roller will turn at a speed that is proportional to the distance from the center of the disk. For example, if the roller is moved out one-half inch from the center of the disk, the roller runs at twice the speed at which it ran when moved one-fourth inch from the center of the disk. If the position of the roller on the disk is varied, the speed of the roller is varied in direct proportion to the distance the roller is positioned from the center of the constant-speed disk.

The friction disk and roller assembly also operates on the principle of comparing an unknown speed with a known speed. The known speed in this case is provided by synchronous motor 4, which drives friction disk 30 through gears at a constant speed. The gearing is such that the disk speed is 16 2/3 rpm for 200 range units and 33 1/3 rpm for 400 range units. The friction disk is held in continuous contact with friction roller 60, which is integral with helical gear 28. The friction roller and helical gear are mounted on traveling yoke 15, which has a total longitudinal motion of approximately 1.10 inches along the radius of friction disk 30. The yoke is positioned along the disk radius by lead screw 16, which is driven by follow-up motor 9.

Friction roller 60, integral with helical gear 28, drives helical gear 32, which is mounted on but free to turn through a limited range about, input shaft 42. Thus, the helical gear rotates at a speed proportional to the distance between the position of the roller on the disk and the center of the disk. The radius of contact at any given point will determine the drive ratio and speed at which roller 60, and gears 28 and 32 will rotate.

The speed of helical gear 32 is automatically adjusted to match the speed of running synchro driven gear 118 by the slip ring and contact assembly 39, the upper two slip rings of which are mounted on the hub of gear 32 and are free to turn through a limited range about input shaft 42. The assembly carries two outside brush contacts, CW and CCW, each of which slides on a slip ring. The center brush contact, C, slides on a slip ring, which is attached to hub 40 and is secured to input shaft 42 by friction thrust washer 54. The contact assembly can be turned in either direction so that one or the other of the outside contacts can mate with the center contact. This action energizes follow-up motor 9 and determines its direction of rotation.

When input gear 118 and helical gear 32 are running at exactly the same speed, the contacts are open, follow-up motor 9 is de-energized, and indicator pointers 88 and 89 are stationary. However, if the speed of gear 118 changes, follow-up motor 9 is energized and drives lead screw 16, which moves yoke 15, in or out, depending on the direction of rotation, If the speed of gear 118 is faster than the original balanced speed, the CW contacts close and, if the speed is lower, the CCW contacts close. The contacts will remain closed to energize the follow-up motor in a correcting direction until the radius of disk contact with roller 60 reaches a new value where the speed of gear 32 is again equal to that of gear 118. At this point, the contacts open to de-energize the follow-up motor.

At zero (rpm) input from running synchro receiver 8, gear 118 is stationary and the contacts of the slip ring assembly will cause follow-up motor 9 to move lead screw 16, forging friction roller 60 toward the center of friction disk 30. At the exact center, indicator pointers 88 and 89 should read zero rpm, and positioning synchro transmitter 7 should be on electrical zero. However, the pointers will not reach the exact scale zero because a limiting switch (not shown in fig. 10-34) de-energizes synchronous motor 4 at a pointer indicator of approximately 1 rpm.

The full-scale indication should occur when the point of roller contact is exactly 1 inch from the center of disk 30. The indicators provide for an overspeed indication of about 10 percent above full scale (1.10 inches disk radius) before limit switch 70 is actuated.

The indicator-transmitter can be provided with speed signal switch 200 to continuously energize a remote light or other signal at propeller speeds below a specified value.

The signal setting is adjustable from about one-quarter of full speed down to about 5 rpm. As the speed of the propeller shaft decreases from higher value above the switch operating point, yoke 15, bracket 205, and actuator screw 204 are advanced along lead screw 16, until the roller and arm of stationary single-pole, double-throw (SPDT) switch 200 are lifted by actuator screw 204. The speed value at which the switch is operated is determined by the height of actuator screw 204, above bracket 205. The speed signal switch is adjusted by turning the actuator screw until the desired operating point is obtained. After the switch has been actuated in decreasing speed direction, it will remain actuated at lower speeds down to zero. Also, when the propeller speed increases, the OFF or release point of the switch will occur at a value slightly above the ON speed value in a decreasing direction because of the operating differential inherent in microswitch 200.

Indicators

Indicators are installed in the pilothouse and engine rooms to indicate the rpm of the associated propeller shaft. An indicator consists of a positioning synchro receiver and a revolving pointer that indicates on a dial the rpm of the associated propeller shaft. The synchro receiver is driven by the positioning synchro transmitter in the associated indicator-transmitter unit. The indicator is also provided with a backing signal that is energized by the unidirectional mechanism in the shaft transmitter when the propeller shaft rotates in the reverse direction.

10.14.0 UNDERWATER LOG SYSTEM

The underwater log system (circuit Y) measures and indicates the speed of the ship in knots and the distance traveled through the water in nautical miles.

There are several types and many configurations of underwater log systems. One type uses a removable rodmeter and the other type uses a fixed rodmeter. The major components of this system (fig. 10-35) (MK 6 Mod 0 is shown) are the sea valve, rodmeter, indicator transmitter, and remote control unit.

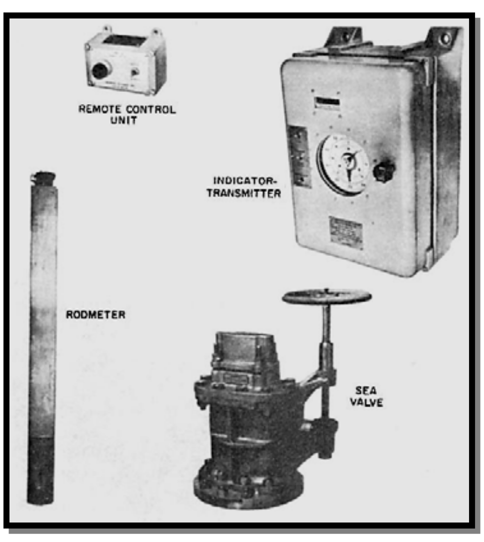


Figure 10-35.—Major components of a MK 6 Mod 0 underwater log system.

Sea Valve

Mounted in the hull of the ship, the sea valve and packing assembly (fig. 10-36) provides a watertight support for the rodmeter. It also functions to seal the hull of the ship when the rodmeter is removed. The sea valve has no function relating to the production, transmission, flow, or conversion of data in the underwater log system.

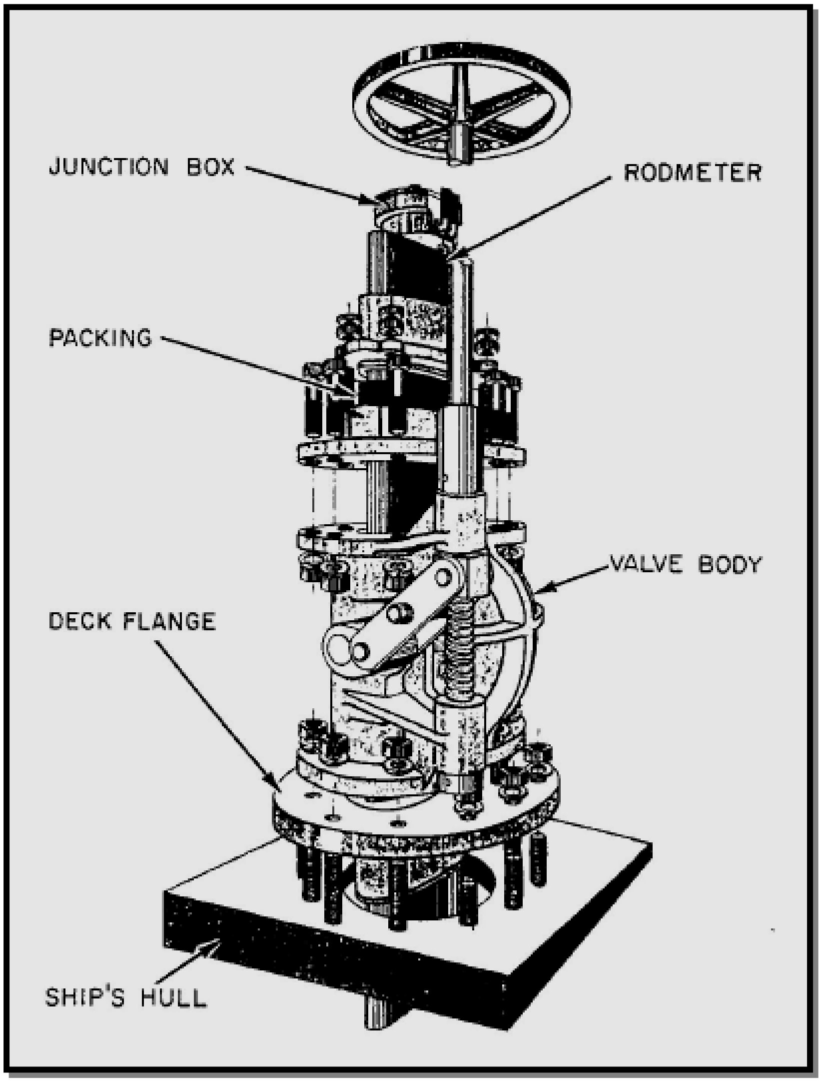


Figure 10-36.—Exploded view of the sea valve and packing assembly with the rodmeter installed.

Rodmeter

The rodmeter (fig. 10-37), or sword as it is commonly called, provides an ac signal that is proportional to the ship's speed. The sensing unit (fig. 10-38) of the rodmeter is contained in a boot at its lower end. The rodmeter operates on the principle of electromagnetic induction; that is, when a conductor is made to move in a magnetic field so that it cuts through the lines of flux, an electromotive force (emf) is induced in the conductor. In the case of the rodmeter, a 60-Hz current is supplied to a coil in the boot of the rodmeter. As the current flows through the coil, a magnetic field is produced that surrounds the rodmeter. The water, the conductor in this instance, flows around the rodmeter and cuts through the magnetic field. The induced voltage is felt at the contacts, or buttons, on either side of the rodmeter. The magnitude of the induced voltage is proportional to the speed of the water flowing through the magnetic field. Even when the ship is stationary, a current flowing around the rodmeter will cause a voltage to be induced.

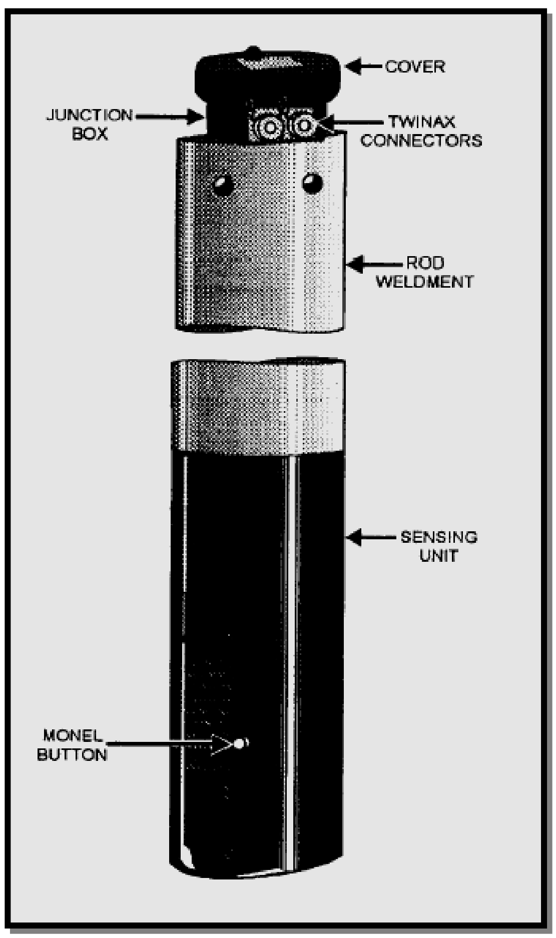


Figure 10-37.—Rodmeter.

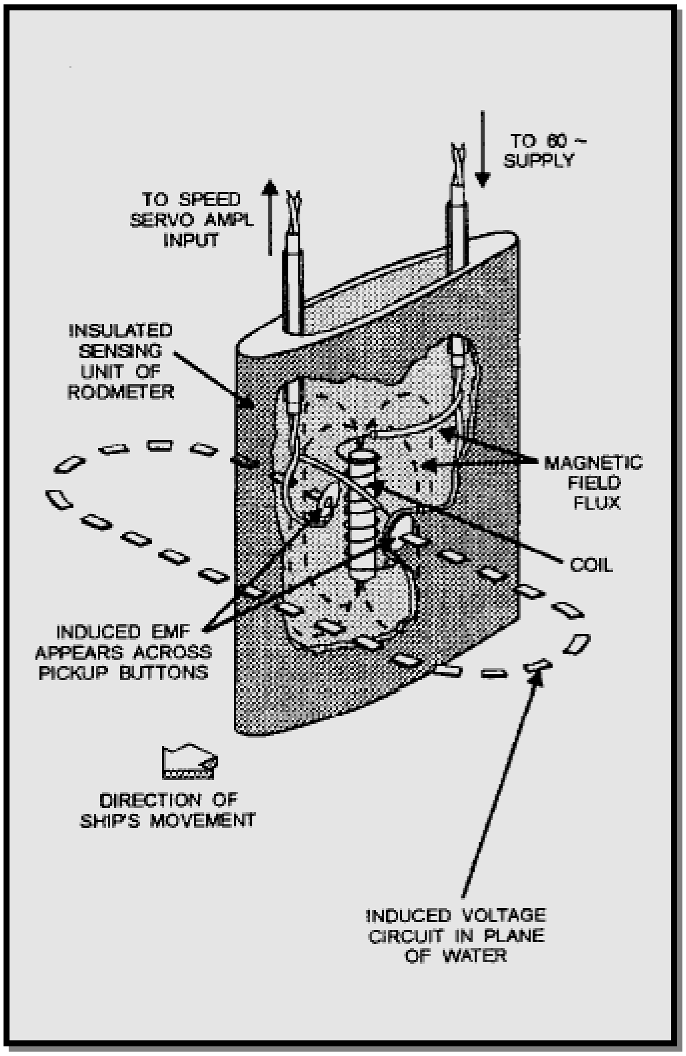


Figure 10-38.—Rodmeter sensing unit.

Indicator-Transmitter

The indicator-transmitter displays the ship's speed on a dial or digital display and the distance on a counter and transmits speed and distance information to various equipment and remote indicators throughout the ship.

The main internal components of the indicator transmitter are the speed servo, the integrator, and the distance servo. The main external components of the indicator-transmitter are a distance motor, a speed dial, a distance counter, an electronic trim pot assembly, and a dummy signal unit.

The ac signal voltage produced by the rodmeter is fed to the speed servo. The speed servo drives the synchro output transmitters, the dual-pointer dial, and the integrator. The integrator converts the speed input to a distance-traveled output, which drives a synchro output transmitter and a six-drum counter to display distance traveled.

Remote Control Unit

The remote control unit, or dummy log as it is commonly called, is used in place of the rodmeter when the ship is operating in shallow water, where lowering the rodmeter is impractical. The unit is normally located in the main propulsion control station. The unit has a spring-loaded, center-off, increase-decrease switch and is operated by the throttleman. The shaft rpm is used to determine approximate ship's speed.

10.15.0 ELECTROMAGNETIC LOG VOLTAGE SIMULATOR (ELVS) MK 1 MOD 0

The Electromagnetic Log Voltage Simulator Mk I, Mod 0 (ELVS) (figure 10-39) is intended for use by personnel involved with the operation or maintenance of electromagnetic (EM) log systems used to measure a ship's speed and distance traveled relative to water. The purpose of this information is to provide personnel with potential uses when adjusting and troubleshooting the EM log system.

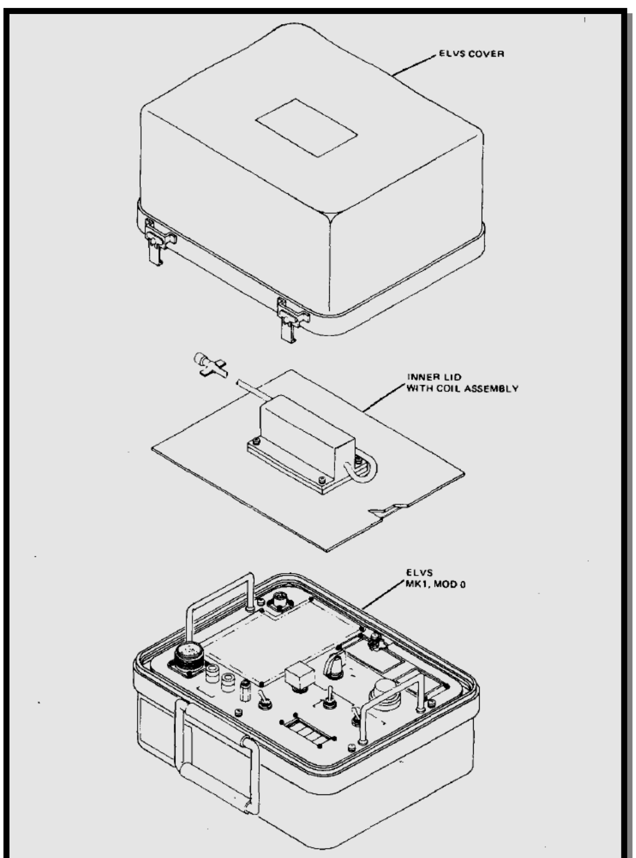


Figure 10-39.—Electromagnetic Log Voltage Simulator Mk 1 Mod 0 (ELVS).

The EM log system used on surface ships and submarines is a system which senses ship's speed through the water by electromagnetic induction and displays and transmits signals representing speed and distance traveled relative to water. Accurate operation of the EM log system requires that the complete shipboard system be calibrated to correct for variations in individual sensors and the ship's hull. SHIPS MUST REPEAT THIS CALIBRATION PERIODICALLY TO ENSURE CONTINUED SYSTEM ACCURACY.

Although the ELVS cannot take the place of a measured range calibration, it can perform many functions essential to maintaining the accuracy of a calibrated system. For example, the accuracy of a system is sometimes degraded when some of its electronic components become degraded or when they are replaced by new ones. The simulator can be used as a comparison standard to determine whether any changes in the log system electronics have reduced its accuracy.

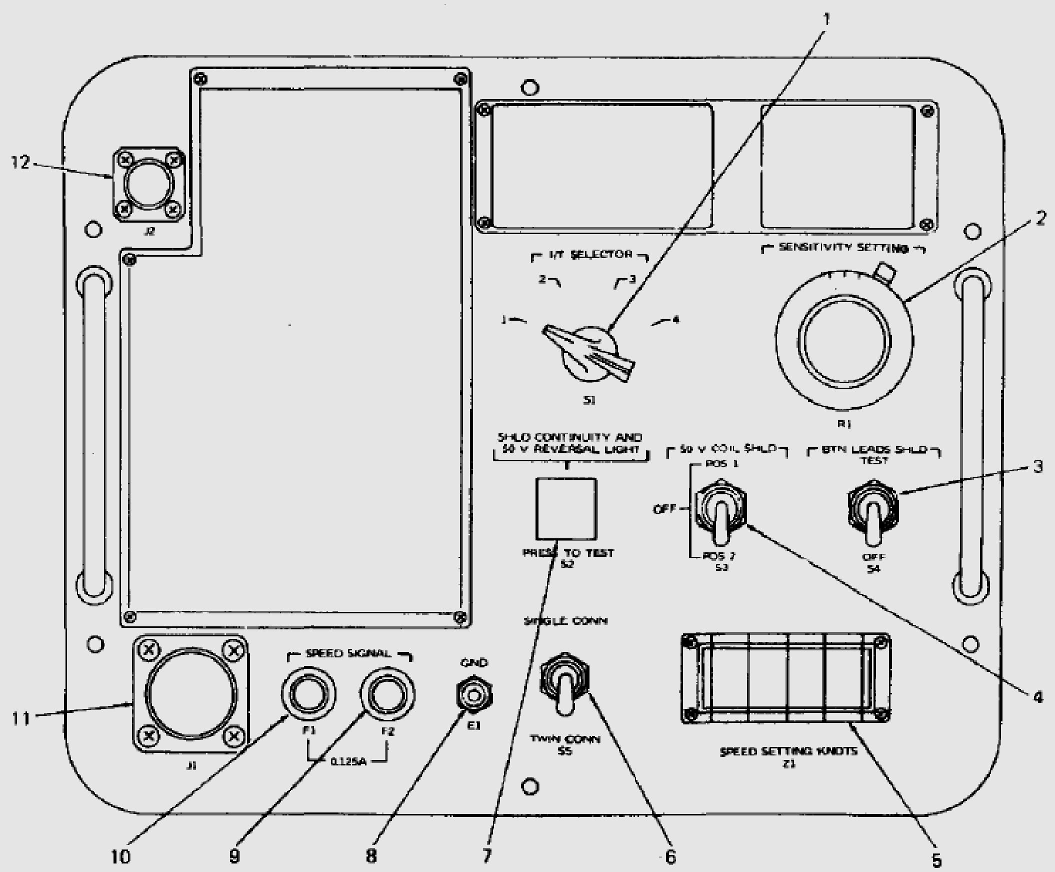
10.15.1 Equipment Description

The ELVS is a self-contained portable unit with its own carrying case and consists of a control panel, eight adapter cables, one input cable, one ground cable, and a calibration graph.

The ELVS provides a simulated speed signal to the input of the Indicator/Transmitter (I/T) and may be connected directly to the input of the I/T or the rodmeter switching unit, the junction box, or to any of the cables at the junction box or rodmeter. To accommodate all log system models, the ELVS supplied adapter cables and input cable permit connection to any I/T, associated rodmeter cable(s) and switching units.

10.15.2 ELVS Interior

The interior of the ELVS contains the miscellaneous wiring and cabling to the components. The front panel assembly may be lifted out for servicing and to give access to wiring components, switches, and lamp sockets.



1. I/T SELECTOR SWITCH.
2. SENSITIVITY SETTING DIAL
3. BTN LEADS SHLD SWITCH
4. 50V COIL SHLD SWITCH
5. SPEED SETTING–KNOTS–THUMBWHEEL SWITCHES
6. SINGLE CONN–TWIN CONN SWITCH
7. SHLD CONTINUITY AND 50V REVERSAL LIGHT INDICATOR
8. GND E1 CONNECTION TERMINAL
9. SPEED SIGNAL–F2 FUSE
10. SPEED SIGNAL–F1 FUSE
11. J1 INPUT/OUTPUT CONNECTOR
12. J2 EXTERNAL COIL INPUT CONNECTOR

Figure 10-40.—ELVS Controls and Indicators.

Control or Indicator	Ref Desig	Position or Condition	Function
I/T SELECTOR	lAlSl	 1 2 3 4	Selects proper input/output signal phase relationships for various log system manufacturers: Litton or Pitometer Control Instrument Chesapeake or McKiernan-Terry Auxiliary test position.
SENSITIV ITY SETTING	lAlRl		Adjusts the simulated rodmeter output signal over a range of 292.5 to 357.5~ V/Kn/0.75A (should be adjusted to sensitivity setting stamped in rodmeter meter base when used aboard ship). If rodmeter sensitivity is unknown, use setting for 325~V/Kn/0.75A.
BTN LEADS SHLD TEST	lAlS4	BTN LEADS SHLD TEST	Verifies continuity of rodmeter button lead shields.
50V COIL SHLD	lAlS3	POS 1 or POS 2	Checks shield continuity of 50V coil wires.
SPEED SETTING -KNOTS	lAlZl		A thumbwheel switch used for setting a simulated speed signal at any value between 00.00 and 99.99 knots.
SINGLE CONN-TWIN CONN	lA1S5	SINGLE CONN or TWIN CONN	Switch position selection depending upon manufacturer of log system. Connects shield within ELVS.
SHLD CONTINUITY and 50V REVERSAL LIGHT	lAlS2	PRESS TO TEST	Depressing the indicator button verifies the operation of the lamp and assures 50V available from I/T. During system operation, the lamp lights if the shield grounds are normal when tested.
GND	lAlEl		Binding post used to connect external ground to ELVS chassis ground.

Table 10-1.—ELVS Controls and Indicators.

Control or Indicator	Ref Desig	Position or Condition	Function
SPEED SIGNAL fuses	lA1Fl, lAlF2		Protects speed output circuitry from inadvertent application of high external voltages.
Jl connector	lAlJl		This input/output connector receives a 50V input signal from the I/T under test and transmits the simulated speed signal to the I/T.
J2 connector	lAlJ2		Connects the external coil located in the ELVS case cover to the ELVS circuitry.

Table 10-1 (Cont'd).—ELVS Controls and Indicators.

10.16.0 UNDERWATER LOG EQUIPMENT MK 6 MOD 0-2 (ELECTROMAGNETIC TYPE)

This section provides information and contains physical and functional descriptions and procedures for the operation of the Underwater Log Equipment (Electromagnetic Type) E/M Log Mk 6, Mods 0, 1, and 2.

The E/M Log System Mk 6, Mods 0, 1, and 2 measures own-ship speed relative to water, and distance traveled from a given starling point. Speed in the range of 0 through 40 ± 0.05 knots is measured *by* a rodmeter and displayed by an indicator transmitter. Distance in the range of 0000.00 through 9999.99 nautical miles ±1 percent, is measured and displayed by an indicator transmitter.

10.16.1 Modes of Operation

The E/M Log System Mk 6, Mods 0, 1, and 2 has three modes of operation which are Underwater, Manual, and Dummy. The LOG MODE switch selects these modes. When the Underwater mode is selected and the maintenance TESTON/OFF switch (A4S4) is set to OFF, the main speed input is generated by the rodmeter. When and if, the TEST switch is set to ON, the main speed input is derived from the test potentiometer (A2R12).

When the Manual mode is selected, the operator is provided with a method to mechanically slew the Speed KNOTS dial using the MANUAL DRIVE handcrank When the Dummy mode is selected, the operator can use the DUMMY LOG INCREASE/DECREASE switch on the indicator transmitter or the INCREASE/ DECREASE switch on the *dummy* log remote control to electrically slew the Speed KNOTS dial to an estimated speed.

10.16.2 Basic Equipment

Figures 10-41 through 10-43 show the basic equipment units of the E/M Log System Mk 6, Mods 0, 1, and 2.

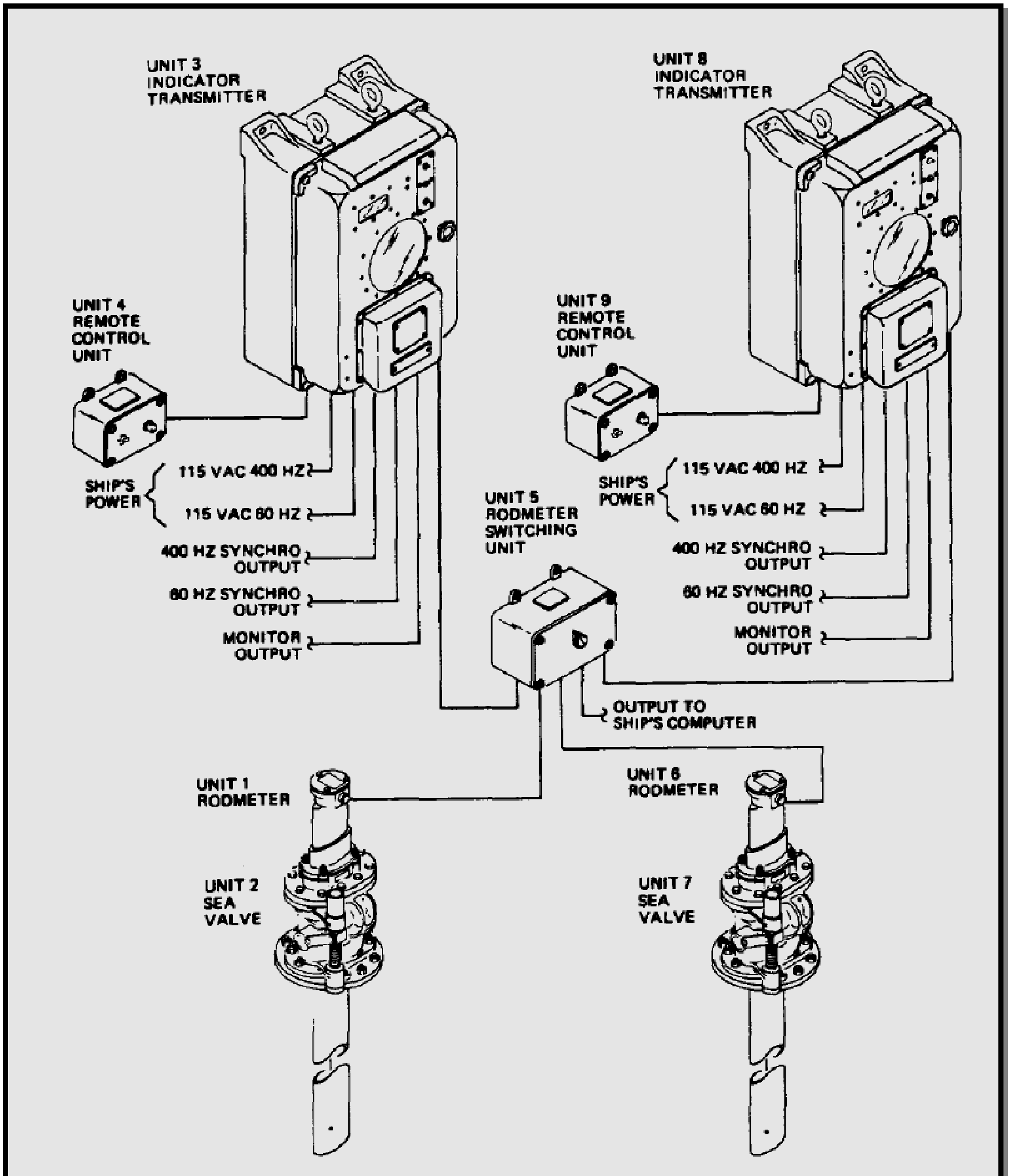


Figure 10-41.—Underwater Log Equipment (Electromagnetic Type), Relationship of Units (Typical Installation Mod 2).

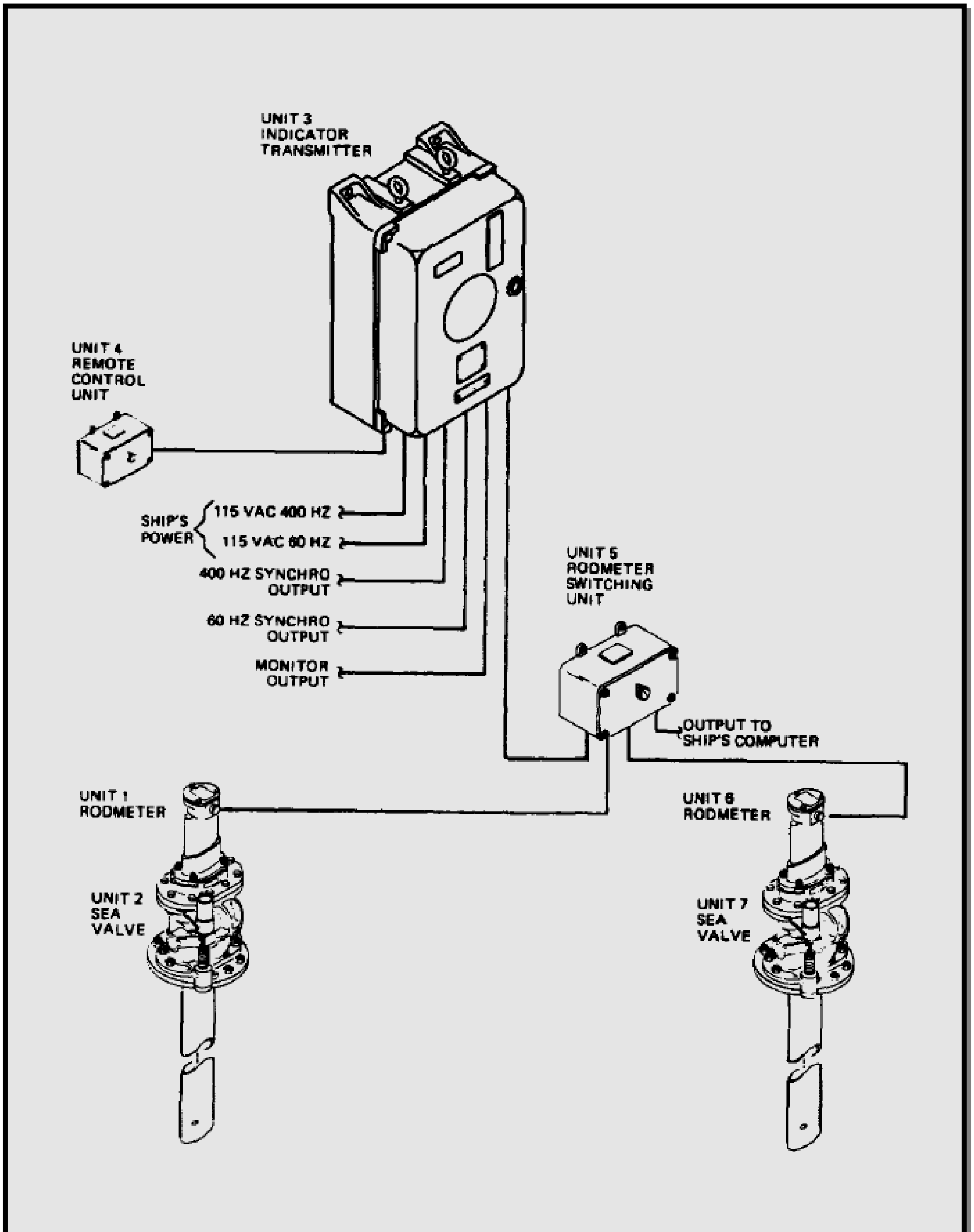


Figure 10-42.—Underwater Log Equipment (Electromagnetic Type), Relationship of Units (Typical Installation Mod 1).

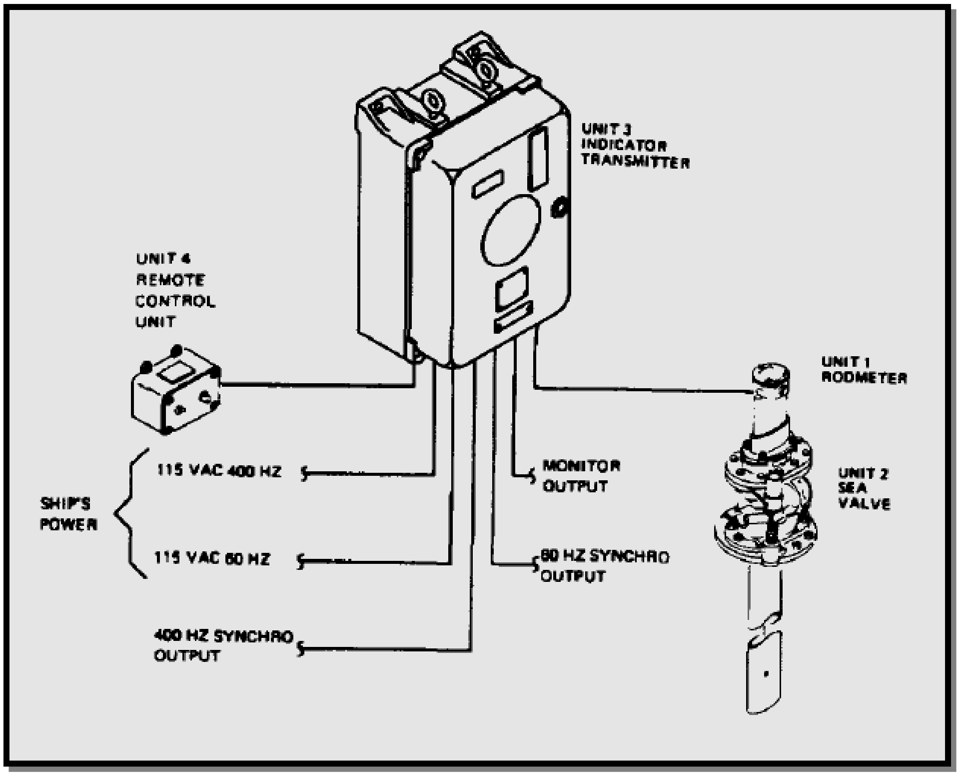


Figure 10-43.—Underwater Log Equipment (Electromagnetic Type), Relationship of Units (Typical Installation Mod 0).

10.16.3 Major Equipment Units

The paragraphs that follow describe the major units of equipment that comprise the E/M Log System Mk 6, Mods 0, 1, and 2.

Rodmeter and Sea Valve

A retractable rodmeter such as the one described in this manual and shown in figure 10-44 requires installation of a sea valve in the ship's hull. Fixed rodmeters, which are mounted on the outer surface of a ship's hull, are described later. The sea valve provides the means for passing the rodmeter into and out of the water with minimal leakage. When the rodmeter is in the water and receiving electric current, it develops a signal proportional to own-ship speed. The signal is relayed to the indicator transmitter for processing, display, and further transmission.

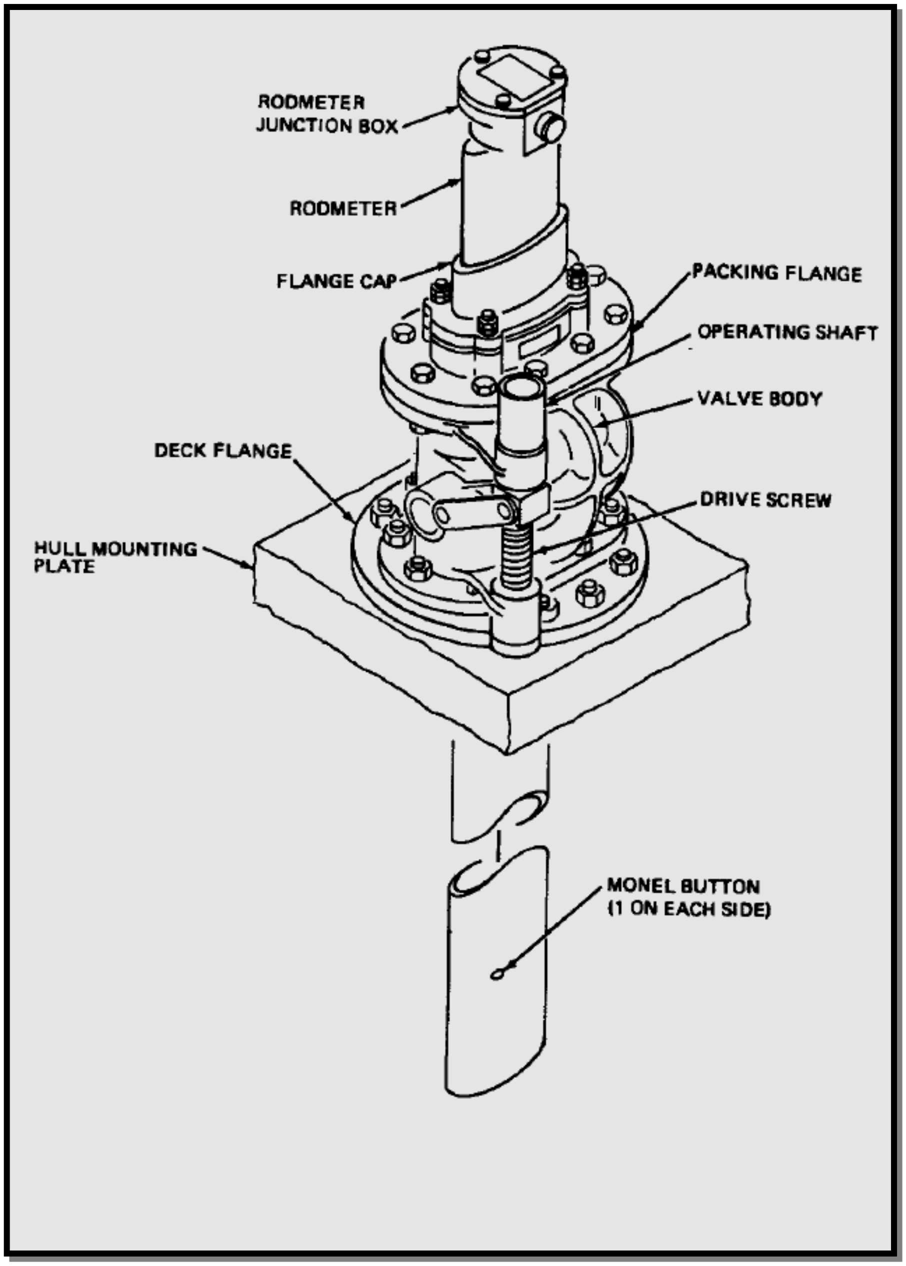


Figure 10-44.—Rodmeter and Sea Valve.

Rodmeter Switching Unit
This unit is used only with dual rodmeter installations (E/M Log System Mk6, Mods I and 2). In E/M Log System Mk6, Mod 1, (single indicator transmitter with dual rodmeter installation) the rodmeter switching unit permits selection of either RODMETER NO.1 or RODMETER NO.2 as the operational rodmeter. In E/M Log System Mk 6, Mod 2 (dual indicator transmitter and dual rodmeter installation) the rodmeter indicator transmitter is connected to its assigned (normal) rodmeter or ALTERNATE operation where the rodmeter to indicator transmitter connections are crossed.

Indicator Transmitter
The indicator transmitter is the major unit of the E/M Log System Mk 6, Mods 0, 1, and 2; it is comprised of the following subassemblies:

a. A1 card file, which houses the following printed-circuit (PC) cards: AlA1 preamplifier, A1A2 summing amplifier, A1A3 synchronous demodulator, A1A4 threshold and logic, A1AS digital integrator, and A1A6 stepped motor driver.

b. A2 calibration assembly, which enables manual adjustment of variable performance factors.

c. A3 reference assembly.

d. A4 speed and distance assembly, which computes and displays speed and distance traveled using signal inputs from the rodmeter. A4 also transmits speed and distance synchro signals to other shipboard equipment.

e. A4A4 built-in test equipment (BITE) on E/M Log System Mk 6, Mod 2 only.

f. AS power supply, which furnishes system operating power.

g. A6 cover assembly, which protects electronic and mechanical assemblies from excessive moisture and dirt, and on the E/M Log System Mk 6, Mod 2 houses the A6B1 blower motor.

Remote Control Unit
Used only in Dummy Log mode, the remote control unit is used to control the speed setting on the indicator transmitter from a remote shipboard location. A switch on this unit allows the operator to increase or decrease the speed dial setting when ownship speed is being estimated from propeller-shaft speed.

Equipment	Specifications	
E/M Log System Mk 6, Mods 0, 1, and 2	Manufacturer:	Pitometer Log Division of the Dewey Electronics Corporation
	Primary Power Requirements:	115-VAC ±6%, 60-Hz ±3%, single phase, 230W maximum l15-VAC ±6%, 400-Hz ± 5% single phase, 5W maximum
	Power Factor:	0.8
	Operating Frequencies: Speed and Distance Computing Circuits Speed Synchros: Distance Synchro:	 60-Hz 60-Hz and 400-Hz 60-Hz
	Rodmeter Operation:	Seawater resistivity, 20 to 200 ohms per cubic centimeter
	Modes of Operation:	Underwater Manual Dummy
	Power Outputs: Rodmeter Indicator Transmitter to Rodmeter to 6O-Hz Speed Synchros 37TRX6 18CX6 to 400-Hz Speed Synchros 18CX4 18CX4 18CX4 to 6O-Hz Distance Synchro 37TRX6	 325uVAC/knot ±5% 50-VAC, 60-Hz 40 knots/turn 100 knots/turn 10 knots/turn 40 knots/turn 100 knots/turn 360 turns/nautical mile
	Zero- to Full Scale Speed Display Response Time: Fast Mode Slow Mode Auto Mode	 60 ±10 seconds (40 knots/min) 8 minutes ±30 seconds (5 knots/min) 60 ±10 seconds (40 knots/min) when indicated speed differs from true speed by more than 1/2 knot 8 minutes ±60 seconds (5 knots/min) when indicated speed differs from true speed by less than 1/2 knot

Equipment	Specifications	
E/M Log System Mk 6, Mods 0,1, and 2 (Contd)	Displayed Speed: Accuracy	0 to 40 knots 0.05 knot of true speed relative to water (ultimate) from 0 to full scale; 60 ±10 seconds when indicated speed differs from true speed by more than 0.500 knot ±10% in Underwater mode, and when fast response is selected in Dummy Log mode; determined by rate of manual cranking in Manual mode
	Displayed Distance:	0000.00 to 9999.99 nautical miles
	Speed-to-Distance: Conversion Error	1% maximum from 4 knots to full scale 2% maximum from 0.5 knot to 4 knots
	Rodmeter Coil:	Electromagnet operating voltage: 50-VAC, 50-Hz, 750mA ±5%
	Rodmeter Electrodes:	Maximum quadrature voltage: 50V
	Compensation Accuracy:	±1.0% between dial calibration and nonlinearity correction entered
	Cooling:	Forced air (Mod 2 only)
	Heat Dissipation:	795 Btu/h
	Relative Humidity:	95% maximum
	Ambient Temperature:	0°C(32°F) to 50°C(122°F)
	Shipping Data Crated Dimensions (inches):	
	Indicator Transmitter	34 x 25 x 22
	Remote Control Unit	4.25 x 6.25 x 8.25
	Rodmeter Switching Unit	12.5 x 14 x 18
	Rodmeter	
	IC/E28-6 (-1)	34 x 9.38 x 7.88
	IC/E28-6F (-2)	34 x 9.38 x 7.88
	IC/E46-6 (-3)	53 x 9.25 x 9.25

Table 10-2.—Reference Data for the E/M Log System MK 6, Mods 0, 1, and 2.

10.17.0 UNDERWATER LOG EQUIPMENT (ELECTROMAGNETIC TYPE) MK 4 MOD 2

The EM Log System Mk 4 Mod 2 (Figure 10-45) measures and displays ship's speed through water in knots, and distance traveled in nautical miles. The displayed speed and distance information is transmitted to remote stations in the ship. This information is transmitted in the form of 60 Hz and 400 Hz synchro outputs for further processing by the remote stations.

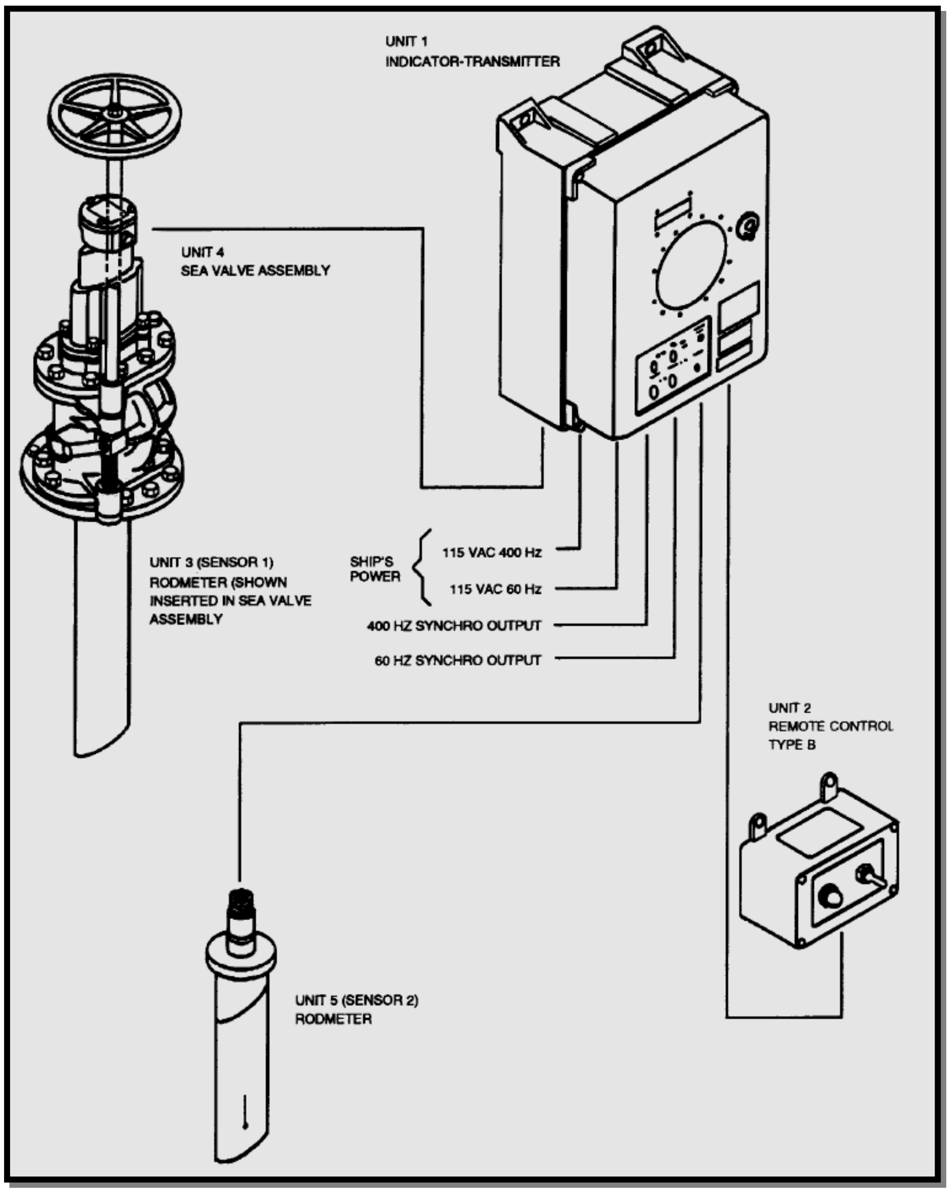


Figure 10-45.— EM Log System Mk 4 Mod 2.

The EM Log System Mk 4 Mod 2 consists of four major hardware elements: Indicator-Transmitter (Unit 1); remote control type B (Unit 2); rodmeter (Units 3, 5); and sea valve assembly (Unit 4).

Unit 1 indicator-Transmitter

The Indicator-Transmitter houses the major functional elements of the EM Log System Mk 4 Mod 2, and is designed to interface a wide variety of shipboard applications such as navigation, fire control, surveillance, and trainer systems. The Indicator-Transmitter accepts ship's speed and dummy speed inputs from the rodmeter and the remote control type B, respectively. These speed inputs are 60 Hz analog signals whose amplitude is proportional to ship's speed (approximately 325 microvolts per knot). The speed range of the EM Log System Mk 4 Mod 2 is established by the Indicator Transmitter. This range is from 0 to 40 knots; with minor modifications, this range is extended to higher speeds.

Unit/Features	Description
Unit 1 Indicator-Transmitter	
Function Characteristics:	
Power Requirements	115 ± 6 VAC 60 ± 3 Hz, 110 watts, 320 volt-amperes
	115 ± 6 VAC 400 ± 20 Hz, 21 watts, 35 volt-amperes
Input signal level (from rodmeter)	325 microvolts/knots ± 5 percent.
Five Modes of Operation	1. LOG
	2. ZERO
	3. TEST
	4. DUMMY
	5. MANUAL
Synchro Outputs	37TRX6 - 40 knots/turn
	18CX4 - 40 knots/turn
	18CX6 - 100 knots/turn
	18CX4 - 100 knots/turn
	18CX4 - 10 knots/turn
	37TRX6 - 360 turns/nautical mile
Capability and Limitations:	
Speed range	0 to 39.8 knots as set by limit stop.
Distance range	Up to 9999.99 nautical miles with automatic reset to 0000.00. Manually reset at any time.
Rated Outputs:	
Speed	Two 115 VAC 60 Hz synchro outputs
	100 knots/turn
	40 knots/turn
	Three 115 VAC 400 Hz synchro outputs

Table 10-3.— Reference Data **EM Log System Mk 4 Mod 2.**

Unit/Features	Description
Speed	100 knots/turn
	40 knots/turn
	10 knots/turn
Distance	One 115 VAC 60 Hz synchro output
	360 turns/nautical mile
Environmental Characteristics:	
Operating Temperature Range	40° to 149° F
Relative Humidity	0 to 95 percent
Extended Storage Temperature Range	-40° to 169° F
Unit 2 Remote Control Type B	
Functional Characteristics	25 to 30 VDC input illuminates indicator lamp; 0.020 VAC 60 Hz at +5V regulated and +5 VDC regulated for INCREASE/DECREASE switch. 0.020 VAC 60 Hz at +5V regulated used for INCREASE and +5 VDC regulated without 0.020 VAC 60 Hz used for DECREASE.
Capabilities and Limitations	INCREASE/DECREASE switch in circuit only when Unit 1 MODE switch is in DUMMY position.
Environmental Characteristics	Same as Unit 1.
Unit 3, 5 Rodmeter	
Functional Characteristics	50 VAC 60 Hz, 0.75 amp normal (0.80 amp max) excites coil.
Rated Outputs	0.013 VAC 60 Hz max ±5 percent (approx 325 microvolts/knot).
Unit 4 Sea Valve Assembly	
Capabilities and Limitations	Designed so that watertight integrity is maintained when Unit 3 rodmeter is inserted through it.
Environmental Characteristics	Must be able to withstand 1500 psi of seawater.

Table 10-3 (Cont'd).— Reference Data EM Log System Mk 4 Mod 2.

Type	Physical Characteristics
IC/E72-6F(X) IC/E100-6F(X)	Later type of retractable rodmeters made of monel in 72 and 100-inch lengths with a 6-inch chord hydrofoil shape. Used with Sea Valve.
IC/E28-6	Fixed rodmeters in 28 and 46-inch lengths with a 6-inch chord hydrofoil shape.
IC/E28-6F	Not used with Sea Valve.
IC/E46-6	

Table 10-4.— Types of Rodmeters.

Functional Description

The Indicator-Transmitter is capable of accepting speed inputs from either of two rodmeters (sensor 1 or sensor 2), or from the remote control type B. The rodmeter inputs are manually selected using the Indicator-Transmitter front panel SENSOR select switch. The remote control type B allows the operator to set and hold a switch until the desired speed is obtained, as indicated on the KNOTS speed dial on the Indicator-Transmitter or as indicated at a remote speed indicator.

Synchro Outputs

The speed inputs from either rodmeter or the remote control type B are converted to a mechanical angular signal by the Indicator-Transmitter. This signal drives the KNOTS speed dial and the rotors of five synchro transmitters, which are part of the Indicator-Transmitter. The KNOTS speed dial displays the ship's speed in knots ranging from 0 to 40 knots, and the synchro transmitters convert the angular speed signals to 60 Hz and 400 Hz stator signals for transmission to remote stations in the ship. The 60 Hz speed synchro outputs transmit speeds of 40 and 100 knots per shaft revolution. These outputs are derived from the 115V 60 Hz power input from the ship's power distribution system. The 400 Hz speed synchro outputs transmit speeds of 10, 40, and 100 knots per shaft revolution. These outputs are derived from the 115V 400 Hz reference power inputs from the ship's power distribution system. A list of the synchro outputs is given in Table 10-3.

Distance Synchro Output

The mechanical angular speed signals in the Indicator-Transmitter are electronically integrated with respect to time to produce a continuous mechanical rotational distance signal corresponding to ship's speed. This signal drives the NAUTICAL MILES counter and the rotor of a synchro transmitter, which is installed in the Indicator-Transmitter. The NAUTICAL MILES indicator registers the distance traveled in nautical miles from 0000.00 to 9999.99 nautical miles. The synchro transmitter converts the mechanical rotational distance signal to a 60 Hz rotational distance signal in the form of stator excitation. The distance synchro output transmits rotational distance signals corresponding to 360 turns per nautical mile.

Modes of Operation

The Indicator-Transmitter establishes the mode of the EM Log System Mk 4 Mod 2 operation. There are five modes of operation: LOG, ZERO, DUMMY, TEST, and MANUAL. All five modes of operation are operator selectable by means of the Indicator-Transmitter front panel MODE select switch. Each mode of operation identifies the type of speed signal the Indicator-Transmitter is processing. In the LOG mode of operation, ship's speed inputs from either sensor 1 or sensor 2 are processed; the KNOTS speed dial hands indicate the speed of the ship through water. In the ZERO mode of operation, a zero-knot speed signal is processed; the KNOTS speed dial hands are driven to the zero-knot position. The zero-knot speed signal is produced automatically by the Indicator-Transmitter when the EM Log System Mk 4 Mod 2 is in the ZERO mode of operation. In the DUMMY mode of operation, dummy speed signals from the remote control type B are processed; the KNOTS speed dial indicates the speed set in by the remote control type B operator. In the TEST mode of operation, speed signals from the SPEED KNOTS control replace and simulate the normal rodmeter speed input. In the MANUAL mode of operation, the speed processing circuits in the Indicator-Transmitter are disabled; the KNOTS speed dial hands are mechanically positioned by the front cover SPEED MANUAL handcrank.

Unit 2 Remote Control Type B

The remote control type B extends the capability of the EM Log System Mk4 Mod 2 to operate as a dummy log, and to provide synchro outputs of speed and distance under emergency conditions. Dummy speed increase/decrease signals are produced by the remote control type B from a remote location in the ship. These signals are processed by the Indicator-Transmitter to set the KNOTS speed dial at any speed from 0 to 40 knots, and provide synchro outputs of speed and distance. The dummy speed signals are processed when the EM Log System Mk 4 Mod 2 is in the DUMMY mode of operation. The remote control type B uses an INCREASE/DECREASE switch to change the speed setting until the desired speed is indicated. Any speed may be obtained, but the Indicator-Transmitter will not run to any preset speed and must be stepped into position each time with the INCREASE/DECREASE switch.

Unit 3, 5 Rodmeter

The rodmeter (Figure 10-46) houses the speed sensing element of the EM Log System Mk 4 Mod 2. The sensing element is an induction device which develops a signal voltage that varies with ship's speed as the ship travels through water. The signal voltage is a 60 Hz signal, which is received from the 50 VAC 60 Hz rodmeter excitation signal from the Indicator-Transmitter. The 60 Hz signal voltages from the rodmeter are processed by the Indicator-Transmitter to set the KNOTS speed dial hands at a position corresponding to the speed of the ship through water, and to provide synchro outputs of speed and distance. Table 10-4 lists the types of rodmeters used and the physical characteristics of each type.

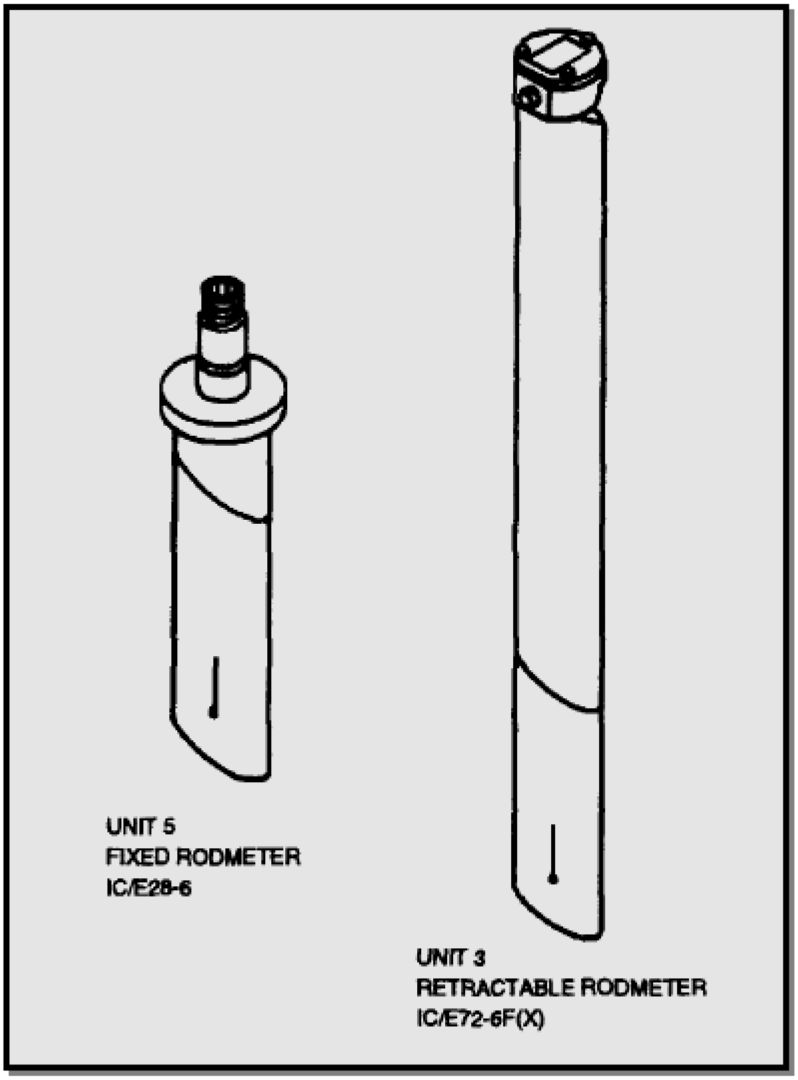


Figure 10-46.— Unit 3, 5 Rodmeter.

Unit 4 Sea Valve Assembly

The Sea Valve Assembly is a mechanical device which provides a water tight support for the rodmeter and allows removal and installation of the rodmeter while the ship remains in the water. When the rodmeter is not installed, the sea valve is closed to maintain watertight hull integrity.

Figure 10-45 shows the major units of the EM Log System Mk 4 Mod 2, the relative size of each, and the basic interconnections between the units.

10.18.0 INDICATOR-TRANSMITTER SET DIGITAL ELECTROMAGNETIC LOG AN/WSN-8 AND AN/WSN-8A (DEML)

The Electromagnetic Log (EM Log) is a component of the conventional navigation system used aboard naval surface ships and submarines. EM Log operates in conjunction with a hull-mounted sensor to measure ship's speed relative to the water and distance traveled from a given starting point. The AN/WSN 8-A is a microprocessor-based system with ISA bus backplane architecture and Commercial Off-the-Shelf (COTS) components. The AN/WSN-8A reduced calibration time and simplifies maintenance requirements by offering features such as menu-driven calibration modes and modular level fault diagnostic test. The AN/WSN-8A also offers accuracies of 0.05 knots for speeds ranging from 0 to 99.99 knots as well as a response time tuned to match the EM Log for ideal inertial system performance.

Figure 10-47.— AN/WSN-8A Digital Electromagnetic Log Indicator Transmitter.

This section is applicable to the AN/WSN-8 DEML, AN/WSN-8 DEML (w/FC-1), AN/WSN-8A(V)1 DEML, and AN/WSN-8A(V)2 DEML. These units can be configured as shown in Figures 10-48 through 10-50. Elsewhere in the manual, the Indicator-Transmitter (I/T) will be referred to as the "DEML" and the system as the "DEML system."

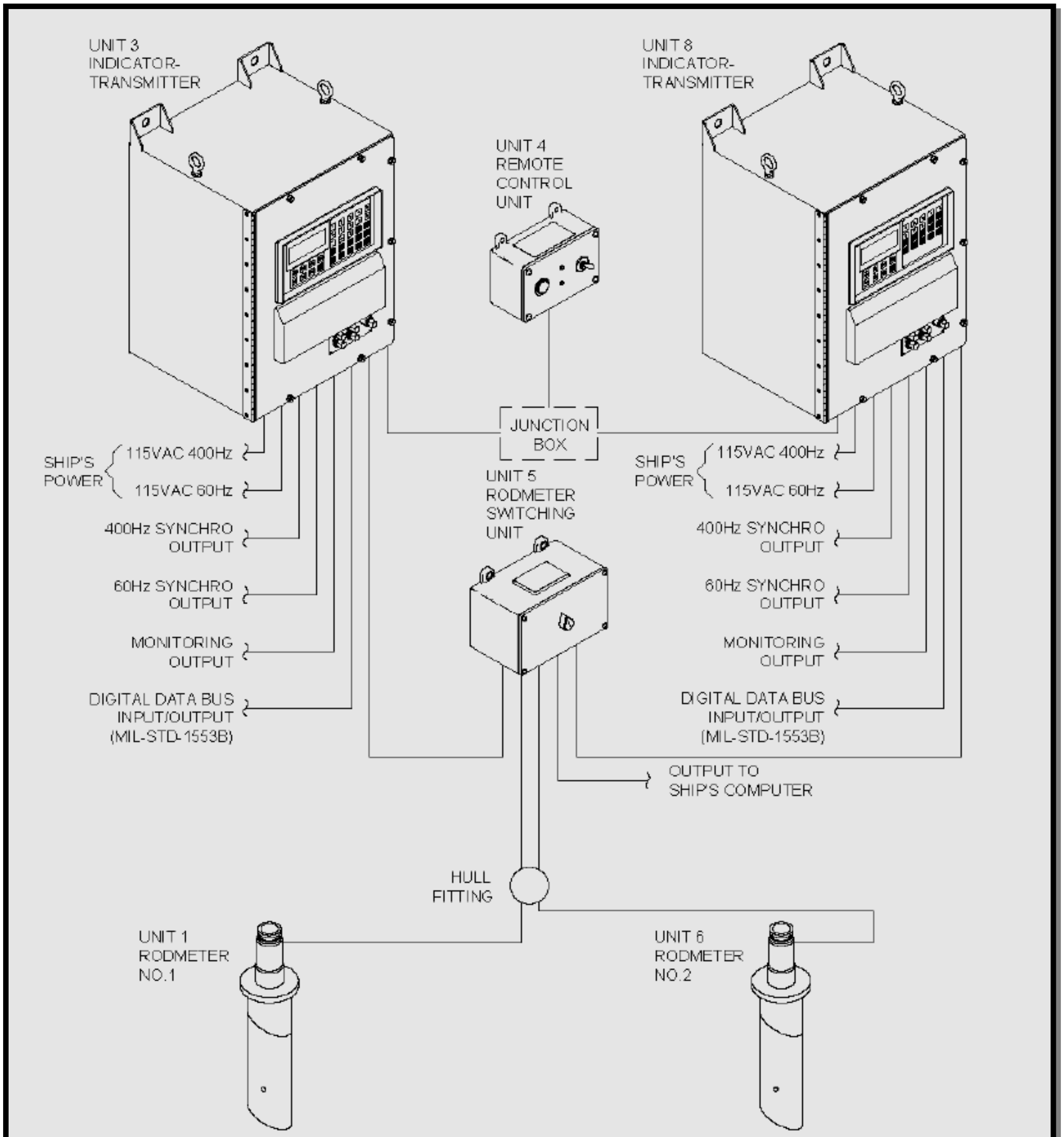


Figure 10-48.— Dual I/T/Dual Rodmeter DEML Installations (Sheet 1 of 3). AN/WSN-8 and AN/WSN-8 (w/FC-1) Configuration.

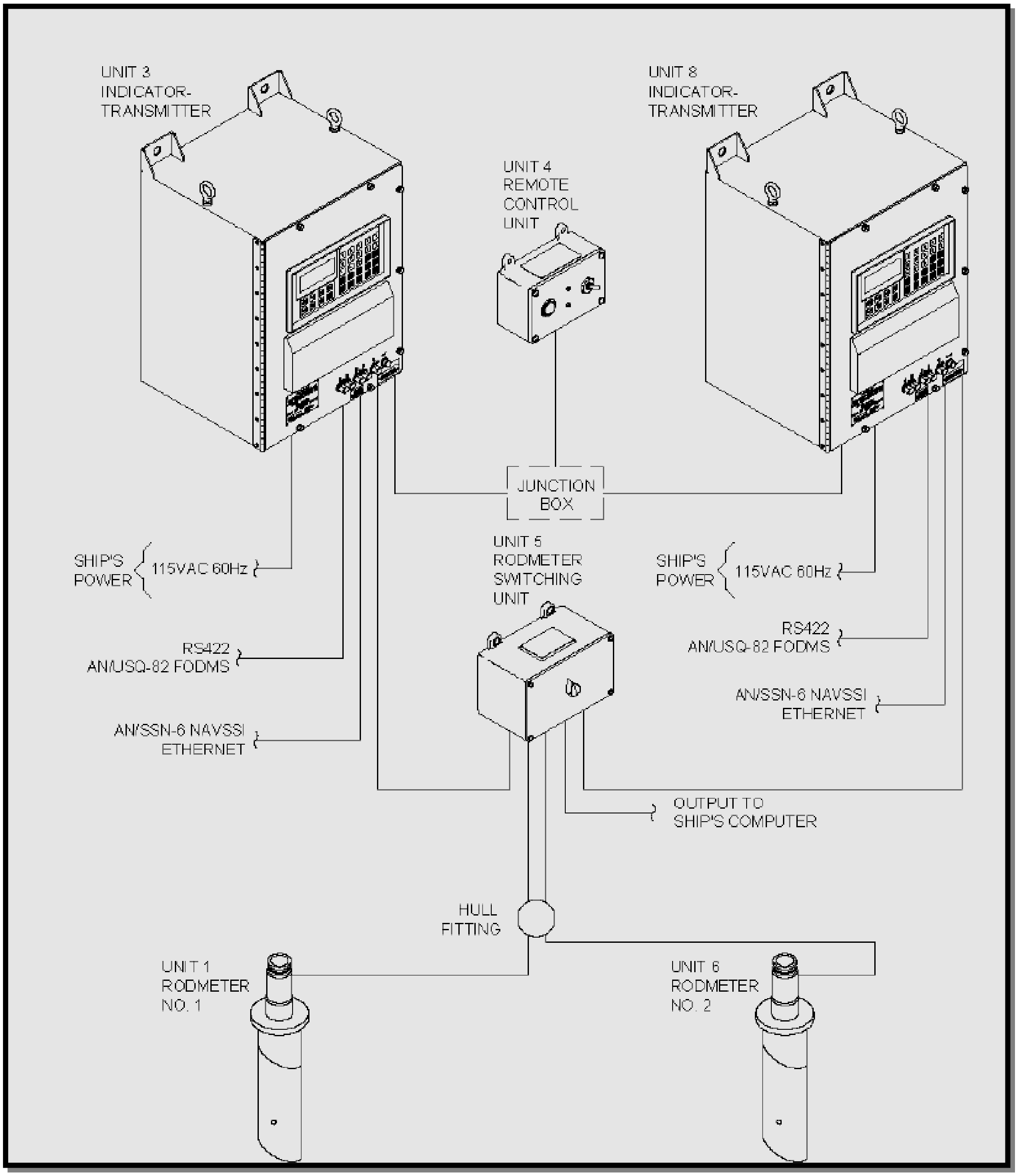


Figure 10-48.— Dual I/T/Dual Rodmeter DEML Installations (Sheet 2).
AN/WSN-8(V)1 Configuration.

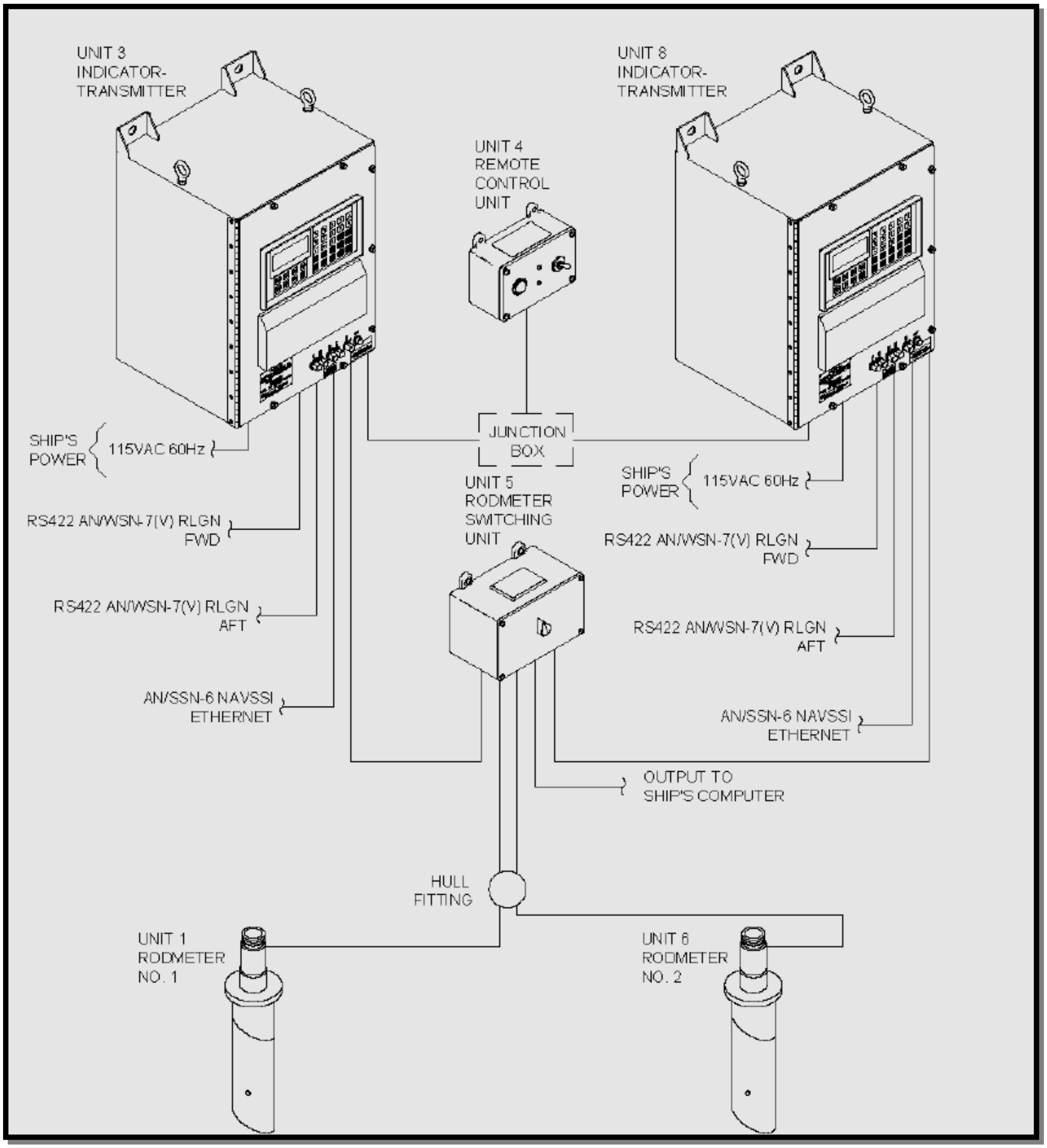


Figure 10-48.— Dual I/T/Dual Rodmeter DEML Installations (Sheet 3). AN/WSN-8A(V)2 Configuration.

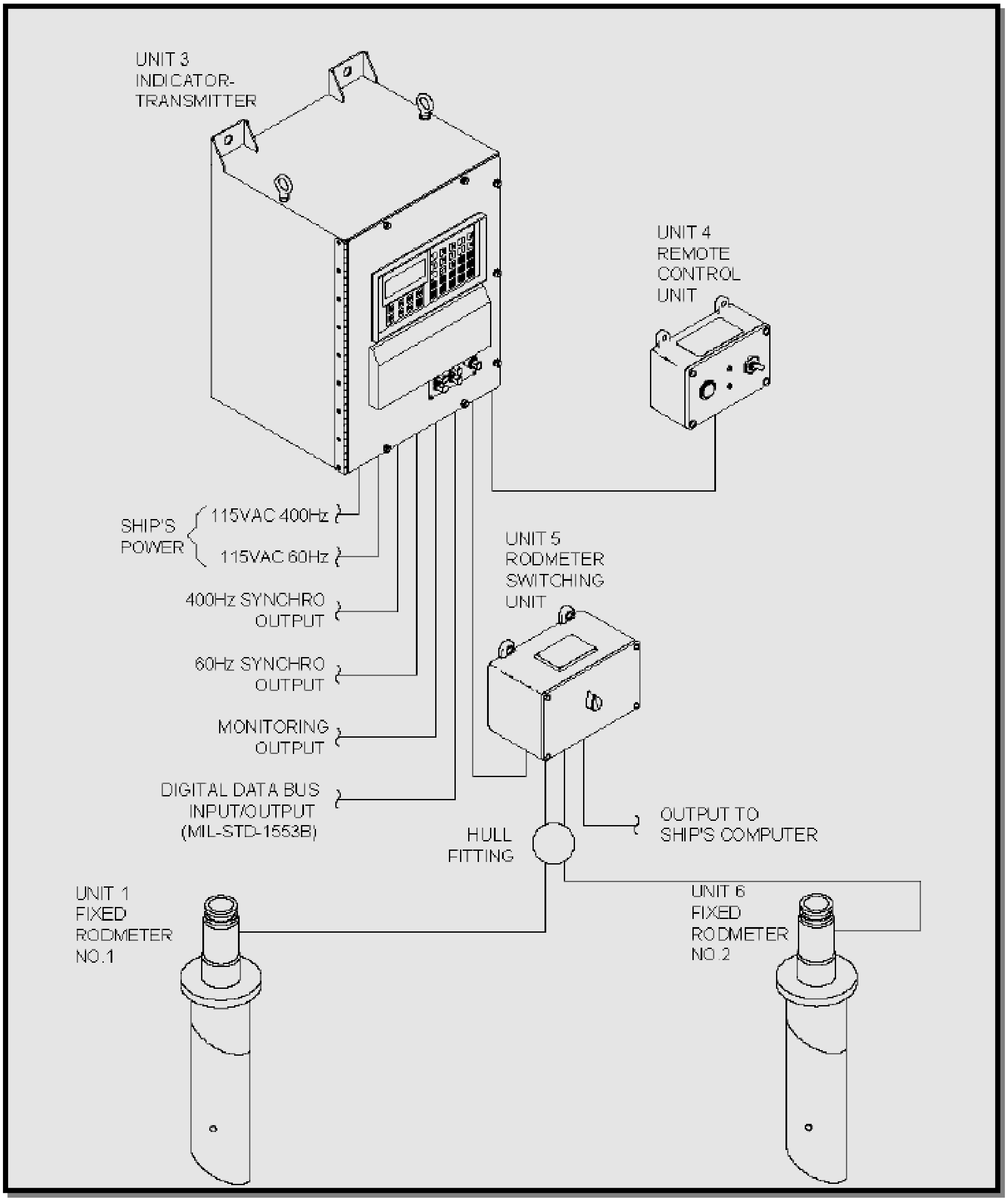


Figure 10-49.— Single I/T/Dual Rodmeter DEML Installations (Sheet 1 of 3). AN/WSN-8 and AN/WSN-8 (w/FC-1) Configuration.

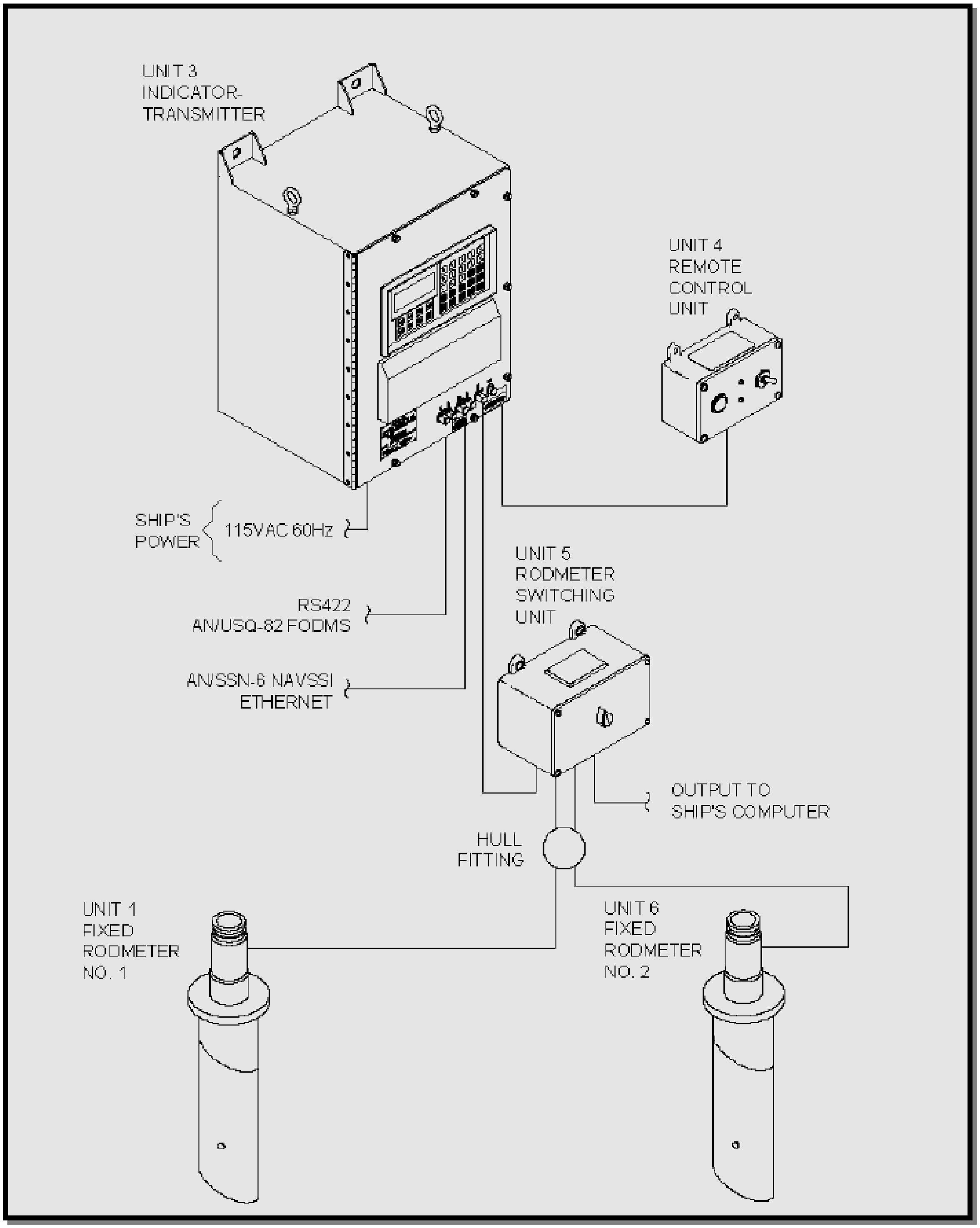


Figure 10-49.— Single I/T/Dual Rodmeter DEML Installations (Sheet 2). AN/WSN-8(V)1 Configuration.

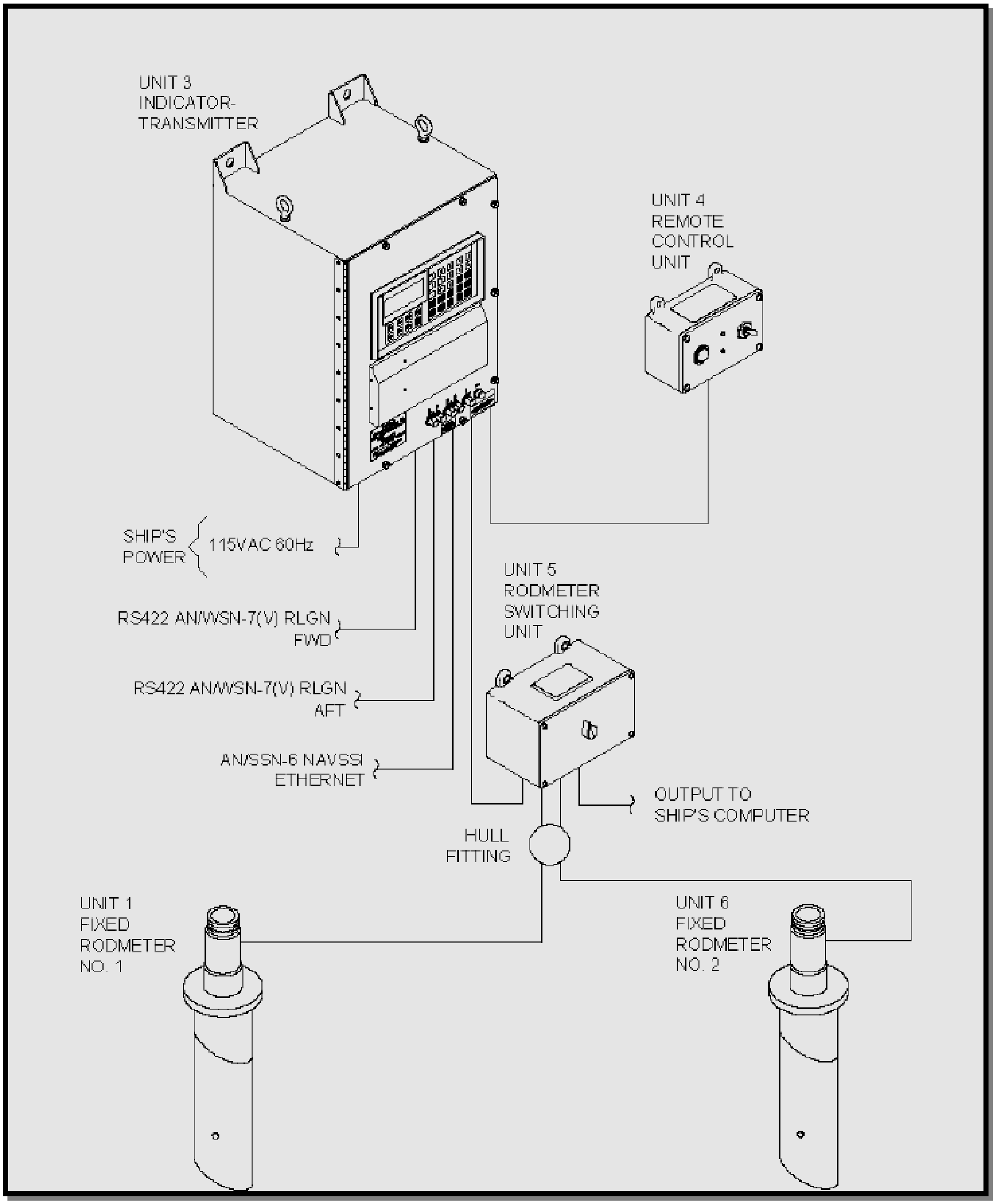


Figure 10-49.— Single I/T/Dual Rodmeter DEML Installations (Sheet 3). AN/WSN-8A(V)2 Configuration.

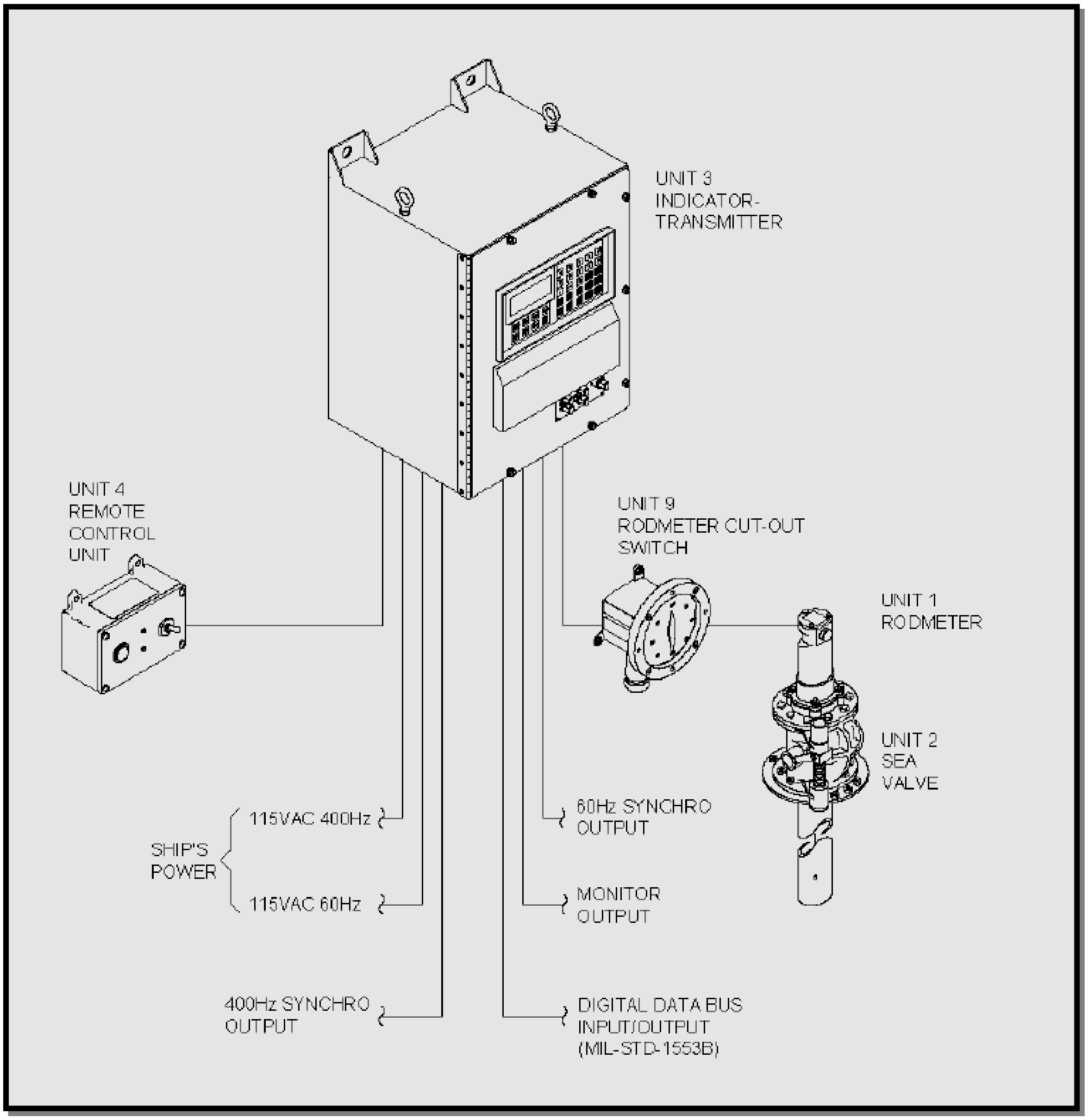


Figure 10-50.— Single I/T/Single Rodmeter DEML Installations (Sheet 1 of 3). AN/WSN-8 and AN/WSN-8 (w/FC-1) Configuration.

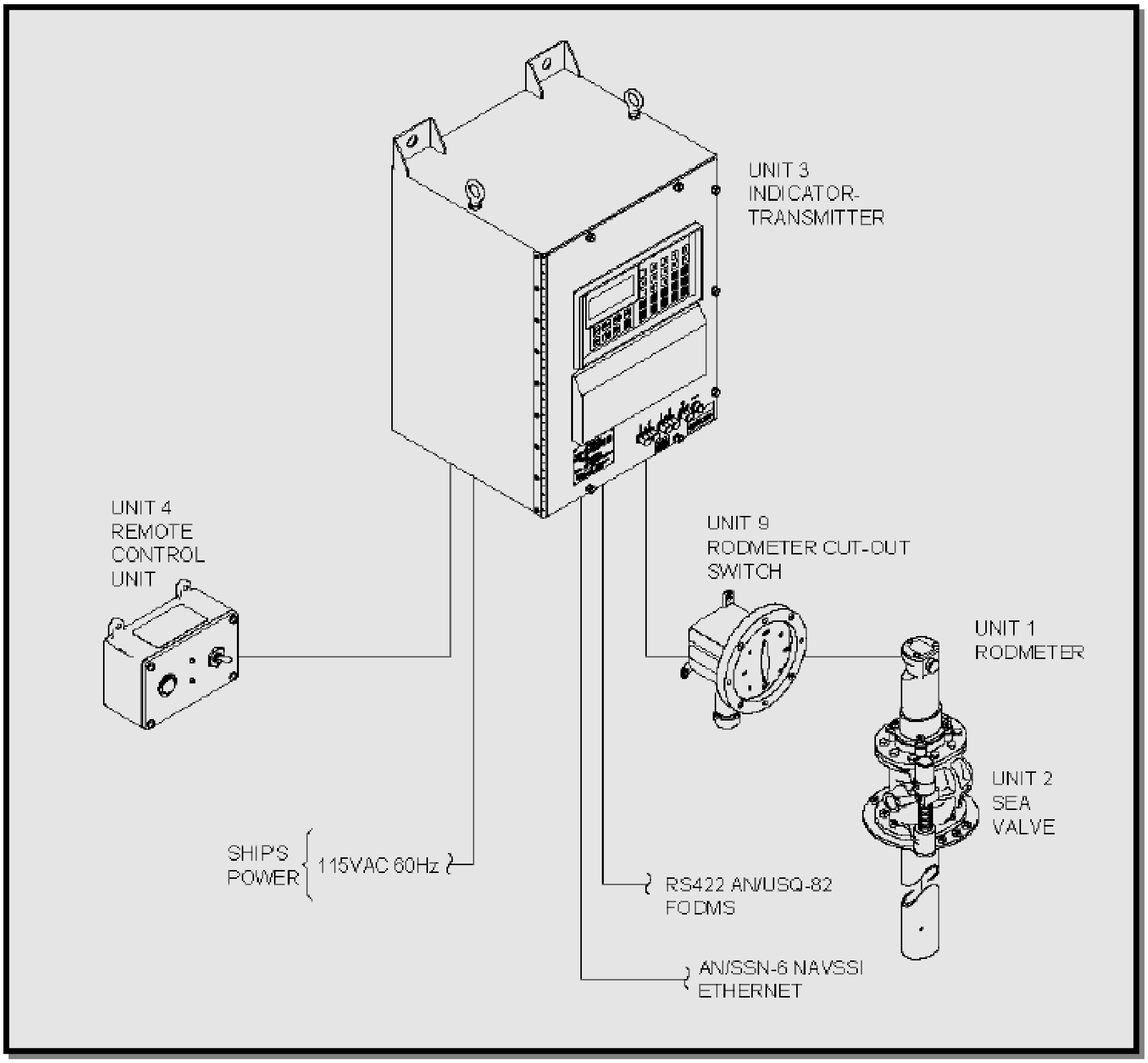


Figure 10-50.— Single I/T/Single Rodmeter DEML Installations (Sheet 2). AN/WSN-8A(V)1 Configuration.

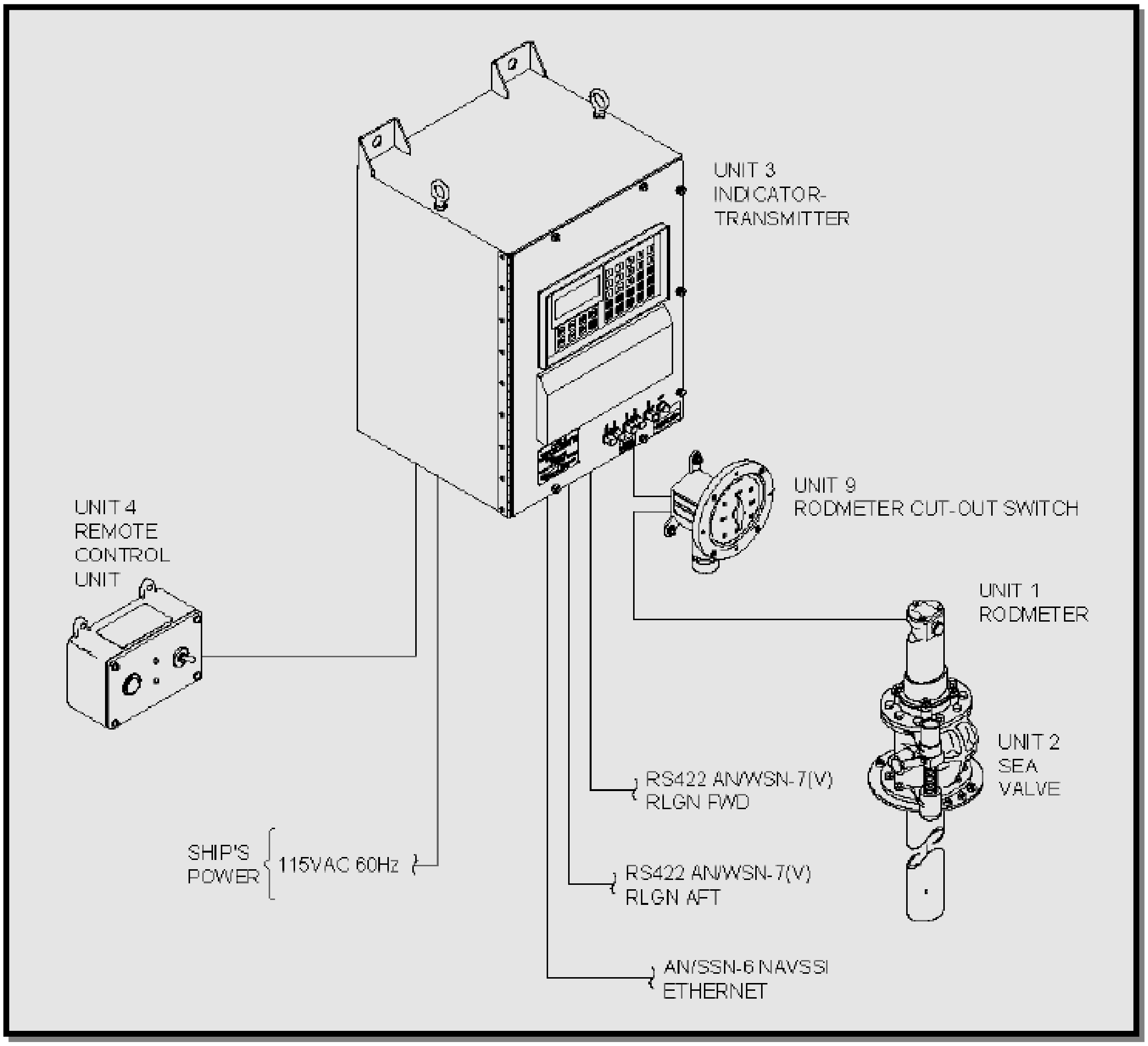


Figure 10-50.— Single I/T/Single Rodmeter DEML Installations (Sheet 3). AN/WSN-8A(V)2 Configuration.

AN/WSN-8 DEML CONFIGURATIONS

The AN/WSN-8 DEML is available in two configurations. The first configuration consists of a Teknor AT4L or AT4L+ Central Processing Unit (CPU) Circuit Card Assembly (CCA) running first generation DEML software version 3.3. Due to obsolescence relating to the first configuration, an AN/WSN-8A DEML, AT520L CPU CCA running newer generation, multi-platform DEML software version 4.31 was inserted into the AN/WSN-8 DEML system design as part of Field Change 1 (FC-1), resulting in the second configuration.

The AN/WSN-8 DEML configuration provides a 60-Hz (Hertz) Synchro, 400-Hz Synchro, and MIL-STD-1553B interface. The AN/WSN-8 DEML (w/FC-1) configuration provides a 60-Hz Synchro, 400-Hz Synchro, MIL-STD-1553B, and National Marine Electronics Association (NMEA) interface. Both configurations are installed on SSBN 726, SSGN 726, SSN 21, LCC, and LHD Class submarines and ships.

AN/WSN-8A DEML CONFIGURATIONS

The AN/WSN-8A(V)1 DEML with AN/WSN-8A(V)1, version 4.31 software, is configured using a jumper setting on the AT520L CPU CCA and Auto-Detecting software, to provide an AN/USQ-82(V) Fiber Optic Data Multiplex System (FODMS) interface. The AN/WSN-8A(V)1 DEML also provides an NMEA interface.
The AN/WSN-8A(V)1 DEML is installed on DDG Class ships.

The AN/WSN-8A(V)2 DEML with AN/WSN-8A(V)2, version 4.31 software, is configured using a jumper setting on the AT520L CPU CCA and Auto-Detecting software to provide a Ring Laser Gyro Navigator (RLGN) interface. The AN/WSN-8A(V)2 DEML is installed on CVN Class ships. Both the AN/WSN-8A(V)1 and AN/WSN-8A(V)2 DEML configurations provide an AN/SSN-6(V) Navigation Sensor System Interface (NAVSSI) interface.

10.18.1 Maintenance Philosophy

The DEML maintenance procedures can be performed at the organizational level. Scheduled maintenance procedures include inspection, cleaning, and performance checks of the equipment. Chapters 5 and 6 of the Technical Manual contain information that will enable the technician to troubleshoot and repair and/or replace malfunctioning assemblies of the DEML.

10.18.2 General Description

The DEML measures Own Ship's Speed (OSS) relative to the water, and distance traveled from a given starting point. The rodmeter generates a micro voltage based on the electromagnetic induction. This micro voltage is processed by the I/T which displays and transmits both speed and distance information. Speed is displayed in the range of 0 through 100 ±0.05 knots (k). Distance is displayed in the range of 0000.00 through 9999.99 nautical miles (Nm) ±5%.

10.18.3 Modes of Operation

The DEML has seven modes of operation: Underwater, Calibration, Manual Dummy, Remote Dummy, Built-In Test (BIT), Configuration, and Status Check. The modes are selected at the I/T Control Display Panel (CDP) keypad. When Underwater mode is selected, the speed input is generated by the selected rodmeter. On the AN/WSN-8 DEML configuration with software version 3.3 and a Teknor AT4L or AT4L+ CPU CCA installed, the Calibration mode has three Calibration options: Electromagnetic Log Voltage Simulator (ELVS), Manual and Automatic.

There is also a feature allowing calibration data to be modified. On the AN/WSN-8A(V)1 and (V)2 DEML configurations, and on the AN/WSN-8 DEML configuration with software version 4.31 and an AT520L CPU CCA installed, the Calibration mode has two Calibration options: Manual and Automatic. There is also a feature allowing the display, modification, and creation of calibration data in software versions 4.31 and higher. When Manual Dummy mode is selected, the operator can enter OSS via the CDP keypad. When Remote Dummy mode is selected, the operator can enter OSS via the INCREASE/DECREASE switch on the Remote Control Unit (RCU).

When BIT mode is selected, the DEML will run a self-diagnostic test and report any faulty modules via the CDP display. In addition to running self-diagnostic tests, the BIT mode for the AN/WSN-8 DEML (w/FC-1), AN/WSN-8A(V)1 DEML, and AN/WSN-8A(V)2 DEML performs real-time performance monitoring. Errors detected are assigned specific fault codes, and are capable of being displayed and acknowledged via the CDP. Configuration mode allows certain operating parameters to be adjusted. Status Check mode permits the operator to observe certain operating status parameters.

10.18.4 Reference Data

Table 10-5 lists data often required for quick reference. This data includes environmental and physical characteristics.

EQUIPMENT	SPECIFICATIONS	
DEML System	Manufacturer:	See List of Manufacturers.
	Primary Power Requirements:	115 VAC ±6%, 60-Hz ±3%, single-phase, 230-W maximum 115 VAC ±6%, 400-Hz ±5%, single-phase, 5-W maximum*
	Internal Fuses:	F1 - F4 3 amps F5 1 amp
	Inputs:	
AN/WSN-8, AN/WSN-8 (w/FC-1), AN/WSN-8A(V)1, AN/WSN-8A(V)2 DEMLs	Rodmeter	325µ (micro) volt/knot
	Remote Control Unit	Dummy Speed
AN/WSN-8, AN/WSN-8 (w/FC-1) DEMLs	Command and Control System (CCS), Digital Data Bus (DDB) [AN/WSN-8 (SSBN 726 Class only)] Ship Control Bus [AN/WSN-8 (SSN 21 Class only)]	Three-dimensional velocity and inertial health
AN/WSN-8A(V)1 DEML	AN/USQ-82(V) FODMS (RS-422):	Heading Roll Pitch Velocity North Velocity East Latitude Longitude Time System Status
AN/WSN-8A(V)2 DEML	AN/WSN-7(V) or AN/WSN-7A(V) RLGN (RS-422):	Roll Pitch Heading Yaw Rate Pitch Rate Roll Rate System Status

Table 10-5.— DEML Reference Data.

EQUIPMENT	SPECIFICATIONS	
AN/WSN-8A(V)1, AN/WSN-8A(V)2, DEMLs	AN/SSN-6(V) NAVSSI (Ethernet):	Julian Date Roll Pitch Roll Rate Pitch Rate Heading Rate System Status
	Outputs:	
AN/WSN-8, AN/WSN-8 (w/FC-1) DEMLs	Synchro OSS (60-Hz):	40 KPR (knots per revolution) 100 KPR**
	Synchro OSS (400-Hz):	10 KPR** 40 KPR** 100 KPR**
	Synchro Own Ship's Distance (OSD) (60-Hz):	360 rev/Nm** (revolutions per nautical mile)
	Analog:	Mode Monitor Coil Current
	Digital Data Bus (MIL-STD-1553B):	Own Ship's Speed Own Ship's Distance Coil Current System Status System Mode Built-In Test
	Ship Control Bus (MIL-STD-1553B):	Own Ship's Speed Own Ship's Distance Coil Current System Status System Mode Built-In Test
AN/WSN-8 (w/FC-1) DEML	NMEA	VBW Message

Table 10-5 (Cont'd).— DEML Reference Data.

EQUIPMENT	SPECIFICATIONS	
AN/WSN-8A(V)1 DEML	AN/USQ-82(V) FODMS (RS-422):	Own Ship's Speed 10 knots Own Ship's Speed 40 knots Own Ship's Speed 100 knots Own Ship's Distance System Status
	NMEA	VBW Message
AN/WSN-8A(V)2 DEML	AN/WSN-7(V) or AN/WSN-7A(V) RLGN (RS-422):	Longitudinal Velocity System Status
AN/WSN-8A(V)1, AN/WSN-8A(V)2 DEMLs	AN/SSN-6(V) NAVSSI (Ethernet):	Own Ship's Speed 100 knots System Status
AN/WSN-8, AN/WSN-8 (w/FC-1), AN/WSN-8A(V)1, AN/WSN-8A(V)2 DEMLs	Modes of Operation:	Underwater Calibration Manual Dummy Remote Dummy Configuration Built-In Test Status Check
	Power Outputs:	
	Rodmeter:	325µ VAC/knots ±5%
	I/T to Rodmeter:	50 VAC, 60 Hz
	Displayed Speed:	0 to 100 knots
	Accuracy:	±0.05 knots
	Displayed Distance:	0000.00 to 9999.99 Nm
	Accuracy:	±5%
	Rodmeter Electrodes:	Maximum quadrature voltage: 50 V
	Rodmeter Coil:	Electromagnet Operating Voltage: 50 VAC, 60-Hz, 500 mA (milli-amp) ±100 mA
	Cooling:	Forced air
	Heat Dissipation:	683 Btu/h (British thermal unit per hour)
	Relative Humidity Tolerance:	90% maximum
	Ambient Temperature Tolerance:	-40°C (-40°F) to 70°C (158°F)

Table 10-5 (Cont'd).— DEML Reference Data.

10.18.5 DEML Configuration Matrix

Table 10-6 contains a configuration matrix for the AN/WSN-8 DEML, AN/WSN-8 DEML (w/FC-1), AN/WSN-8A(V)1 DEML, and AN/WSN-8A(V)2 DEML. Information provided includes supported interfaces, current software versions, and type of ship class that DEML configurations are installed on.

UNIT NOMEN-CLATURE:	WSN-8	WSN-8 (w/FC-1)	WSN-8A (V)1	WSN-8A (V)2	WSN-8A (V)3	WSN-8A (V)4
Supported Interfaces:						
60-Hz Synchro	X	X			X	
400-Hz Synchro	X	X			X	X
MIL-STD-1553B	X	X			X	X
FODMS			X			
NAVSSI			X	X		
RLGN				X		
NMEA		X	X			
Current Software:	WSN-8, Version 3.3	WSN-8, Version 4.31	WSN-8A(V)1 Version 4.31	WSN-8A(V)2, Version 4.31	WSN-8A(V)3, Version 4.31	WSN-8A(V)4, Version 4.31
Installed On:	SSBN 726 Class SSN 21 Class LCC 19 LHD 3	SSBN 726 Class SSN 21 Class LCC 19 LHD 3	DDG 80-112	CVN 76	TBD	TBD
NOTE: Victor numbers (V)1, (V)2, (V)3, and (V)4 differentiate DEML configurations and are used to reference specific procedures for each configuration.						

Table 10-6.— DEML Configuration Matrix.

10.18.6 Major Equipment Units

The following subsections describe the major units and assemblies of the equipment that comprise the DEML System.

RODMETER (UNITS 1, 6)

The rodmeter (Figure 10-51 and Figure 10-52) is the speed sensor for the DEML System. When the rodmeter is in the water and receiving electrical current, it develops a signal whose strength is proportional to OSS. This signal is passed to the I/T for processing, display, and speed data output to user systems.

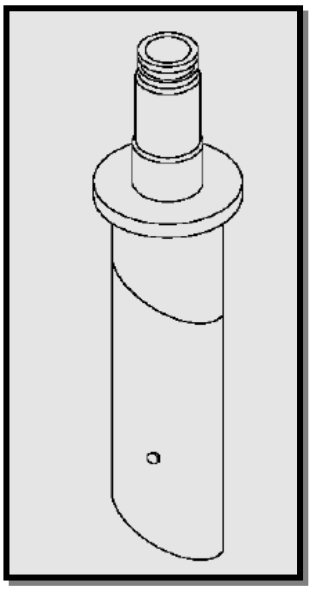


Figure 10-51.— Fixed Rodmeter.

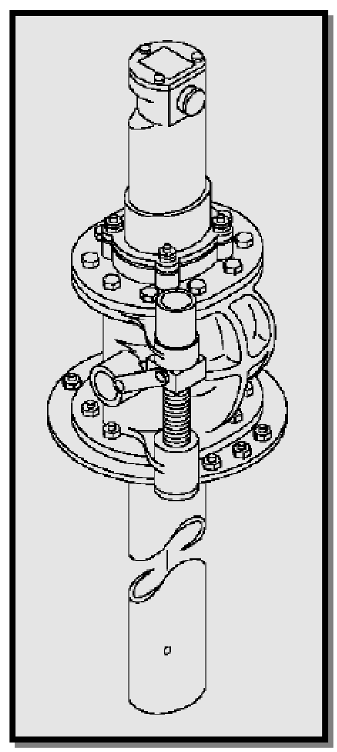


Figure 10-52.— Retractable Rodmeter and Sea Valve Assembly.

INDICATOR-TRANSMITTER

The I/T is the major unit of the DEML System. It performs all the signal processing, display, and transmitting functions. The AN/WSN-8, AN/WSN-8 (w/FC-1), AN/WSN-8A(V)1, and AN/WSN-8A(V)2 I/Ts consist of the subassemblies described in the following subsections.

Control Display Panel

The CDP is the principal Man-Machine Interface (MMI) of the DEML.

Card Cage

The AN/WSN-8 DEML Card Cage Assembly contains a CPU CCA, Analog-to-Digital (A/D) CCA, MILSTD-1553B Interface CCA, 60-Hz Digital-to-Resolver (D/R) CCA, and a 400-Hz Digital-to-Synchro (D/S) CCA all mounted on an Industry Standard Architecture (ISA) electronic backplane.

The AN/WSN-8A(V)1 and AN/WSN-8A(V) DEML Card Cage Assembly contains a CPU CCA, A/D CCA, and an Ethernet CCA, all mounted on an ISA electronic backplane.

Synchro Signal Booster Amplifiers

Two SSBAs boost the power of the 60-Hz synchro speed outputs, enabling them to drive higher loads. The SSBAs are not applicable to the AN/WSN-8A(V)1, and AN/WSN-8A(V)2 I/Ts. They are installed in the AN/WSN-8 I/T configurations only.

Relay CCA

The Relay CCA processes incoming signals from the RCU (Unit 4) and Rodmeter Switching Unit (RSU) (Unit 5), and outputs discrete status signals to external users.

Rodmeter CCA

The Rodmeter CCA processes the rodmeter reference signal and rodmeter speed signal. It also outputs rodmeter coil current to external users.

Power Supply Assembly, 200 Watt

The 200-W (Watt) Power Supply Assembly provides ±5 VDC and ±12 VDC power to the card cage.

Power Supply Assembly, 28 VDC

The 28-VDC Power Supply Assembly provides operating power to the RCU (Unit 4) and Relay CCA.

Step-Down, 50 VAC Transformer Assembly
The Step-Down, 50-VAC Transformer Assembly provides excitation to the rodmeter coil.

Constant Voltage Transformer Assembly
The Constant Voltage Transformer Assembly provides conditioned power to the Step-Down, 50-VAC Transformer Assembly

Scott-T Transformer Assembly
The Scott-T Transformer Assembly translates the distance output of the 60-Hz D/R CCA to 60-Hz synchro format. The Scott-T Transformer Assembly is not applicable to the AN/WSN-8A(V)1, and AN/WSN-8A(V)2 I/Ts. It is installed in the AN/WSN-8 I/T configurations only.

Fans
Three fans consisting of two Intake Fans on the Front Access Panel Assembly, and one Circulating Fan in the top of the I/T Cabinet, provide forced-air ventilation of the I/T enclosure.

Front Access Panel Assembly
The Front Access Panel Assembly contains two Intake Fans, the CDP, and five fuses consisting of four 3-amp fuses and one 1-amp fuse which protect the unit from input power surges. In addition to the fans, CDP, and fuses, the AN/WSN-8A(V)1 and AN/WSN-8A(V)2 DEML Front Access Panel Assemblies contain a fault indicator lamp that illuminates when a fault condition is detected.

Lower Access Panel
The Lower Access Panel contains all external interface connectors.

REMOTE CONTROL UNIT (UNIT 4)
The RCU (Unit 4) is used only in the Remote Dummy mode. It controls the speed setting on the I/T from a remote shipboard location. A switch on the unit allows the operator to increase or decrease the speed setting when OSS is being estimated from shaft speed.

RODMETER SWITCHING UNIT (UNIT 5)
The RSU (Unit 5) controls the configuration of rodmeters to I/Ts. It is not used in single-rodmeter installations.

In dual I/T installations (using RSU) selecting NORMAL connects each I/T to its normal rodmeter; selecting ALTERNATE cross-connects the rodmeters (i.e., I/T No. 1 is connected to Rodmeter No. 2 and I/T No. 2 is connected to Rodmeter No. 1).

In single I/T installations (using RSU) selecting RODMETER NO. 1 or RODMETER NO. 2 determines which rodmeter furnishes the speed signal to the I/T.

RODMETER CUTOUT SWITCH (UNIT 9)

The Rodmeter Cutout Switch (Unit 9) disconnects the 50-VAC excitation to the Rodmeter whenever the Rodmeter is not immersed in water.

10.19.0 AN/WQN-2 DOPPLER SONAR VELOCITY LOG (DSVL) SYSTEM

The Doppler Sonar Velocity Log (DSVL) System AN/WQN-2 is a speed measuring sensor which functions by transmitting acoustic energy of a specific frequency and receiving returns from the reflection medium as a result of the transmissions.

The shift in frequency (Doppler shift) in the returned signals with respect to the transmitted signals is then determined and used to calculate the ship's three axes (fore-aft, athwartships and vertical) speed in a local vertical coordinate frame.

The DSVL system is capable of accepting roll, pitch and heading inputs to compensate calculated speed for ship's angular rates. When the bottom is within the acoustic range of the DSVL system, the capability is also provided to manually select bottom reflections for true speed over the ground.

Ship's speed is displayed on the equipment's front panel and can be supplied to end-users in 16-bit parallel and serial digital format. Ship’s speed can also be supplied to end-users in analog format using 60 and 400 Hertz, 10, 40, and 100 knots/revolution synchro data.

The DSVL system is a three-unit system consisting of a Transducer (sensor), a Transmitter/Receiver (transceiver) Unit and an Electronics Control Unit. Primary system functions and controls are performed by the Electronics Control Unit utilizing digital signal processing and control techniques.

The Electronics Control Unit also incorporates Built-In Test Equipment (BITE) which indicates DSVL system malfunctions by audible alarm. Signal conditioning of both the final output and initial input of the Doppler signal is performed in the Transceiver Unit. The Transducer, a flush mounted sensor, acts to interface the system functions with the water medium.

Figure 10-53.— AN/WQN-2 Doppler Sonar Velocity Log System.

10.20.0 DEAD RECKONING ANALYZER MK 6 MOD 1

This section provides information required to install, operate, and maintain the Dead Reckoning Analyzer Mk 6 Mod 1 (DRA) shown in figure 10-54.

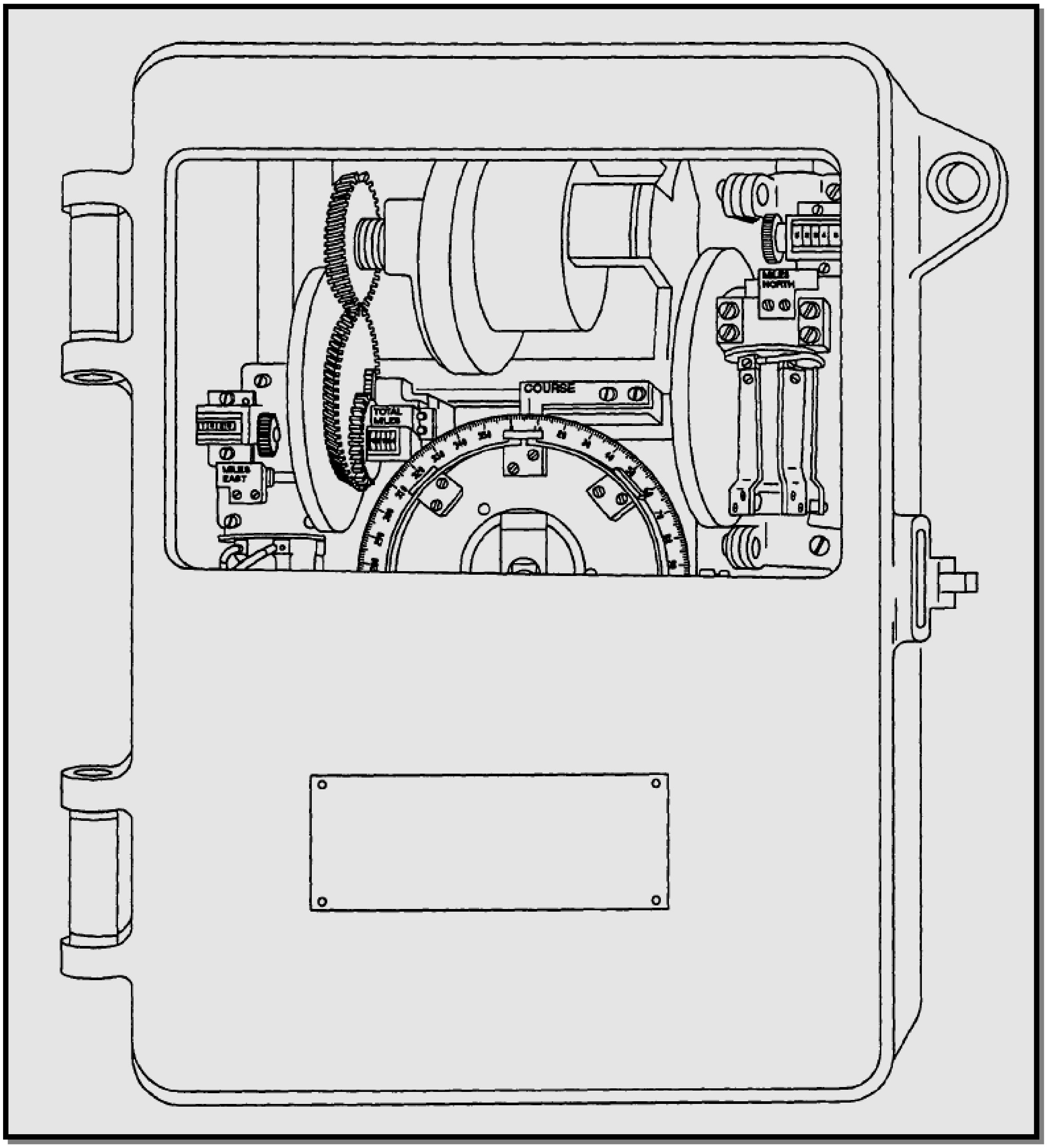


Figure 10-54.— Dead Reckoning Analyzer Mk 6 Mod 1.

The Dead Reckoning System indicates ship's position in latitude and longitude and provides a graphic record of own-ship's position relative to a fixed starting point. When properly set at the starting point, the dials indicate continuously own-ship's present latitude and longitude, computed by dead reckoning. Total distance traveled by the ship, regardless of course, is indicated in the analyzer. In addition to total miles, the analyzer also indicates the overall North-South and East-West distances and the compass heading of own ship in degrees.

10.20.1 Relationships of Units

The DRA consists of the following units:

a. Distance Converter
b. Roller Carriages
c. Ship's-Course Crank-Arm Mechanism.

10.20.2 DRA Major Unit Description

The DRA consists of three major assemblies. Figure 10-55 shows the Distance Converter, figure 10-56 shows the Roller Carriage Assembly, and figure 10-57 shows the Ship's-Course Crank-Arm Mechanism.

DISTANCE CONVERTER

The distance converter, shown in figure 10-55, includes distance-input motor G, which is connected to the log distance transmitter; total miles counter J, which indicates the total miles of own-ship's travel; and North component disk Ml and East component disk M2, which are used to determine total miles North and East.

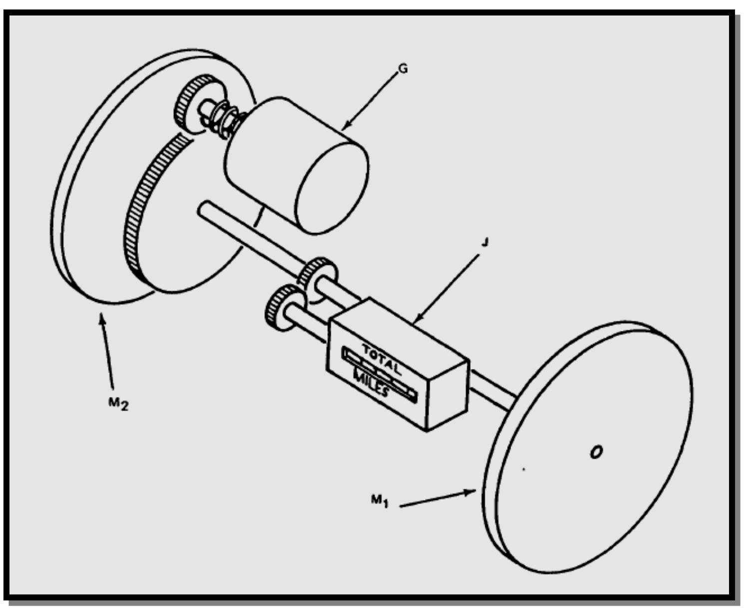


Figure 10-55.— Distance Converter.

ROLLER CARRIAGES

These are two movable carriages PI and P2, shown in figure 10-56, suitably mounted on guide rods Rl and R2. Counters Nl and N2 indicate total miles North and total miles East.

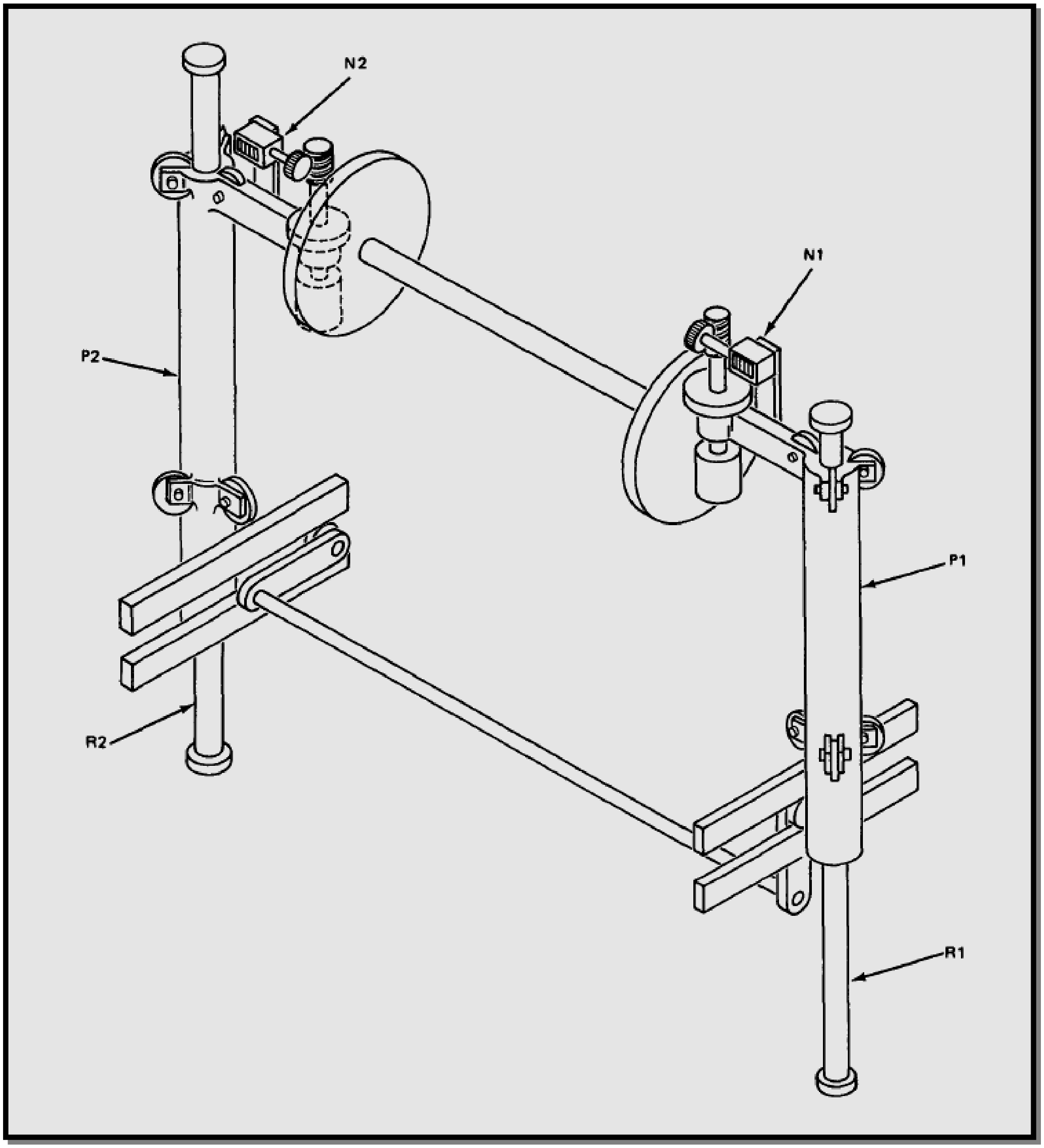


Figure 10-56.— Roller Carriage Assembly.

SHIP'S-COURSE CRANK-ARM MECHANISM

The ship's-course crank-arm mechanism, shown in figure 10-57, consists of course synchro motor V, connected to the master- compass transmitter and controlling follow-up motor U.

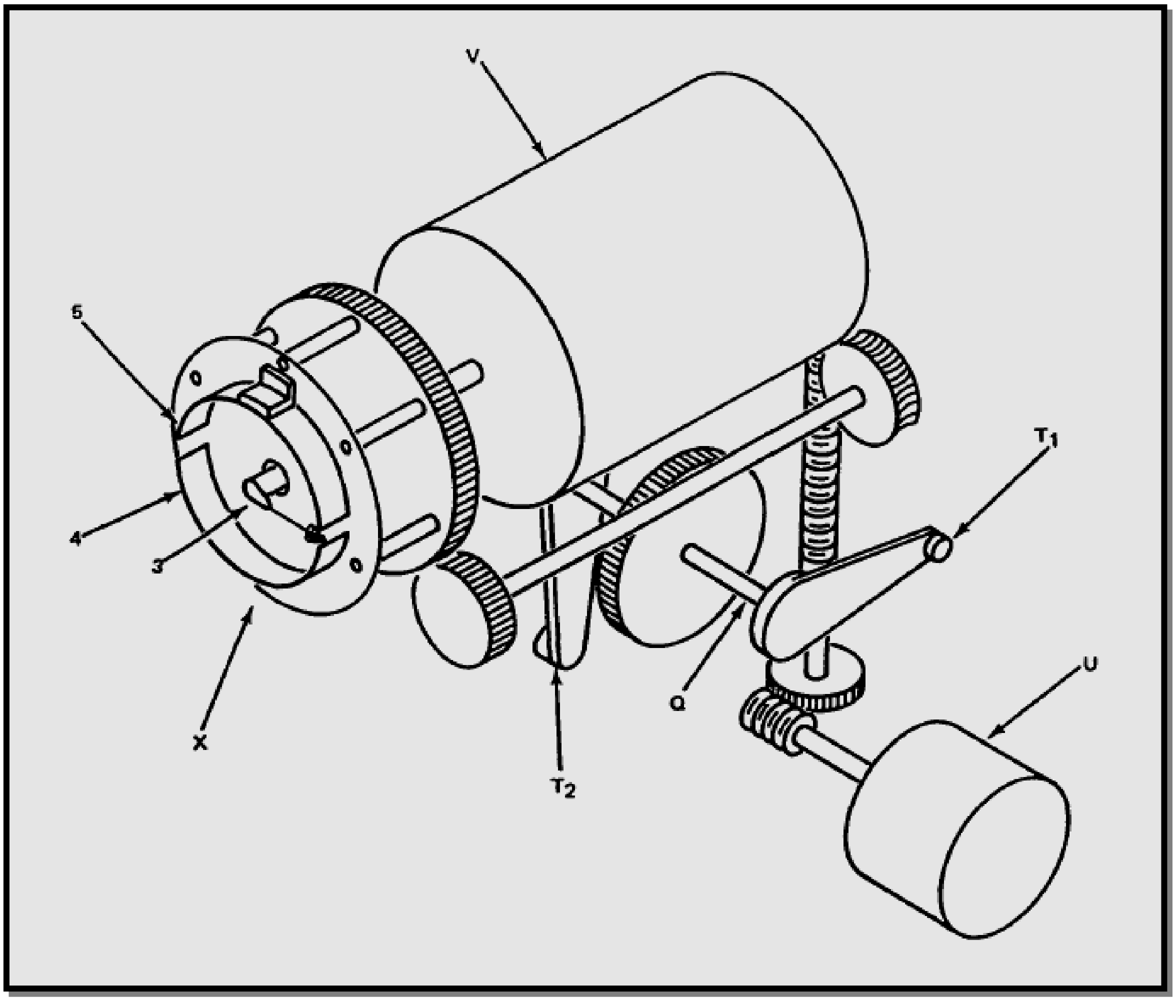


Figure 10-57.— Ship's-Course Crank-Arm Mechanism.

10.20.3 Operation
This section describes the indicators and operator relationship to the Dead Reckoning Analyzer Mk 6 Mod 1 (DRA). There are no controls or operating procedures for the operator to perform.

INDICATORS
There are four indicators in the DRA. Total miles counter J, shown on figure 10-55, displays ownship's total miles traveled. Counters Nl and N2, shown in figure 10-56, indicate total miles of own ship's travel in a North and East direction. Own-ship course indicator X, shown on figure 10-57, indicates the compass heading of own ship in degrees.

OPERATING PROCEDURE
The only operating procedures for the DRA are to record the miles from the counters. These counters indicate total miles traveled and total miles North and East traveled.

10.22.0 DEAD RECKONING ANALYZER-INDICATOR (DRAI) MK 10 MOD 0
The Dead Reckoning Analyzer-Indicator (DRAI) MK 10 MOD 0 equipment shown in Figure 10-58, is part of a dead reckoning system.

The DRAI computes distance north and distance east by resolving own ship speed into north-south and east-west components and integrating. The DRAI equipment performs as an indicator repeater for the ship’s gyro compass (OWN SHIP’S HEADING indicator) and for the underwater log equipment (OWN SHIP’S SPEED and TOTAL DISTANCE indicators).

DISTANCE traveled NORTH and DISTANCE traveled EAST is displayed by means of resettable counters on the front panel of the DRAI. DISTANCE NORTH-SOUTH and EAST-WEST Signals are also available as synchro outputs at one Turn/Nautical Mile 60Hz for use with the AN/SPA-25 Radar Indicator.

Distance N-S and E-W Signals in 4-wire, 5-Volt DC Step Format are also provided to drive the MK 6 Mod 4C DRT. The DRAI also has the capability of driving three additional Dead Reckoning Tracer Units.

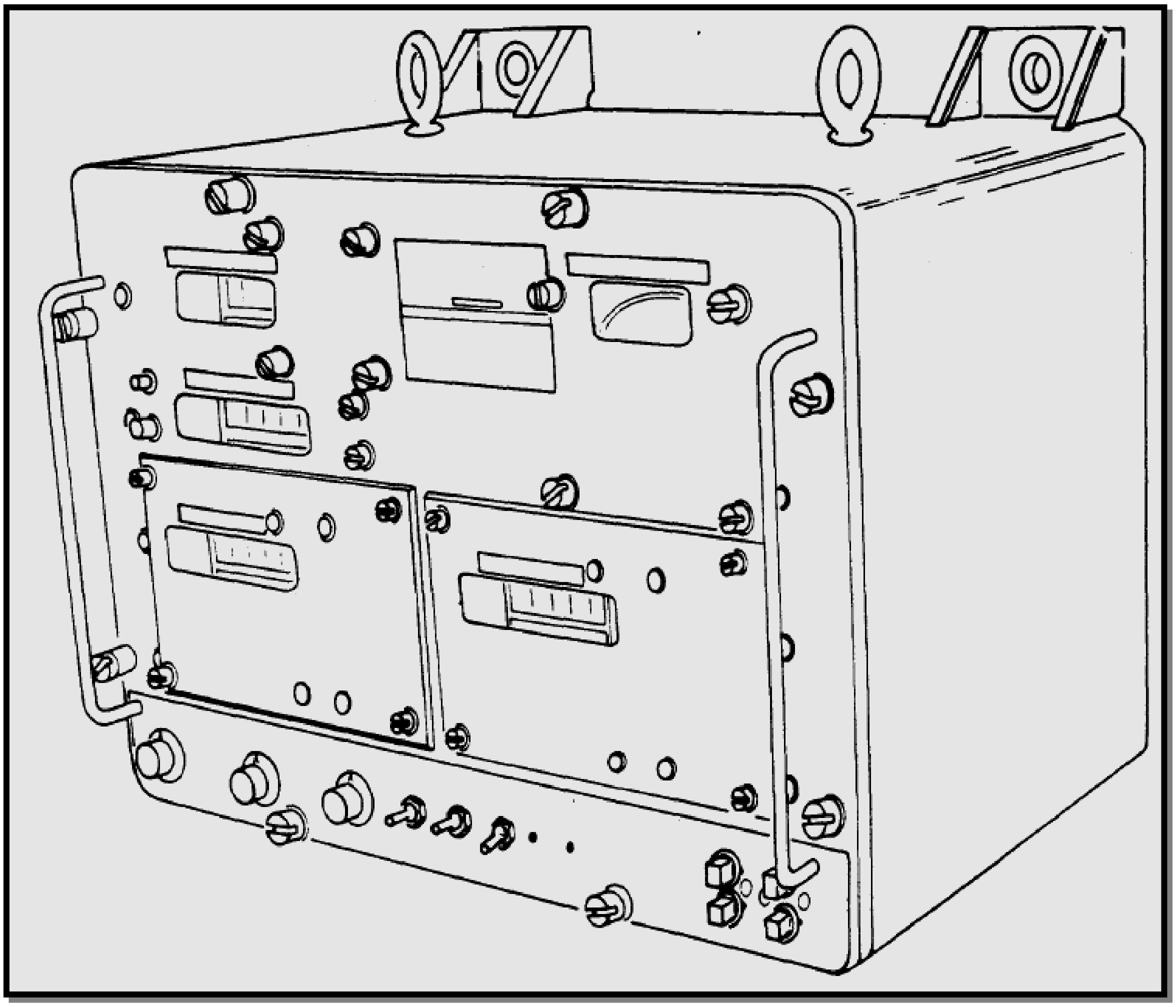


Figure 10-58.— Dead Reckoning Analyzer-Indicator.

10.22.1 Equipment Description

The DRAI equipment is designed using a modular concept to the fullest extent possible. Each input servo subassembly and output solid-state integrator motor drive subassembly is built to be bolted onto the DRAI chassis drawer and electrically connected with multipin connectors. Each of the twelve circuit boards is vertically mounted in a circuit board rack and held in place by a holding assembly that is a part of the circuit board rack. Electrical connections for the circuit boards are accomplished by the plugs inside the circuit board rack which are physically wired to the DRAI equipment wiring harness.

Mounting of the DRAI equipment is accomplished by locating mounting holes to correspond with the DRAI mounting tabs and bolting the equipment to a suitable bulkhead inside the ship. Electrical connections to the DRAI equipment are accomplished by fabricating five interconnection cables using the plugs supplied with the equipment.

10.22.2 Operation

This section includes those operating procedures required by the operator to effectively and efficiently utilize the DRAI equipment. Also included are operational procedures for a self-test, using built in test equipment (BITE), to ensure that the DRAI equipment is functioning properly. All operating controls and indicators are located on the front, however, some of the controls and a meter indicator used with the CAL mode (BITE) are located inside the DRAI case. Access to the BITE is accomplished by pulling the DRAI equipment drawer out to the extended position.

10.22.3 Controls and Indicators

Figure 10-58 displays the DRAI controls, indicators and jacks utilized by the operator in the performance of his duties. Table 10-7 describes the function of each control, indicator, and jack. The BITE controls and indicator, used for DRAI checkout, are shown in Figure 10-59 and described in Table 10-8.

NAME	FUNCTION
POWER OFF/ON switch 1S1	Used to control all 115 Vac power inputs and synchro inputs to the DRAI equipment.
POWER ON indicator 1DS1	Indicates that application of power has resulted in distribution of unregulated +12 Vdc.
ILLUMINATION control 1R1	Used to vary the brightness of the panel lights.
MODE OPR/CAL switch and CAL indicator 1S2 and 1DS2	Used to select operate or calibration modes of equipment operation-CAL indicator lamp lights when mode switch is in the CAL position.
HEADING INCREASE/DECREASE switch 1S3	Used to drive the heading servo to a desired heading indication. The switch is spring loaded to the center off position. Control of the heading synchro is accomplished when the MODE switch is in CAL only.
SPEED INCREASE/DECREASE switch 1S4	Used to drive the speed servo to a desired speed indication. The switch is spring loaded to the center off position. Control of the speed servo is accomplished when the MODE switch is in CAL only.
SLEW RATE FAST/SLOW switch 1S5	Used to control rate at which the heading and speed synchros turn. Switch is positioned to FAST or SLOW and remains in position until manually changed.
RUNNING TIME meter 1M1	Indicates total number of hours that the DRAI is in operation.

Table 10-7.— DRAI Controls and Indicators.

NAME	FUNCTION
DC SUPPLIES	
+5V/F5 (5 amp) indicator 1DS3	Lights when fuse has blown.
+12V/F6 (1 amp) indicator 1DS4	Lights when fuse has blown.
-12V/F7 (1 amp) indicator 1DS5	Lights when fuse has blown.
115V SUPPLIES	
F1/HD 1 AMP fuse indicator 1XF1	Lights when fuse is blown.
F2/SP 1 AMP fuse indicator 1XF2	Lights when fuse is blown.
F3/DIST 1 AMP fuse indicator 1XF3	Lights when fuse is blown.
F4/PWR 2 AMP fuse indicator 1XF4	Lights when fuse is blown.
OWN SHIP'S SPEED indicator 1A17	Indicates a numerical value that represents ship's speed in knots.
OWN SHIP'S HEADING indicator 1A18	Indicates with two dials the value that represents ship's heading in degrees from the ship's gyro compass.
TOTAL DISTANCE indicator 1A16	Indicates a numerical value that represents the total distance transmitted from the ship's underwater log.
DISTANCE NORTH indicator 1A15	Indicates a numerical value that represents distance north as computed from speed and heading input signals.
DISTANCE EAST indicator 1A14	Indicates a numerical value that represents distance east as computed from speed and heading input signals.

Table 10-7(Cont'd).— DRAI Controls and Indicators.

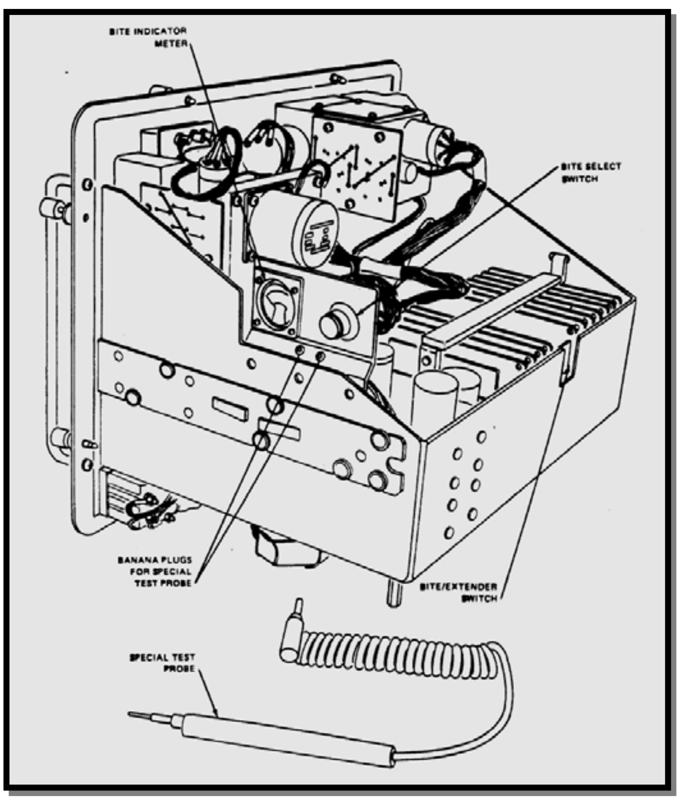


Figure 10-59.— BITE Controls and Indicators.

NAME	FUNCTION
BITE SELECT switch 1S6	Used to select several points in the DRAI equipment for monitoring performance.
BITE INDICATOR meter 1M2	Indicates performance levels of monitor points selected by the BITE SELECT switch and Bite/Extender switch.
7.5 VDC Banana Jack	Bite indicator meter functions as 7.5 VDC Voltmeter.
15 VDC Banana Jack	Bite indicator meter functions as 15 VDC Voltmeter.
Bite/Extender switch 1A9S1	Extends function of BITE SELECT switch.

Table 10-8.— BITE Controls and Indicators.

10.22.4 Operating Procedures

The operating procedures consist of those steps required to turn on the DRAI equipment, perform a self test, and the initial control settings required to put the DRAI into normal operation. Table 10-9 provides the turn-on and normal operating procedure. The turn-on procedure and normal operating procedure are the same. Follow the instructions given in Table 10-9 to accomplish turn-on. Table 10-10 provides the preparation check procedure.

STEP	OBSERVE
1. Place the POWER Switch to the ON position.	Power ON indicator lights.
2. Place the MODE switch to the OPR position.	The CAL light is not lit.
3. Adjust the ILLUMINATION/DIM control.	The panel lights vary in brightness. Adjust to desired level of brightness.
4. Check OWN SHIP'S HEADING indicator.	The indicator numerical value should correspond to readings from the ship's gyro compass.
5. Check OWN SHIP'S SPEED indicator.	The indicator numerical value should correspond to speed readings from the underwater log.
6. Check TOTAL DISTANCE indicator.	The indicator numerical value should correspond to total distance transmitted from the underwater log.

Table 10-9.— Operator Turn-On and Normal Procedure.

STEP	OBSERVE
1. Place the Power switch to the OFF position.	
2. Loosen eight captive screws securing the front panel to the case and pull the drawer assembly out to the fully extended position.	
WARNING: This procedure is performed with power on. Potentials hazardous to life can be encountered. Do not come in contact with any exposed terminals.	
3. Place the Power switch to the ON position.	POWER ON indicator lights.
4. Place the MODE switch 1S2 to the CAL position.	CAL indicator lights.
5. Place the Bite/Extender switch 1A9S1 located inside the DRAI to position 1.	Bite meter (M2) inside the DRAI reads 1.0 ±0.1, indicating that the 5 Vdc regulated power supply is operating correctly.
6. Place the Bite/Extender switch to position 2.	Bite meter (M2) reads 1.0 ±0.2, indicating that ±regulated supply balance is correct.
7. Place the Bite/Extender switch to position 3.	Bite meter (M2) reads 1.2 ±0.1, indicating that the ±12 Vdc regulated supply is operating correctly.
8. Place the Bite/Extender switch to position 4.	Bite meter (M2) reads 1.1 ±0.2, indicating that the +5 Vdc unregulated supply is operating correctly.
9. Operate HEADING switch 1S3, as necessary, until 045.0° is indicated on the OWN SHIP'S HEADING indicator. Operate SPEED switch 1S4, as necessary, until 25.5 knots are indicated on the OWN SHIP'S SPEED indicator.	DISTANCE NORTH and DISTANCE EAST indicators should be increasing at the rate of 0.1 nautical mile each 20 seconds.
10. Check reading on the TOTAL DISTANCE indicator.	Numerical value should be increasing 0.1 nautical mile each 9 seconds (due to 40 knot simulated speed signal applied with 1S2 in the CAL position).
11. Operate HEADING switch 1S3, as necessary, until 225.0° is indicated on OWN SHIP'S HEADING indicator.	DISTANCE NORTH and DISTANCE EAST indicators should be decreasing at the rate of 0.1 nautical mile each 20 seconds.
12. Check reading on the TOTAL DISTANCE indicator.	Numerical value should be increasing 0.1 nautical mile each 9 seconds.
13. Place the Power switch to the OFF position.	

Table 10-10.— Pre-Operational Checks.

10.22.5 Modes of Operation

Two modes of operation are selectable with the DRAI equipment MODE switch; OPR and CAL. When the MODE switch is in the OPR position the DRAI should he operating in normal system configuration. When the MODE switch is in the CAL position the DRAI equipment is prepared for self checkout and testing with BITE. Table 10-9 provides an explanation and operating procedures for the OPR position of the MODE switch. Table 10-10 provides procedures for performing a preparation check of the DRAI equipment. Performing this check determines the operational readiness of the equipment for normal use.

10.22.6 Overall Description

The DRAI equipment consists of two input servo subassemblies (OWN SHIP'S HEADING and OWN SHIP'S SPEED), two solid state integrators at the outputs (DISTANCE NORTH and DISTANCE EAST), and an electromechanical totalizer (TOTAL DISTANCE). Each of the inputs is displayed on the front panel of the DRAI and represent inputs from the ship's gyro compass and the underwater log equipment. Each of the outputs is also displayed on the front panel and represent DISTANCE NORTH/ DISTANCE EAST which is fed to the Dead Reckoning Tracer Units, and the AN/ SPA-25 Radar Indicator.

INPUT SERVO SUBASSEMBLY FUNCTIONS

Initial operation of the input servo assemblies occurs when the ship's gyro compass (OWN SHIP'S HEADING) or the underwater log (OWN SHIP'S SPEED) applies voltage to the stators of the input synchro control transformers. This voltage induces a signal in the rotor of the synchro control transformer which causes a signal to be applied to the input summing network of the limiter/detector circuit. The signal from the summing amplifier is phase detected to determine direction that the stepping motor, at the output of the servo loop, should turn (Increase or Decrease).

This increase/ decrease, signal from the limiter/detector is applied to the input of a "sequential" step motor drive circuit. The output of the step motor drive circuit is applied to the stepping motor input causing the motor drive shaft to start rotating. The rotating motor shaft drives the input synchro rotors. The input synchro rotors are driven until the input error signal is at zero (null) and the servo loop returns to the quiescent state. The servo loop will remain in the quiescent state until another "error" signal is present at the input synchro control transformers.

Note that at the same time that null is reached for the input synchros, the resolver rotor is driven to a specific position if the heading servo subsystem is operating, and a ten turn precision potentiometer is driven to a specific position if the speed servo subsystem is operating.

SOLID STATE INTEGRATOR FUNCTIONS

Positioning the rotor of the resolver (HEADING component) and speed potentiometer (SPEED component) results in a sine/cosine output from the resolver that is fed to the solid state integrators. A solid state integrator in the DRAI consists of an analog circuit board, digital circuit board, step motor drive circuit, and stepping motor.

The Distance North and Distance East solid state integrators are identical, so the following text applies to both. The input to the analog board is either the cosine function (SPEED NORTH) or sine function (SPEED EAST) from resolver 1A18B4. The output from the resolver is applied through a summing amplifier, phase detected, and sent from the analog board as an increase/decrease, and high speed/low speed signal.

The increase/decrease and high speed/low speed signals are applied to the digital board to determine which direction the stepping motor of the solid state integrator should turn and at what speed. The digital board also generates a speed gate signal that is applied to the Clock, Scale, and Distance Driver board to determine quantity the stepping motor should turn. Outputs from the digital board up/down counters provide feedback to the analog board.

This digital feedback signal is converted to an analog equivalent and applied to a summing amplifier. The feedback signal builds in amplitude until the input to the analog board is at a null condition which causes the solid state integrator to assume a quiescent state. Increase/decrease signals plus scaled distance north/ distance east gates are applied to the solid state integrator stepping motor driver and also to outputs required to drive the Dead Reckoning Tracer units.

TOTAL DISTANCE INDICATOR FUNCTIONS

The Total Distance Indicator is operated with one of two possible external input signals. The acceptable signals to operate the indicator are a synchro stator input (360 turns/nautical mile) or 10 pulses per knot (36,000 pulses/nautical mile) signal from the ship's log equipment.

When the synchro stator signal is applied to the DRAI, the signal is applied to a synchro to digital converter. The synchro to digital converter changes the 360 turns/nautical mile synchro signal to a 10 pulses per nautical mile digital signal that is used to drive the TOTAL DISTANCE indicator.

When the 36,000 pulses/nautical mile signal is applied to the DRAI, the signal is divided by 50 and by 72 to produce a 10-pulse per nautical mile digital signals. This resultant signal is used to drive the TOTAL DISTANCE indicator in 0.1 mile increments.

MISCELLANEOUS TEST AND CONTROL FUNCTIONS

The miscellaneous Test and Control functions are required to provide circuitry for four separate functions of the DRAI equipment; total distance signal scaling, resolver speed, signal amplification, and range amplifiers for the BITE function.

Total Distance Signal Scaling

The TOTAL DISTANCE indicator (1A16) is designed to increment once for each 0.1 nautical mile. Digital counters located on the Miscellaneous Test and Control board are used to count down a 720 pulse per nautical mile signal or a 36,000 pulse per nautical mile signal, depending on which of the Total Distance inputs to the DRAI is being used.

BITE Range Amplifiers

The BITE circuits of the DRAI are selected by a Bite/Extender switch (1A9S1) and the BITE SELECT switch 1S6. The range amplifiers on the Miscellaneous Test and Control board are selected by the Bite/Extender switch (1A9S1) and allow the operating range of the BITE INDICATOR to be set at 7.5 volts full scale or 0.75 volts full scale. This circuitry allows the technician, through a means of manual selection, to monitor the DRAI BITE signals as an aid during fault isolation. The BITE function is also used to perform operational and performance checks to assure optimum functioning of the DRAI equipment.

10.23.0 DIGITAL DEAD RECKONING TRACER (DDRT) AND DEAD RECKONING TRACERS (DRT)

This section provides information for of the Digital Dead Reckoning Tracer Mk 6 Mod 4E (DDRT), and Dead Reckoning Tracers MK 6 Mod 4B and Mod 4C (DRT-4B/ 4C). Differences between the DDRT and DRT-4B/4C will be explained or annotated as required. Figure 10-60 illustrates the equipment.

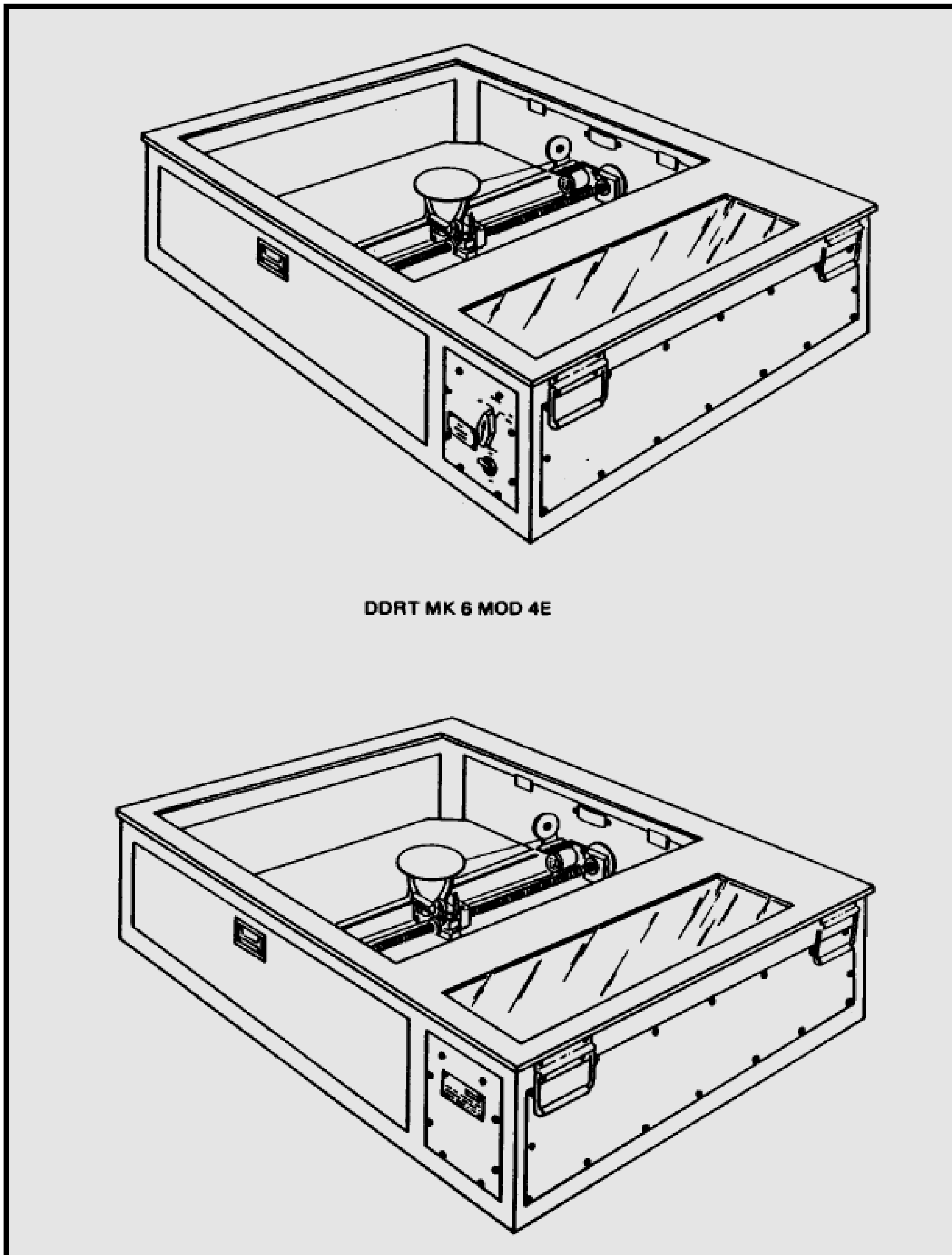


Figure 10-60.— Digital Dead Reckoning Tracer Mk 6 Mod 4E and Dead Reckoning Tracers Mk 6 Mod 4B/4C.

10.23.1 Equipment Function

The DDRT and DRT-4B/4C graphically record own-ship's dead reckoning track, and compute and display own-ship's position (longitude and latitude) on counters.

10.23.2 Unit Description

The DDRT and DRT-4B/4C are composed of two major compartments, the tracing compartment and the control compartment.

Tracing Compartment

The tracing compartment consists of mechanical and electromechanical assemblies to record own-ship's track on a smooth drafting vinyl surface. The glass cover of this compartment is an auxiliary plotting surface for manually plotting own-ship's track and/or a target's position and movement with respect to own ship.

Base

The base of welded aluminum extrusions is the foundation to which all tracer components are mounted.

Tracking Board

The tracking board is a large honeycombed aluminum panel which is secured to the base and covered with a smooth drafting vinyl. A chart for recording own-ship's track can be taped to the vinyl.

Guide Rails

Two 3/4-inch diameter guide rails, mounted to the base, support the carriage which moves on four linear ball bearings as positioned by the lead screw (left-right motion).

Carriage

The carriage is an aluminum casting with its ends riding on the guide rails. It supports the cross screw drive assembly and the projector pencil assembly. The carriage is positioned left or right by the lead screw drive.

Lead Screw Drive

The lead screw drive transmits left-right motion to the carriage assembly through a ball nut. The ends of the lead screw are supported by bearing blocks containing ball bearings. The lead screw is driven by a step motor through two gears which provide a 25:4 stepdown ratio. The carriage is moved 1 inch for each revolution of the lead screw, which requires 450 steps of the step motor. (See figure 10-61 for the gearing diagram for both lead and cross screw drives.)

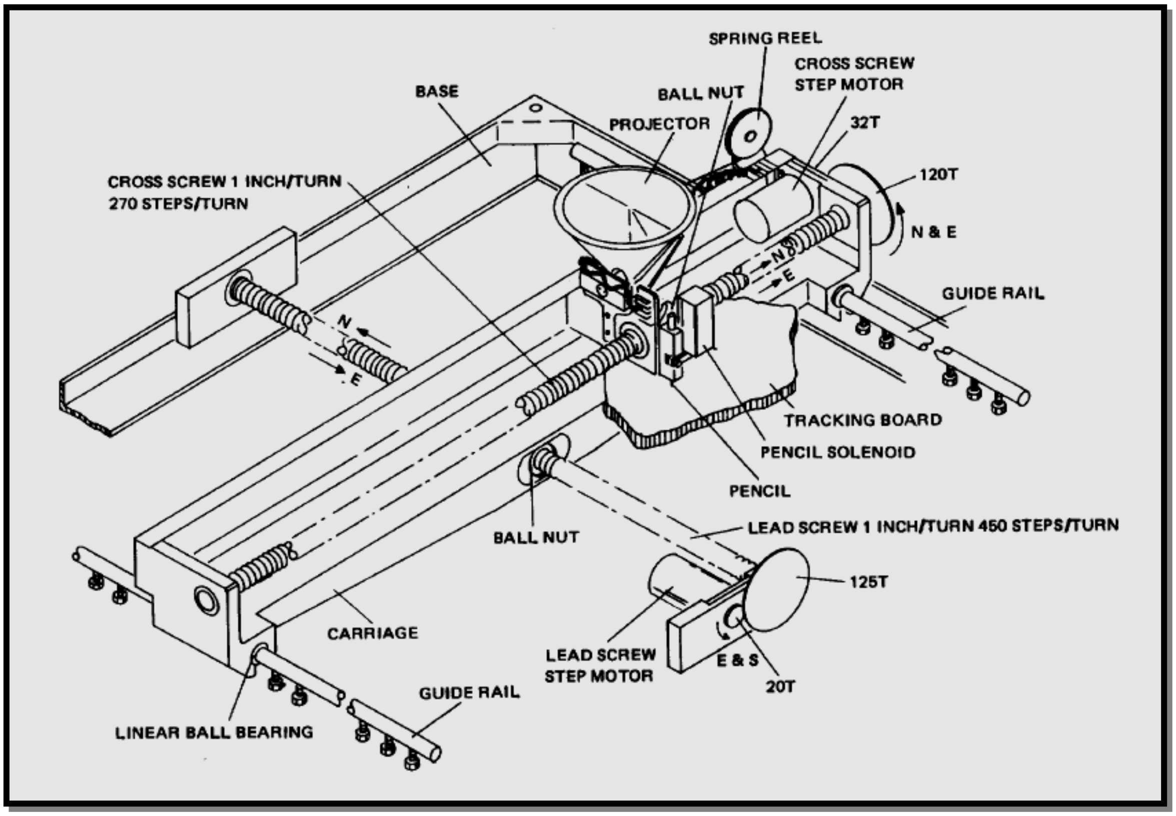


Figure 10-61.— Gearing Diagram for the Lead and Cross Screws.

Cross Screw Drive

The cross screw drive transmits horizontal motion (perpendicular to the carriage motion) to the pencil and projector assembly through a ball nut. The ends of the cross screw are supported on the carriage assembly by bearing blocks containing ball bearings. The cross screw is driven by a step motor through two gears which provide a 15:4 stepdown ratio. The pencil assembly is moved 1 inch for each revolution of the cross screw, which requires 270 steps of the step motor.

Pencil and Projector Assembly

The pencil and projector assembly is mounted to a ball nut which is positioned by the cross screw. The ball nut is a block containing helical races in which bearing balls circulate. The nut is fitted with two tubular ball guides which carry the balls diagonally across the outside of the nut, and return them to the active raceway. As the screw rotates, linear motion is imparted to the ball nut with very low friction.

Energizing power for both the pencil solenoid, and the projector lamp, comes from the control compartment through a cable to a terminal board on the cross screw assembly, and on through a spring-coiled cable to a terminal board on the pencil and projector assembly. The lead screw drive and cross screw drive move the pencil to provide a recording of the own-ship's track on a chart.

Pencil Assembly

The pencil assembly is solenoid actuated with spring tension to maintain contact during tracing. The tension spring maintains constant uniform pressure to the tracing lead as it wears down. The pencil is secured by a thumbscrew in an actuating arm which is lifted by a solenoid to lift the pencil and interrupt the trace at either 1- or 10-minute time intervals.

Projector Assembly

The projector assembly is mounted with the pencil assembly on the tracking carriage so that it is positioned in the same manner as the pencil assembly. The projector assembly consists of a mounting base, lamp assembly, inverted conical light shield, and image assembly. The image assembly is a clear, circular, plastic film plate containing a compass rose. When the lamp is lit, the image of the compass rose (figure 10-62) is projected up to the auxiliary plotting surface. A spring reel and cable assembly is installed on the carriage assembly to apply a retracting load to the projector assembly for minimizing vibration of the projected image when under non-operating and testing conditions. When tracing paper is taped to the plotting surface, the enlarged image of the compass rose is plainly visible with the center representing own-ship's position. A shadow disk, normally stored under the cover of the control compartment, can be fitted over the projector to permit only a spot of light, representing own-ship's position, to be projected onto the plotting surface.

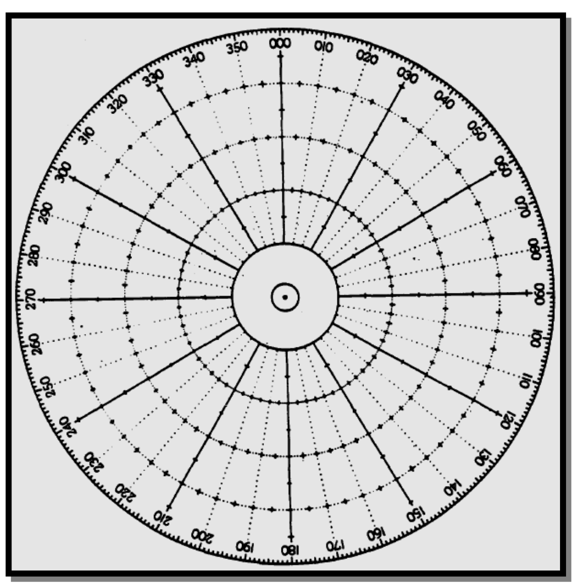


Figure 10-62.— Compass Rose.

Control Compartment

The control compartment contains the electronics portion, the operating and testing controls, the position indicators, and the clock. Lights under the glass cover provide illumination for the control panel. Three connectors at the rear provide electrical connections for all input and output power and signals. A gearing diagram for the latitude and longitude counters is provided in figure 10-63.

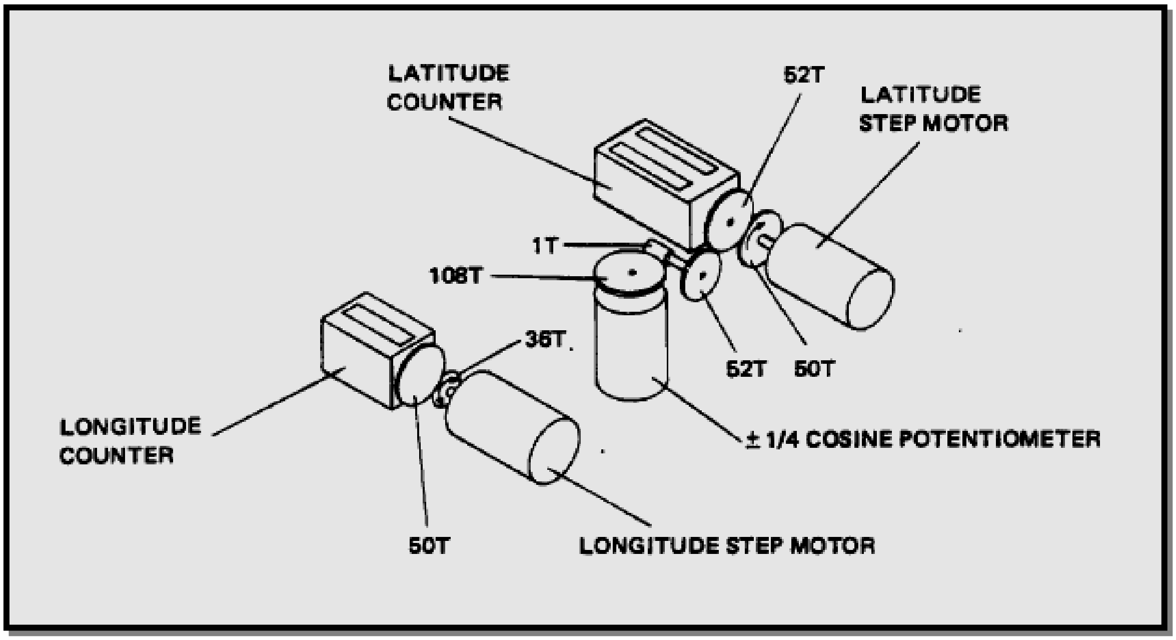


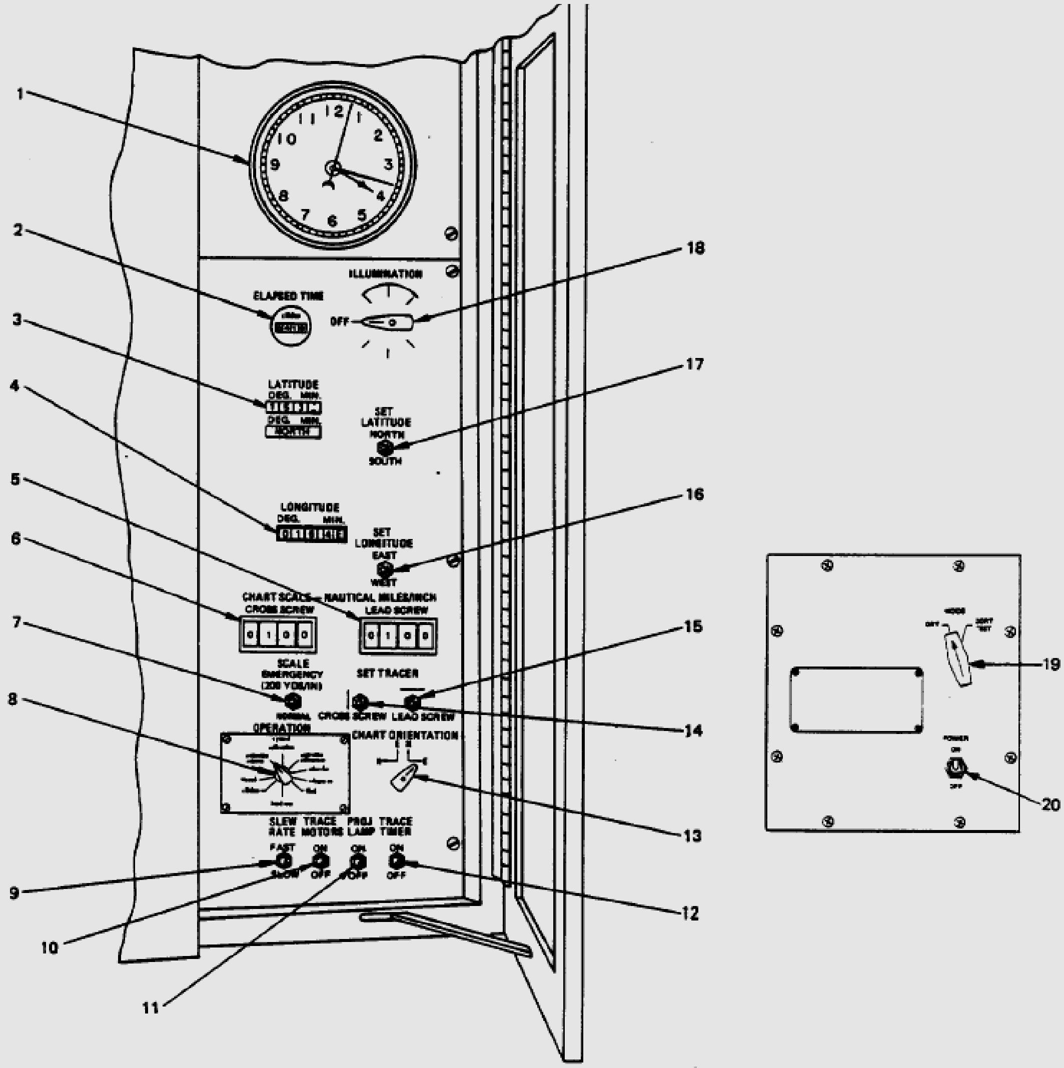
Figure 10-63.— Gearing Diagram for the Latitude and Longitude Counters.

Clock Assembly

The clock is a mechanically operated, manually wound, 8-day clock with a sweep second hand and electrical contacts. Contacts close for 15 seconds every minute, and for 1 minute every 10 minutes.

Control Panel Assembly

The control panel assembly contains the controls and indicators for operating and testing of the DDRT and DRT-4B/4C. The panel is hinged so it can be tilted up for access to assemblies and connections on the rear of the panel. See figures 10-64 and 10-65.



1. CLOCK
2. ELAPSED TIME METER
3. LATITUDE INDICATOR
4. LONGITUDE INDICATOR
5. CHART SCALE LEAD SCREW DIGISWITCH
6. CHART SCALE CROSS SCREW DIGISWITCH
7. SCALE SWITCH
8. OPERATION SWITCH
9. SLEW RATE SWITCH
10. TRACE MOTORS SWITCH
11. PROJ LAMP SWITCH
12. TRACE TIMER SWITCH
13. CHART ORIENTATION SWITCH
14. SET TRACER CROSS SCREW SWITCH
15. SET TRACER LEAD SCREW SWITCH
16. SET LONGITUDE SWITCH
17. SET LATITUDE SWITCH
18. ILLUMINATION SWITCH
19. DRT/DDRT TEST SWITCH
20. POWER ON/OFF SWITCH

Figure 10-64.— DDRT Operator's Controls and Indicators.

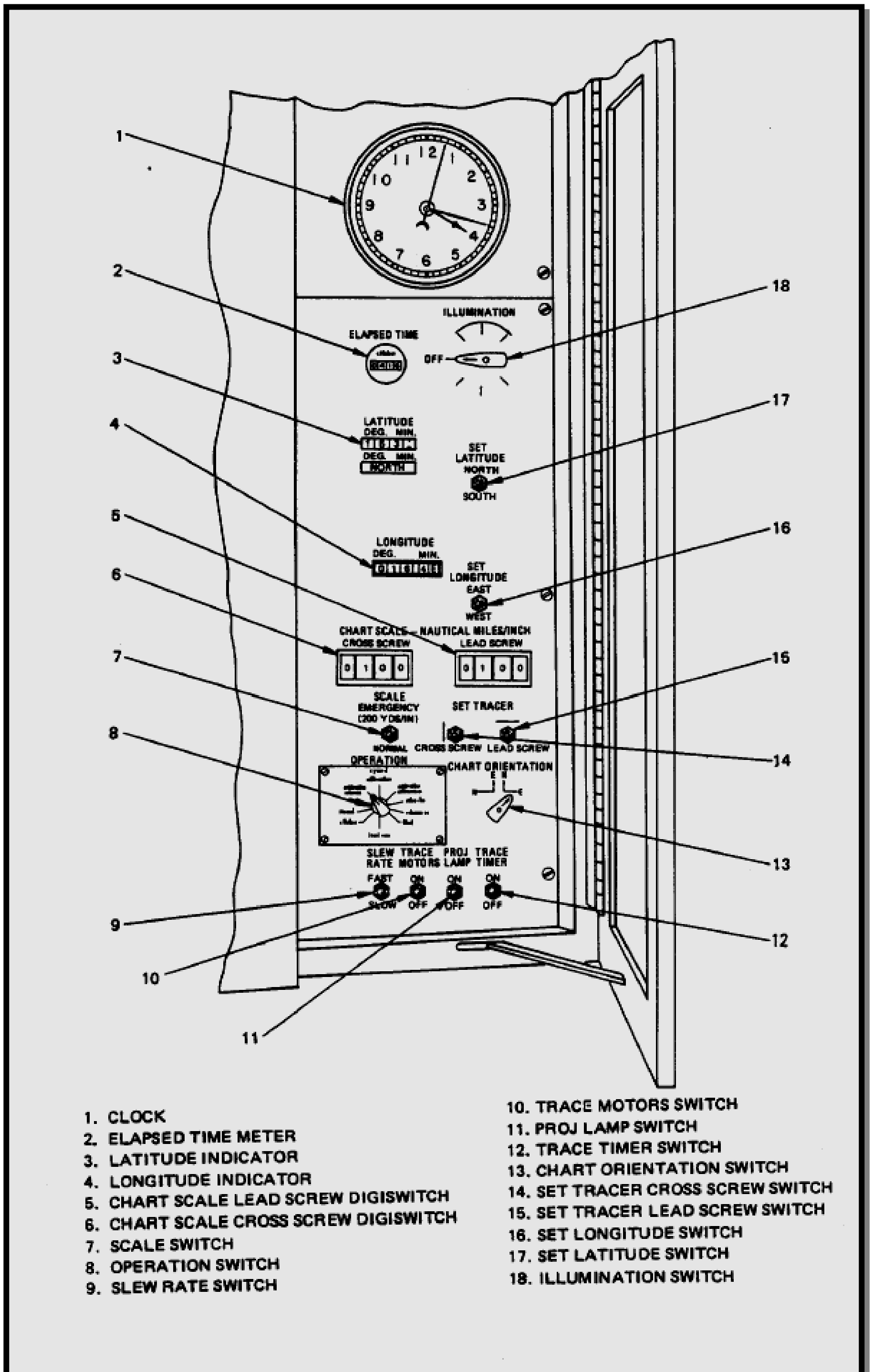


Figure 10-65.— DRT-4B/4C Operator's Controls and Indicators.

Card Rack Assembly

The card rack assembly contains the major portion of the electronic circuits and a test point assembly. It is mounted behind the panel to the rear of the clock, and has connectors for 9 printed circuit boards with a test point board permanently mounted and containing 17 resistively isolated test points. The printed circuit board assemblies that plug into the card rack are as follows:

a. +4.8 volt regulator board assembly

b. Pulse and drive board assembly

c. Longitude computer board assembly

d. Phase detector, reset board assembly

e. Lead/cross screw, dual step motor drive board assembly

f. Longitude/latitude indicator, dual step motor drive board assembly

g. Buffer board assembly

h. Function generator board assembly

i. Bridge rectifier board assembly.

Regulator Board (+4.8V)

This board produces +4.8 volts power for the DDRT and DRT-4B/4C.

Pulse and Drive Board

This board scales the north and east distance pulses into pulse trains compatible for the different lead screw and cross screw gear ratios.

Longitude Computer Board

This board computes longitude change by dividing the north distance pulses by the cosine of latitude.

Phase Detector Reset Board

This board produces pulses for the longitude counter drive circuits.

Dual Step Motor Drive Boards

These are two identical circuit boards. One drives the lead screw and cross screw step motors; the other drives the latitude counter and longitude counter step motors. These circuit boards are supported by two separate hardware information packages. One hardware package supports the originally designed circuit board in use (to be used until the supply is exhausted). The other package supports the newly designed circuit board (for use when the original supply is exhausted) which is functionally equivalent to the original circuit board.

Buffer Board

This board converts 3-phase test signals to two pulse trains.

Function Generator Board

This board generates test signals for internal test of the DDRT and DRT-4B/4C, and generates clock signals.

Bridge Rectifier Board

This board rectifies the incoming AC supply for the power supplies.

Transformer Assemblies (DDRT only)

Two transformers (1T1 and 1T2) and three filter capacitors (1C1, 1C2, and 1C3) are mounted in the bottom of the control compartment. Transformer 1T2 works in conjunction with circuit board 1A7 to produce -28V, -15V, and -6.2V. Transformer 1T1 provides 7.5-VAC, 14-VAC, and 25-VAC to the 1A5 assembly for generation of +4.8V, +4.1V, +12V, -12V, and +O.7V. These voltages are used by the DDRT operating circuits. The 50-VAC and 0.25-VAC are provided to the longitude circuitry for longitude calculation. Transformer 1T1 also generates the AC voltages for the illumination circuit.

Transformer Assembly (DRT-4B/4C only)

Transformer 1T1 and the three filter capacitors (1C1, 1C2, 1C3) are mounted in the bottom of the control compartment. Transformer 1T1 provides 7.5-VAC, 14-VAC, and 25-VAC to the 1A5 assembly for generation of +4.8V, +4.1V, +12V, -12V, and +0.7V. These voltages are used by the DRT-4B/4C operating circuits. The 50-VAC and 0.25-VAC are provided to the longitude circuitry for longitude calculation. Transformer 1T1 also generates the AC voltages for the illumination circuit.

East Distance and Parity Assembly (DDRT only)

The east distance and parity assembly is located in the bottom left-hand corner of the control compartment. It processes input data and external calibration data to convert the east parallel data to serial data. Input and output signals can be monitored on test point board 1A8.

North Distance and Power Supply Assembly (DDRT only)
The north distance and power supply assembly is located adjacent to the east distance and parity assembly. Its operation is similar to the east data processor for north data signals. The power supply section provides -28V, -15V, and -6V regulated power to other assemblies.

Test Point Assembly 1A8 (DDRT only)
The test point board contains 20 resistively isolated test points for monitoring of the north and east input and output signals, and the negative DC voltages.

Clipper Circuit Assemblies (Types A and B)
There are two clipper circuit assemblies supplied with the DRT-4C, and one with the DRT-4B. The Type A clipper circuit assembly is used when 115-VDC drive signals are supplied by the Dead Reckoning Analyzer Indicator (DRAI). The Type A clipper circuit assembly limits, clips transient peaks, and attenuates the 115-VDC signal down to 5-VDC. The Type B clipper circuit assembly is used when 5-VDC drive signals are supplied by the DRAI. The Type B clipper circuit assembly simply routes the drive signals to the internal circuitry. The DRT-4C/4B may use either clipper circuit assembly, depending on the level of drive signals from the DRAI. The DRT-4B is supplied with only the Type A clipper circuit. The DRT-4C is supplied with both types. The DDRT also has the capability of using either clipper circuit assembly, but the DDRT must first be placed in the DRT mode.

Discrete Output Assembly (DDRT only)
Relays on this board are energized by signals from the control switch and the parity board to provide signals to the computer, to command it to provide desired signals to the DDRT.

10.23.3 Relationship of Units
The DDRT and DRT-4B/4C are single units and are illustrated showing their relationship to other shipboard equipment. Figure 10-66 illustrates the DDRT. Figure 10-67 illustrates the DRT-4B/4C and the DDRT when in DRT mode. These figures are typical installations.

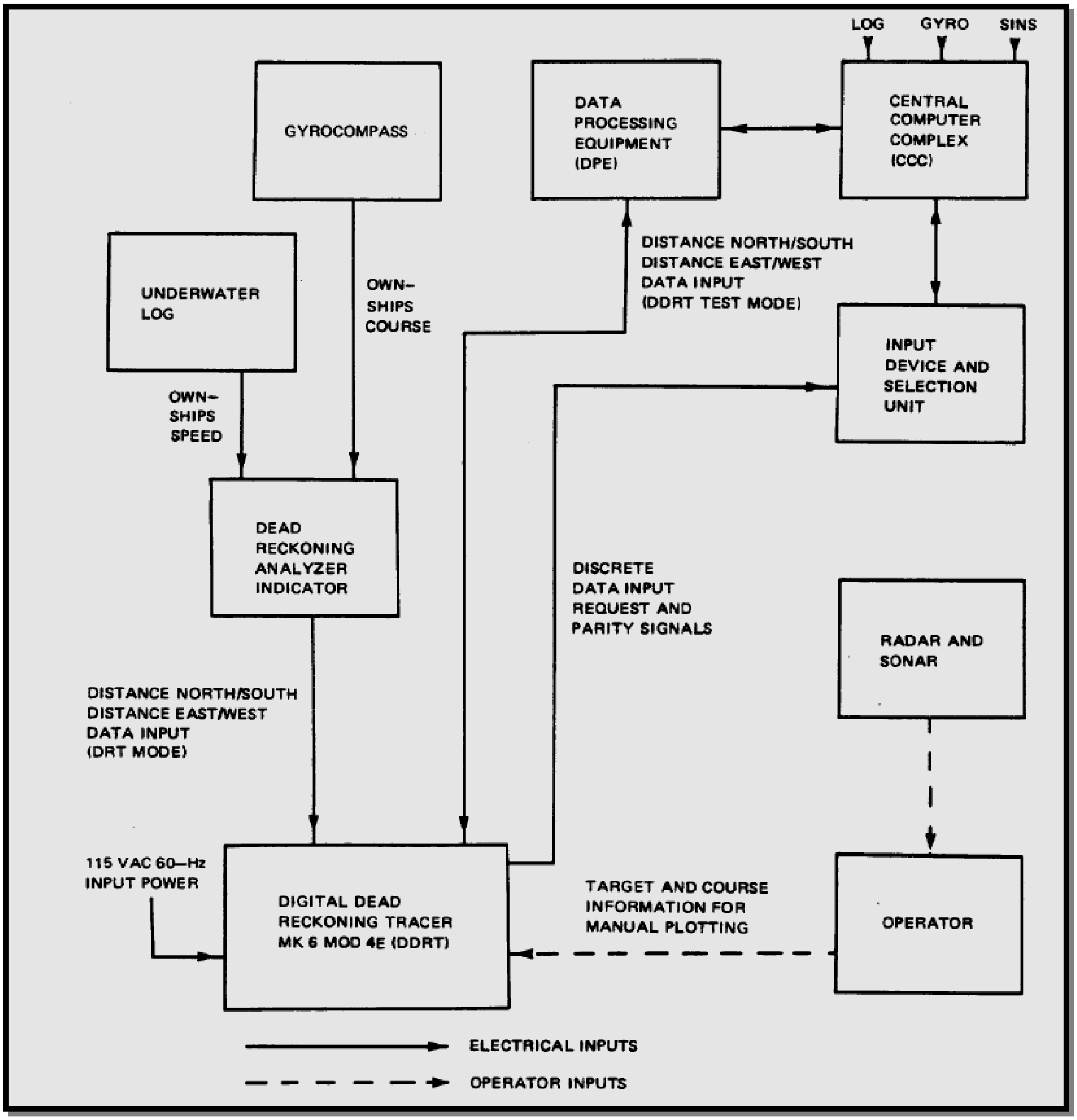


Figure 10-66.— Digital Dead Reckoning System, Relationship of Units (Typical Installation).

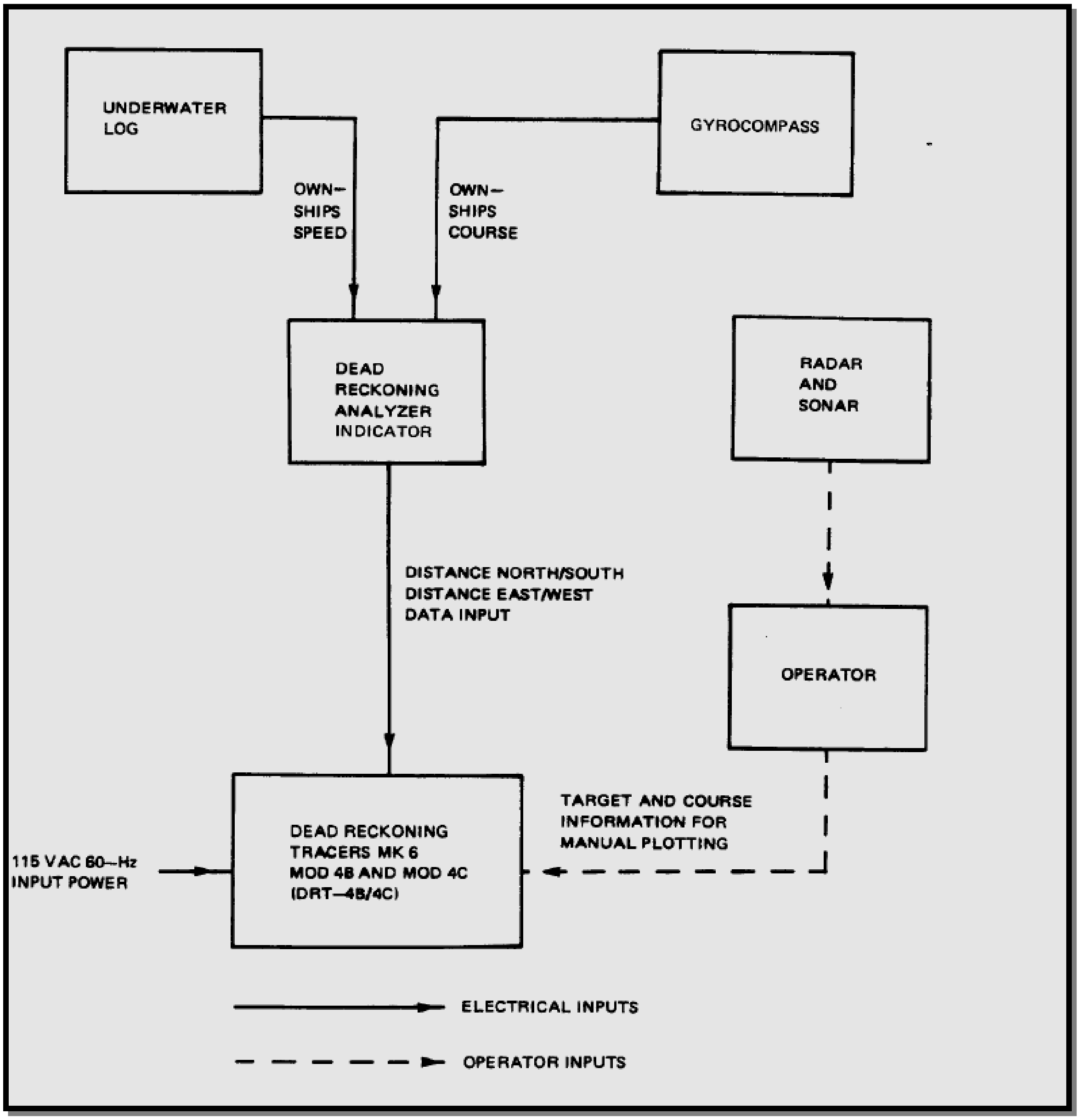


Figure 10-67.— Dead Reckoning System, Relationship of Units (Typical Installation).

Reference Data

Reference data for the DDRT and DRT-4B/4C are provided in table 10-11.

Features	Description
Manufacturer:	
DDRT	Gould Inc. Ocean Systems Division, formerly Defense Electronics Division
DRT-4B/4C	Chesapeake Instrument Corp
Equipment:	
DDRT	Digital Dead Reckoning Tracer
DRT-4B/4C	Dead Reckoning Tracers
Model:	
DDRT	Mk 6 Mod 4E
DRT-4B/4C	Mk 6 Mods 4B and 4C
Functional Characteristics:	
Power Requirements	115±6 VAC, 60±3 Hz, 1-PH, 0.98 power factor, 1.25 AMP
Internal Fuses	F1 - 1 AMP F2 - 3 AMP F3 - 10 AMP F4 - 10 AMP F5 - 1 AMP (DDRT only) F6 - 1/8 AMP (DDRT only)
Input:	
DDRT	Distance north and distance east data are received in digital format from a central computer complex. Source of signal data depends on mode of operation selected. Distance north and distance east data are received from the DRAI.
Modes of Operation:	
DDRT	1. External Calibration 2. Navigation 3. Test 4. DRT
DRT-4B/4C	1. Navigation 2. Test

Table 10-11.— Reference Data for Digital Dead Reckoning Tracer Mk 6 Mod 4E and Dead Reckoning Tracers Mk 6 Mod 4B/4C.

Features	Description
Capabilities and Limitations:	
Range:	180° east or west (no limit stop)
Longitude	85° north or south (limit stop 90° north and south)
Latitude	
Tracing Scales:	
Normal	0.10 to 99.99 nautical miles/inch (variable in 0.01-mile/ inch increments)
Emergency	200 yards/inch (fixed)
Accuracy:	
Tracer	±0.5 percent
Position	±2.0 percent
Resolution:	
Tracer	Lead screw-1/450 inch; cross screw-1/270 inch
Position	Latitude and longitude-.2 minute
Environmental Characteristics:	
Operating Temperature Range	40 to 140 °F (4.4 to 65 °C)
Relative Humidity	0 to 95 percent

Table 10-11(Cont'd).— Reference Data for Digital Dead Reckoning Tracer Mk 6 Mod 4E and Dead Reckoning Tracers Mk 6 Mod 4B/4C.

10.24.0 DIGITAL DEAD RECKONING TRACER (DDRT) MK 6 MOD 5

The MK 6 Mod 5/5A/5B Digital Dead Reckoning Tracer (DDRT) graphically records Own Ship Dead Reckoning tracks, computes and displays Own Ship Position (OSP) through digital displays for Latitude and Longitude. The DDRT (figure 10-68) is also used to plot contacts relative to OSP.

The MK 6 Mod 5 DDRT is a micro-processor-based system that utilizes standard electronic module architecture. The MK 6 Mod 5 DDRT improves reliability, simplifies maintenance and overcomes equipment obsolescence. It provides a resolution of 1/525 inch and 1/180 inch on lead and cross screws, respectively. The MK 6 Mod 5A/B DDRT eliminates the Dead Reckoning Analyzer, Dead Reckoning Analyzer Indicator and DC power requirements.

Figure 10-68.— MK 6 Mod 5 DDRT.

The MK 6 Mod 5 DDRT utilizes a digital interface for MIL-STD-1397 Type A NTDS Interface.

Operation of the MK 6 Mod 5B Digital Dead Reckoning Tracer (DDRT) is identical to the MK 6 Mod 5 DDRT and MK 6 Mod 5A DDRT with one exception. The External Calibration mode of operation is not applicable to the MK 6 Mod 5B DDRT.

There are five modes of operation in the MK 6 Mod 5B DDRT. The modes are Idle, Strategic Navigation, Tactical Navigation, Internal Calibration and Test. The External Calibration function is not used by the MK 6 Mod 5B DDRT.

A description of the modes of operation is provided in chapter 2 of the technical manual. There is no difference between the Strategic Navigation and Tactical Navigation modes. In the Tactical Navigation and Strategic Navigation Modes, own ships heading and own ships speed synchro signals are processed by the MK 6 Mod 5B DDRT.

The Synchro Interface Test described in the technical manual is used to test the interface between the gyrocompass and underwater log synchro transmission systems.

The MK 6 Mod 5 DDRT utilizes own ships heading and own ships speed synchro signals from the gyrocompass and underwater log. These synchro signals are converted to digital data by the Dual Synchro/Digital Converter SEM 1A2A3A1 and processed by the Control and Display Function. Figure 10-69 provides a simplified block diagram of the MK 6 Mod 5B DDRT Data Interface Function.

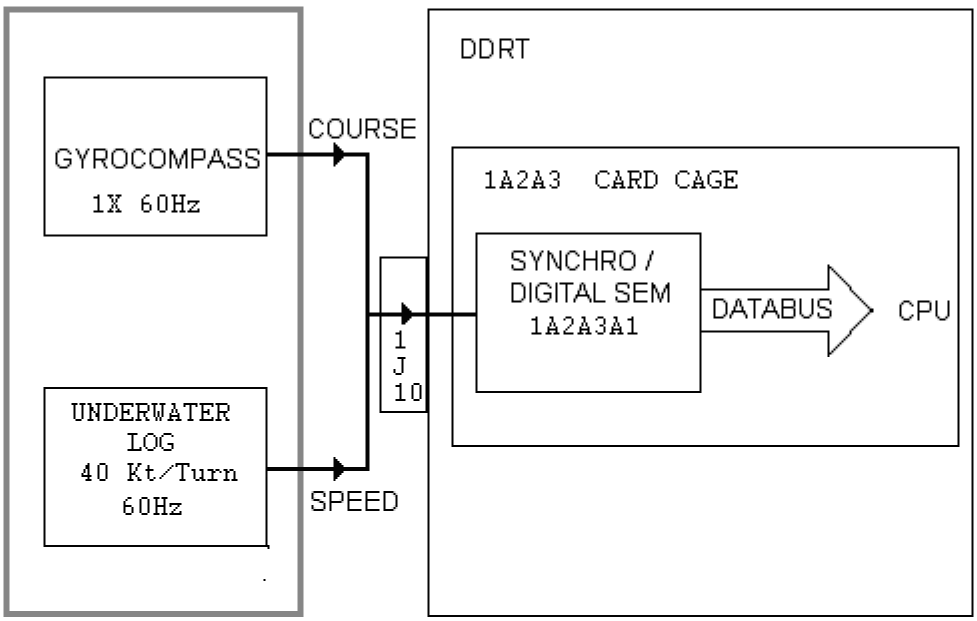


Figure 10-69.— Data Interface Simplified Block Diagram.

10.25.0 INTEGRATED NAVIGATION AND TACTICAL PLOTTING SYSTEM (INTPS)

The INTPS purpose is to provide the operator with a computer based system that will assist the operators with navigational and tactical procedures and responsibilities.

The operator is prompted through visual feedback from the system's light spot; located in the table and pages of data on a display device.

The operator attaches charts and/or plot sheets to the top of the table and following registration proceeds with regular navigation plotting or tactical work aided by the light spot and information from the display.

The system has only one light spot. However, the system memory keeps track of ownship and other targets/tracks simultaneously. Data on these tracks/targets may be viewed sequentially.

The system keeps the operator informed on any decision changing processes. The only "automatic" features of the system are associated with time (the system has a built-in quartz clock) and update of ownship and track positions on a Dead Reckoned basis.

The INTPS may be used for both coastal and ocean navigation and tactical operations plotting. It is not intended to be used for blind pilotage or automatic weapon aiming/firing. Although through correct operation, INTPS will provide significant assistance to the operator for these activities. Major features of the system are as follows.

10.25.1 POSITION

The system consistently indicates target and ownship track as a position via both the light spot on the table and the relevant data page on the Keyboard Display Unit (KDU). These positions may be displayed on the plotting table using any one of the following:

a) Mercator Chart
b) Transverse Mercator Chart
c) Gnomic Chart
d) Polar Stereographic Chart
e) Linear Plotting Sheet
f) Mercator Plotting Sheet

The system is capable of storing registration data on up to 20 charts. Registration data may be entered at any time.

A position being plotted on the table can be displayed simultaneously on the KDU in any of the following formats:

a) Latitude and Longitude
b) Range and bearing from another position stored as a track
c) Coordinates on a Cartesian Coordinate Grid (CCG)

The position may be entered at the KDU in any of the above formats and the position plotted on the table. Position may also be entered by using the slew keys on the KDU to move the light spot to the required point on the chart. The position data for that point is then displayed on the KDU.

INTPS Table (shown fully assembled)

INTPS Table (shown with electronic panel cover removed)

At Right: Keyboard Display Unit (KDU)

Below: INTPS Table (shown with glass plotting surface lifted)

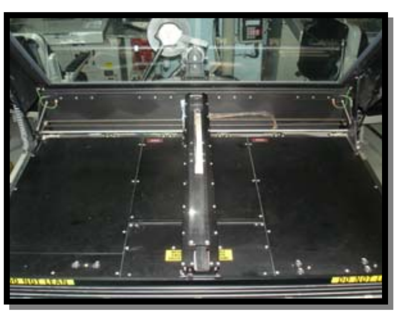


Figure 10-70.— INTPS Table.

10.25.2 Track Handling

The system stores the name, position, time, source, course and speed of up to 128 tracks in addition to ownship. The track positions can be projected forward or backward in time using the track's present course and speed. The information is stored in the system's track table and can be modified manually from the KDU.

10.25.3 General Facilities

The system has numerous facilities for performing tasks associated with navigation and tactical plotting. A few examples are:

Man Overboard

The Man Overboard facilities provide support for man overboard operations. It logs the Man Overboard position and provides a dynamic display of bearing and distance from the current ownship position to the Man Overboard position. On commencement of Man Overboard, it automatically registers a plot sheet with a scale of 200 yards per inch

Intended Movement

The system can maintain a moving origin that represents the intended movement (PIM) of the ship and can move along a rhumb line or great circle path with up to 20 legs. The system calculates and displays the actual ship's position as an offset from this origin. Alternatively, the system can retain a proposed track of up to 20 legs and indicate ownship's distance off track at any time. The system can store up to 3 routes each of 20 legs at any one time.

Passage Planning

Passage planning calculations can be made for multi-leg routes. For each leg, the system can compute the leg distance, course and speed and the heading and log to steer. For the complete passage, the system calculates the sum distance of all legs and the average speed of advanced required.

Relative Velocity

The system can be used to calculate relative velocity problems, including the calculation of intercept course and speed between ownship and target or targets and targets.

10.25.4 Built-In Test (BIT)

The system has hardware and software BIT incorporated to detect fault conditions down to modular level. A detected fault causes an error message to be displayed on the KDU.

10.25.5 Primary Unit Description

The system is comprised of two primary modules: the plotting table annotated the Integrated Navigation Computer and Plotter (INCAP); and the Keyboard Display Unit (KDU).

INTEGRATED NAVIGATION COMPUTER AND PLOTTER (INCAP)

The purpose of the INCAP is to position a light spot beneath a navigation chart or plotting sheet to indicate a position demanded by the computer or by the operator using the KDU.

The INCAP contains all necessary power supplies, electric drive systems and feedback controls to operate the gantry and carriage housing the light spot. A computer is housed within the INCAP comprising a 16-bit control processor and the necessary electronic modules to interface with the Data Multiplex System (DMS) and KDU. The INCAP also includes a battery back-up system that will maintain processor and KDU operation for a minimum of 30 minutes.

The INCAP is powered by 115V 60Hz via electrical connections made through the bottom of the table.

The INCAP controls all reside at the front of the table in the left and right areas of the control panel.

Maintainer switches are accessible, when the front panel is removed, for KDU power supply, table power supply and battery power/charge. Holes are provided in the front panel for the operator to determine the status of each switch.

NOTE: The electric switch logic is - UP means OFF.

KEYBOARD DISPLAY UNIT (KDU)

The KDU provides the interface between the INTPS system and the operator. The KDU comprises an alphanumeric keyboard together with a group of specialist keys and a back lit LCD display with a 20 by 8 character capacity. A cursor symbol is displayed on the KDU as an underscore in the character slot. It is produced automatically by the computer and indicates where data entry is required. The cursor reverts to the top left-hand corner when the KDU display is cleared.

When a key is pressed its character or function is passed to the computer. For some entries, the computer knows what data to expect and will refuse an illogical entry. For example, if the operator attempts to access an illogical data page, the KDU will display '**INVALID**'. The operator may key '***CLR***' and re-evaluate the entry.

A description of the key operation is shown in Table 10-12.

KEYS	OPERATION
A-Z **0-9** **+ -**	Pressing of these keys causes the appropriate character to be displayed in the position indicated by the cursor (assuming a legal entry).
SP	This is the space key that moves the cursor 1 slot across the display line for each operation of the key.
□ □	Moves the cursor in the direction indicated by the key without altering the data displayed.
CLR	This clears the display and allows selection of a different data page. The lightspot reverts to ownship's current position. Any operation not completed prior to pressing CLR is aborted.
INJ	The key enters the displayed data into the computer for action.
BLANK **(Test)**	This key allows specific built-in test functions to be accessed.
BRT/DIM	These control the level of back lighting to the LCD display. Different levels of bright/dim are obtained each time a key is pressed.

Table 10-12.— KDU Key Operation.

The INTPS system is controlled by the operator through a series of data pages displayed on the KDU. In total the system utilizes 21 data pages as shown in Table 10-13.

Clearing the current page being displayed by pressing the 'CLR' key on the KDU keypad allows access to another data page. The operator then presses the first two letters of the required page and presses the '***INJ***' key on the KDU keypad. The page data is then indicated on the KDU.

The data pages are divided into two categories:

1. Static pages - these display positional information at the displayed time or that entered by the operator.
2. Dynamic pages - these display position at current time and update once every second.

If a data page shows no positional information, the light spot displays the current ownship's position (if this position is within the present chart/plot sheet coordinates). If the position of ownship or a track is outside the table area (chart/plot sheet), the light spot remains in its present position and a warning is given to the operator by flashing the '**P**' in the position field on the KDU. The system is able to carry out the various calculations and tasks using these positions even though they are outside of the table area. (Note that a flashing '**P**' does not initiate a BIT warning flag.)

PAGE TITLE	IDENTIFIER	STATIC(S)/ DYNAMIC(D)	USE
ON	ON	S	Gain access to the KDU if set to Off
OFF	OF	S	Deny access to KDU
NAVIGATR	NA	S	Initialize
DATE	DA	D	Insert or change date, time and zone
LOG	LO	D	Input log data
COMPASS	CO	D	Input compass data
LINK	LI	S	Activate DMS data link
CHART	CH	S	Register and verify charts
PLTSHEET	PL	S	Set up and register plot sheet
OWNSHIP	OW	D	Display ownship, position course, speed and drift
DRIFT	DR	D	Insert tidal stream/current data
OVERBRD	OV	S/D	Activate man overboard operations
TRACK	TR	S	Set up and display tracks and reference points

Table 10-13.— INTPS Data Pages.

PAGE TITLE	IDENTIFIER	STATIC(S)/ DYNAMIC(D)	USE
ERRORS	ER	S	Display error messages
POSITION	PO	S	Fix by bearings and/or ranges
PASSAGE	PA	S	Set up passage plans
PIM	PI	D	Display ship's position relative to passage plan
WAYPOINT	WA	S	Set up great circle passage
CCG	CC	S	Set up Cartesian Coordinate Grid Origin
HAVEN	HA	S/D	Haven/zone operations
RELVEL	RE	S	Calculate relative velocity problems

Table 10-13(Cont'd).— INTPS Data Pages.

The computer continually monitors operations and status. If an operator warning is initiated, the operator will be warned by a flashing '**E**' displayed on the first row. Warnings are displayed in the '**ERRORS**' data page. If a system fault occurs, the present page on the KDU will be replaced by description of the system fault.

10.26.0 TACTICAL DECISION SUPPORT SUBSYSTEM (TDSS) AND COMPUTER AIDED DEAD RECKONING TRACER (CADRT)

The TDSS and CADRT software when installed on Unit 540 of the AN/SQQ-89(V) are designed to replace existing DRT/DDRT/INTPS units.

The DRT uses a paper trace plot to provide a limited geographic plot on contacts of interest derived from sensor data verbally reported to DRT plotters. The DRT is solely dependent on human recording and manipulation of information for both display and interpretation of tactical data and is, therefore, limited to use on a few selected targets.

The Digital Dead Reckoning Tracer (DDRT) followed the DRT and allowed improved digital input of ownship position data, but continued to use manual plotting on a paper trace.

The Integrated Navigation and Tactical Plotting System (INTPS) is an improvement over DDRT in that it provides some automation of contact tracking but it also uses a manually plotted paper trace.

DRT/DDRT/INTPS operation is manpower intensive and prone to error. The number of DRT/DDRT/INTPS watchstanders varies depending on the mission being supported. A maximum of two operators is needed for the TDSS or CADRT in support of any given mission area.

10.26.1 Functional Description

The functionality of TDSS and CADRT is generally the same as DRT/DDRT/INTPS. The TDSS and CADRT automatically receive real-time, multi-source data inputs to generate and maintain a geographically referenced tactical plot of contact, target motion analysis data, and environmental overlay display. All automatically input data and information can be archived to tape for reconstruction and to maintain a permanent record as required.

10.26.2 Physical Description

The AN/USQ-132 Dual Display Station (DDS), Unit 540 of the AN/SQQ-89(V) USW Combat System, will contain one or two TAC-4 central processor units (CPUs) using HP-743I (TDSS only configuration) and HP-744i (TDSS/CADRT configuration) processors. The DDS provides two displays: a 37-inch high-resolution, horizontally mounted Large Screen Display (LSD) and a 19-inch high-resolution Small Screen Display (SSD) mounted approximately 30 degrees off vertical. Each display has a keyboard/trackball user input device. There is a 4mm-tape drive used for software installation and data archiving and a CD-ROM used for loading digital maps.

The DDS is located in CIC of the DD, DDG, and CG ship classes. A remote display unit is located in the SONAR Control Room. TDSS and CADRT are included in the ship's sonar suite and maintained by the ship's sonar personnel.

Figure 10-71.— Unit 540, AN/USQ-132/DDS CADRT/TDSS.

10.27.0 VALVE POSITION INDICATOR SYSTEMS

Valve position indicator systems (circuit VS) provide personnel at remote stations of the positions (open or closed) of certain valves.

Sensitive switches, mounted on the valve housing and actuated by the valve, energize the indicators. On most installations, you will find two switches. One switch indicates that the valve is open and the other indicates that the valve is closed. They normally have a make contact arrangement. There are usually two lamps in each indicator; one lamp for the open position of a valve and the other for the closed position. The remote indicators may be found individually, but they are normally grouped into valve position indicator boards containing from 5 to 15 indicators to indicate the positions of valves located in the same engineering space.

10.28.0 SALINITY INDICATOR SYSTEM

The salinity indicator system, described in this chapter, is a representative system. When working on the salinity system on your ship, you should consult the technical manual pertaining to your equipment for specific settings. The salinity indicator system (circuit SB) measures the electrolytic impurities present in fresh water in equivalent parts per million (epm) or parts per million (ppm); the terms are interchangeable. For purposes of our discussion, we will use epm. The system is a necessity aboard ship because all fresh water, particularly when underway, is made from seawater. Excessive salinity in the boiler feedwater causes pitting of the tubes and rapid deterioration due to electrolysis. Salinity indicators are usually provided in the engine rooms and the firerooms for checking the condensate from the main and auxiliary condensers. They are also provided for the evaporator plants to indicate the degree of purity of the fresh water and condensate at various selected points in the distilling system.

The ship's water system (fig. 10-72) pumps water aboard the ship from the sea, sends it through the evaporator to remove the salt, and then stores the purified water in freshwater tanks. The fresh water is used for showers, drinking water, cooking, and, most importantly, it is used in the ship's boilers to generate the steam that drives the ship. The boiler feedwater must contain less than 0.065 epm or the boilers can be damaged or "salted up." The salinity system monitors the impurity content continuously; should the impurities reach alarm proportions, the salinity system de-energizes the dump valve solenoid and redirects the contaminated water to the ship's bilge or directly overboard.

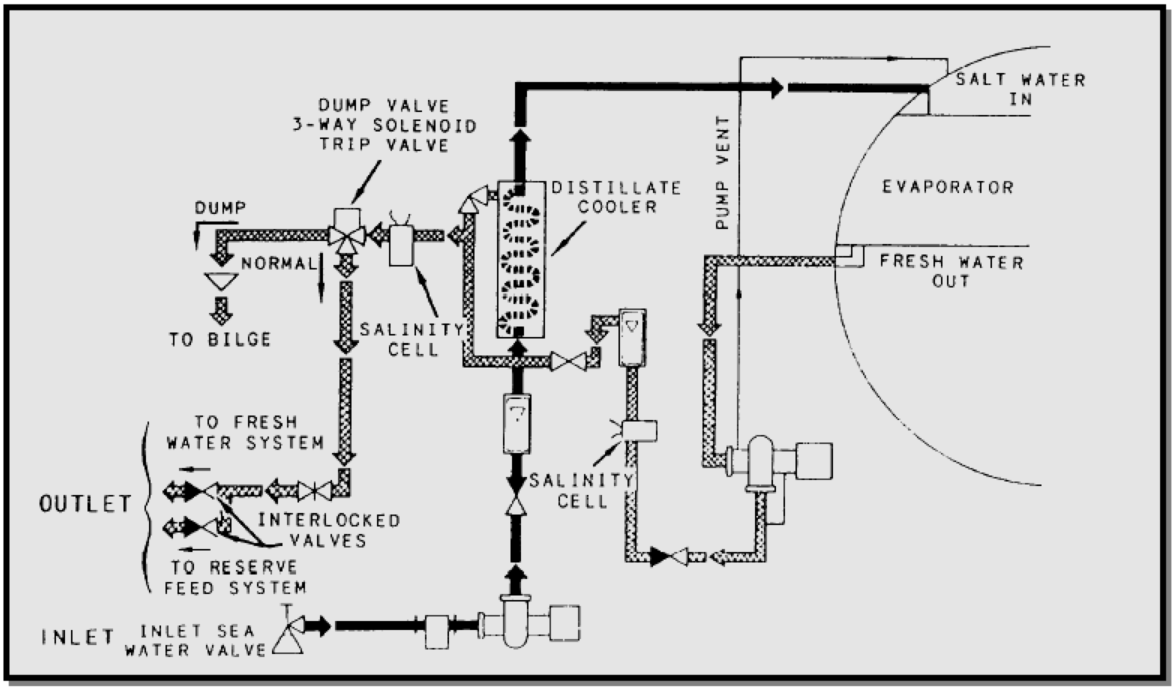


Figure 10-72.— Ships' water system diagram.

The operation of the salinity indicator system is based on the principle that an increase of the electrolytic impurities (principally salt) in water increases the electrical conductivity of the water and, conversely, that a decrease in the impurities increases the electrical resistance of the water. If two electrodes are immersed in the water tested and a stable alternating voltage is applied across the electrodes, a stable alternating current will flow, provided the impurity content and the temperature of the water remain unchanged.

The amount of current flow is indicated on a meter, the scale of which is graduated in equivalent parts per million. If the saline content of the water increases because salt water leaks into the system or because the operation of the distilling plant becomes faulty, the conductivity between the electrodes increases and the meter reading increases an amount that is proportional to the increase in salinity.

The salinity system is composed of three major components: the salinity cell, the salinity indicator panel, and the dump valve and solenoid.

Salinity Cell

The salinity cell (fig. 10-73, views A and B) is the device that does the actual detecting of impurity. It operates on the principle that an increase in electrolytic impurities (salt) will increase the conductivity of the water. Therefore, the higher the impurities, the higher the current.

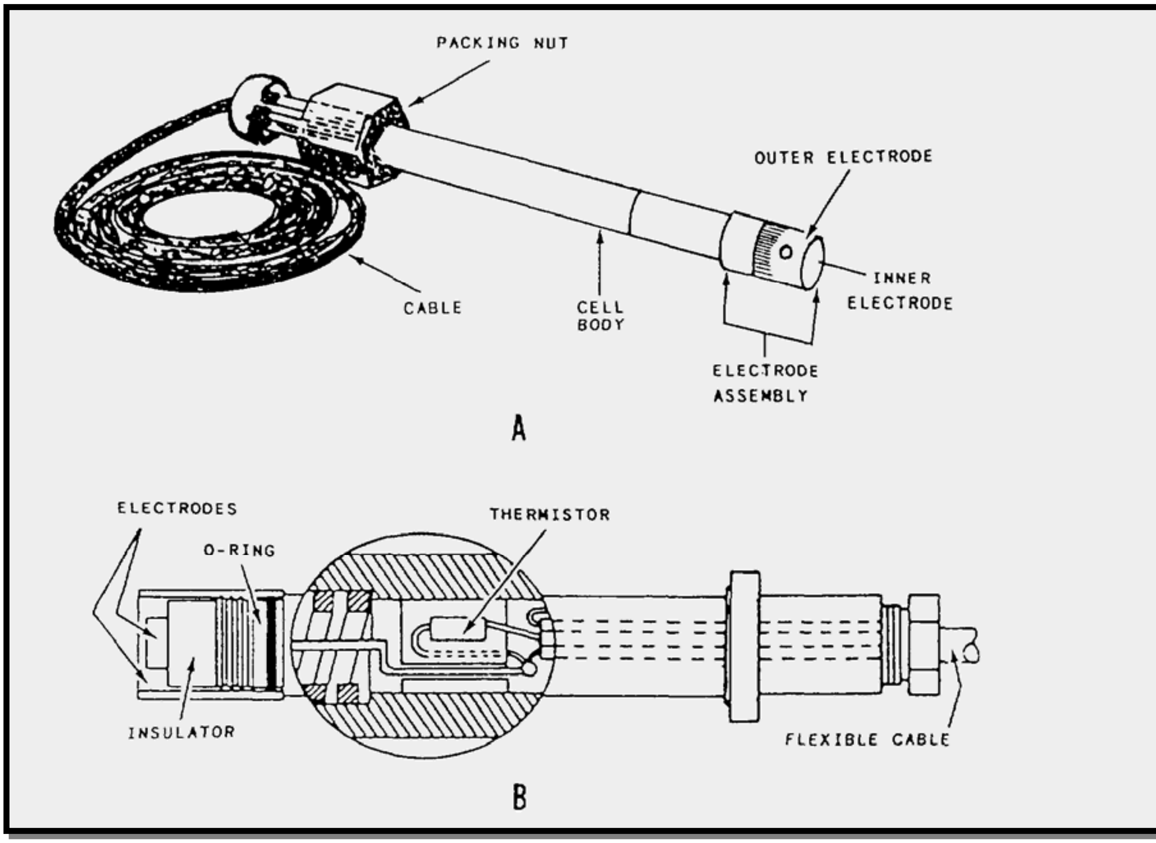


Figure 10-73.— Salinity Cell.

The salinity cell is a self-contained unit consisting of a nipple, packing nut, cell tube, and electrode assembly. The cell tube provides a means of extending the electrode assembly through the valve and is connected to the tee through the nipple and packing nut to form a watertight seal. The packing nut has a set screw that screws into a groove in the cell tube to prevent axial displacement of the tube by the hydrostatic pressure. A steel ring stop on the cell tube, between the packing nut and the nipple, locates the cell properly in the piping.

A 6-foot, three-conductor cable connects the cell to the salinity indicating panel and the ship’s 115-volt, 60-Hz power. The cable is secured to the cell by means of a gland nut.

The electrode assembly comprises the inner electrode, adapter, automatic temperature compensator, and the outer electrode. The inner electrode is a hollow platinum-coated brass cylinder closed at the forward end. It is held in the adapter by means of a spring-loaded nut on the end of the inner electrode holder. A solder lug under this nut connects the white conductor of the incoming cable.

The outer electrode is a hollow brass cylinder, the inside of which is coated with a thin layer of platinum. This electrode screws onto the adapter, which in turn screws onto the cell tube. It is pierced with holes to vent the gases trapped in the space between the electrodes and to allow for free circulation of the water. The connection for the outer electrode is made by soldering the green conductor of the incoming cable into the hole provided in the cell tube.

The cell body (fig. 10-73, view A) has two platinum electrodes with a constant voltage applied to them. When they are exposed to air, no current flows. When they are immersed in water, the impurities in the water determine the amount of current flow. If the impurities in the water increase, the resistance of the water decreases, and this causes a corresponding increase in the current flow. If the current exceeds the alarm set point, an alarm (visual and/or audible) warns the ship's personnel of the condition.

A thermistor (fig. 10-73, view B) is located within the cell which automatically corrects for all temperature changes between 40°F and 250°F. The thermistor has a negative temperature coefficient of resistance, which means that as the temperature increases the resistance decreases. Therefore, the salinity circuit current is affected only by the impurities in the water and is unaffected by temperature changes.

Salinity Indicator Panel

The salinity indicator panel (fig. 10-74) indicates to the operator by meter indication the salinity level of the water at various points in the distillation process. The salinity indicator panel has switches and alarm indicating lamps for each salinity cell in its system, as well as an alarm lamp to indicate that the dump valve solenoid has "tripped" and water is being diverted from the potable water tanks. The meter indicating unit is calibrated in epm.

The salinity indicator panel is designed to function in a system having five salinity cells, external alarm bells, and two solenoid trip valves. The panel contains a power unit, a meter unit, five salinity cells, a valve position and meter test unit, and a relay unit. The units are of the plug-in type to facilitate removal for inspection and repairs.

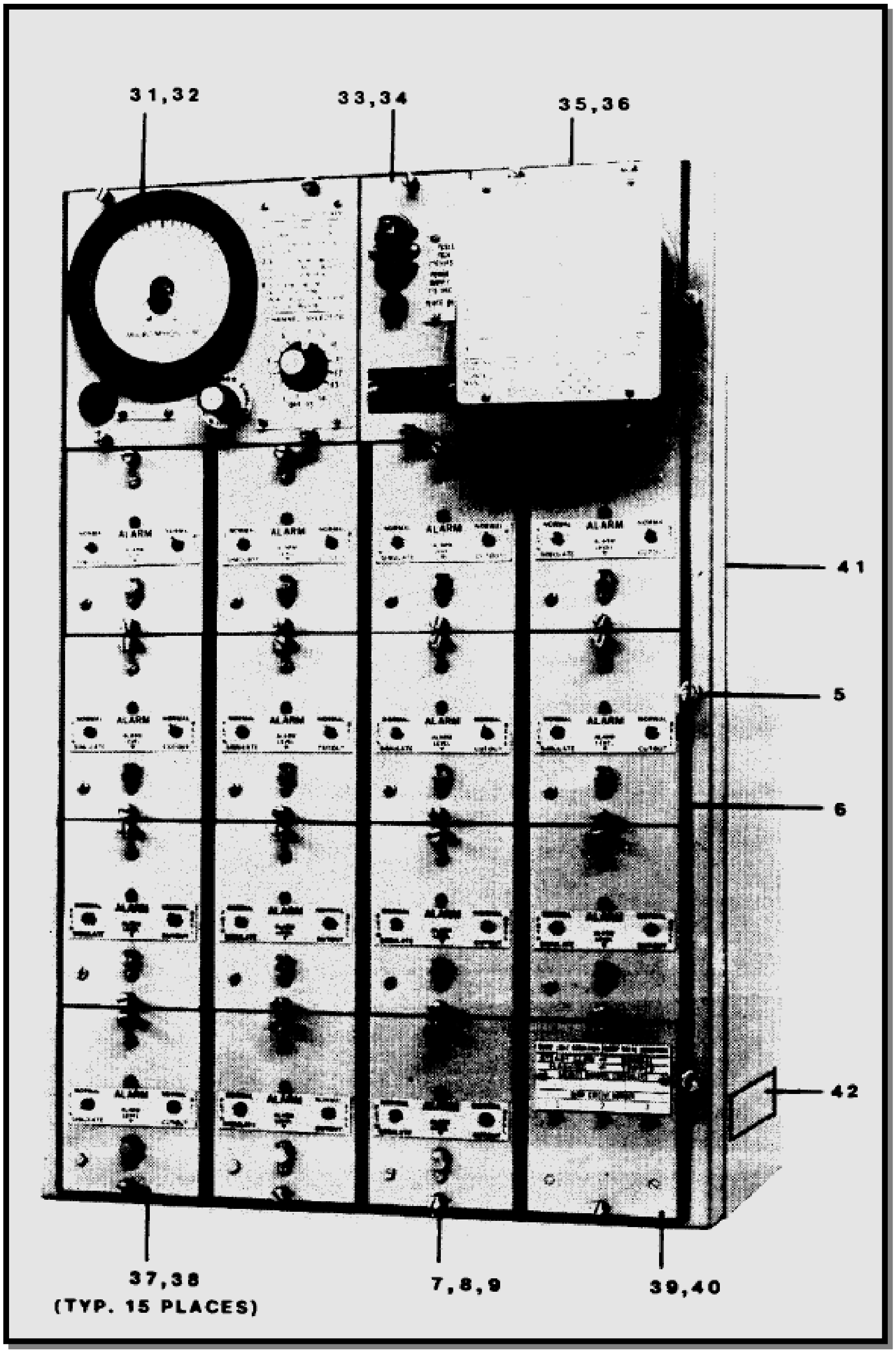


Figure 10-74.— Main Assembly (Exterior) IC/SB15B.

POWER UNIT.— The ship's 115-volt, 60-Hz power is applied to the salinity indicator panel through the power unit (fig. 10-75). The power unit is not a plug-in type, but is wired directly onto the panel. It is provided with a white power-on indicator lamp, two fuse holders, and two blown-fuse indicators. The two fuses protect only the salinity cell and the alarm circuit wiring. The power circuits to the solenoid-operated control valves are not fused.

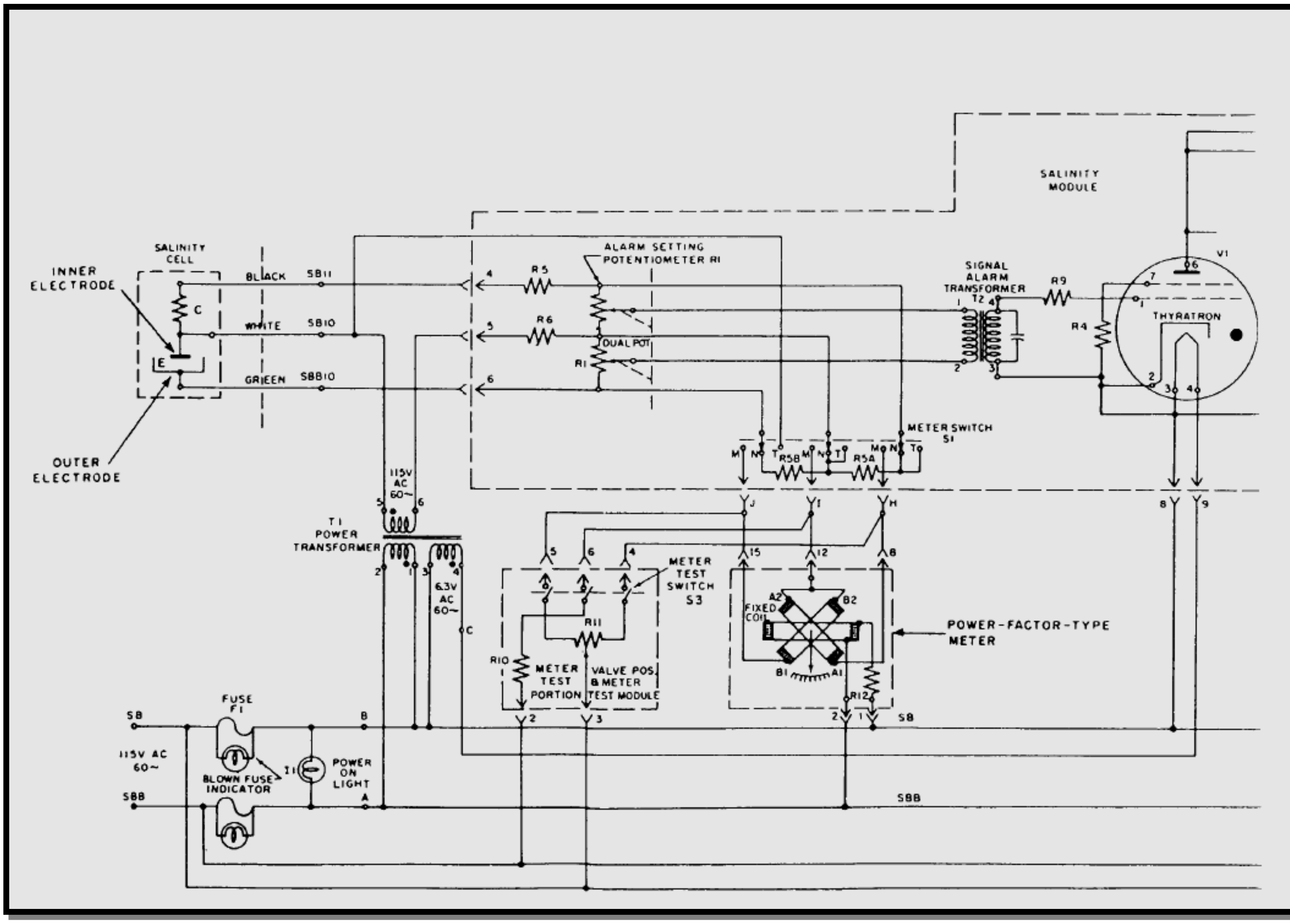


Figure 10-75.— Schematic diagram of the salinity indicator system.

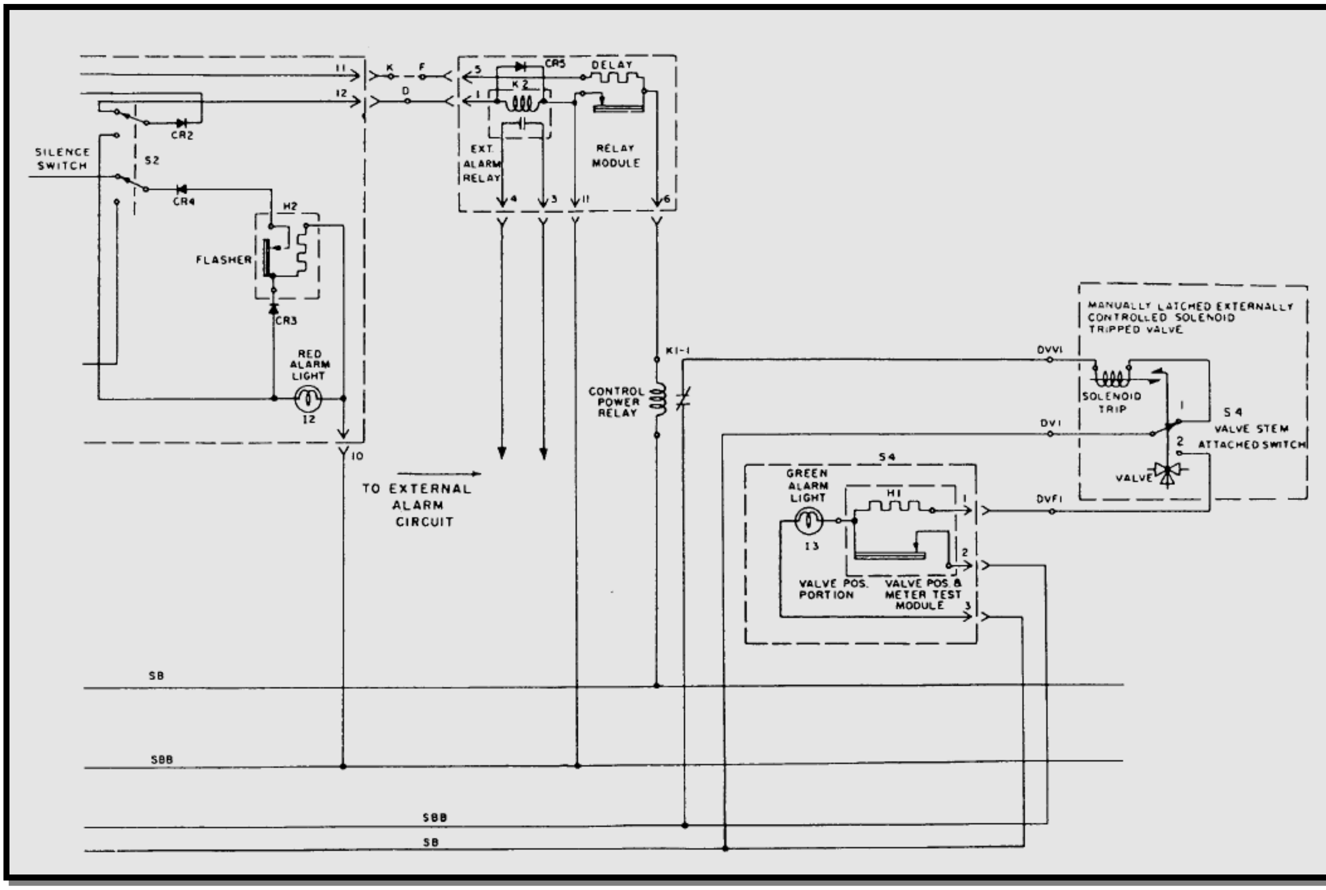


Figure 10-75(Cont'd).— Schematic diagram of the salinity indicator system.

METER UNIT.— The meter unit (fig. 10-75) measures the specific electrical conductivity of the water. The conductivity values are then converted by meter scale calibration into equivalent concentrations of seawater. The meter is connected to the cell circuits by individual switches on each salinity cell. The specific electrical conductivity is measured by means of a bridge circuit that employs a special power-factor type of meter. The meter measures the ratio of currents in the two separate arms of the bridge. One arm of the bridge is the dilute solution of seawater to be measured. The other arm of the bridge is an automatic temperature compensating resistor that has the same resistance-temperature characteristics as dilute solutions of seawater.

The power-factor type of meter (fig. 10-75) employs a fixed coil and a movable coil. The movable coil consists of two windings, A and B, at right angles to each other. It is free to rotate within the fixed coil. The movable coil is energized from the secondary of the power transformer, T1. Hence, the currents in windings A and B are in phase with each other and the circuits are resistive because of the series limiting resistor, R6. The fixed coil is energized from the ship's 115-volt, 60-Hz power supply in series with the voltage dropping resistor, R12. The movable coil turns until its resultant field lines up with the field of the fixed coil. Therefore, the meter indication is directly dependent on the resultant field of the two movable windings, which, in turn, is dependent on the ratio of the currents in the two windings. The meter indication is independent of minor voltage and frequency changes of the power supply because there is no iron on the meter magnetic circuits and because the coil circuits are essentially resistive.

The currents in the two windings of the movable coil are proportional to the two loads in the bridge circuit. As previously stated, the load in one leg of the bridge (movable winding A) is the automatic temperature compensator, C, located in the salinity cell, and in the other leg (movable winding B) is the resistance of the water being measured by the electrodes, E. The meter reading, which is determined by the ratio of the currents in the crossed windings, is therefore determined by the ratio of the cell resistance and the compensator resistance. At any given salinity and temperature there is only one possible meter reading. If the temperature is either raised or lowered from this point, the meter reading will remain unchanged because of the action of the compensator even though the water resistance may change appreciably. The temperature compensation occurs because any thermal change of the water being measured by the cell is immediately transferred to the automatic temperature compensator. The resistance of the compensator is inversely proportional to its temperature so that the thermal change transmitted to the compensator causes its resistance to change accordingly.

The resistance-temperature characteristics of the compensator are the same as those of dilute solutions of seawater. Therefore, the thermal change in the compensator, which is exactly the same as the thermal change of the seawater, causes sufficient resistive change in the compensator to compensate for the resistive change occurring in the cell. Although the absolute values of current in the windings have changed, their ratio has not changed and, consequently, the meter reading is unchanged. Because the temperature compensation is equally effective at all salinities, the only change that can vary the meter reading is a change in the current ratio caused by a change in salinity.

SALINITY CELL UNIT.— A salinity cell plug-in unit (salinity module, fig. 10-75) is provided for each salinity cell to continuously monitor the purity of the water of the cell. The unit consists of an alarm circuit that includes a dual potentiometer, R1, signal transformer, T2, thyratron tube, VI, flasher, H2, red alarm light, I2, and silence switch, S2. A three-position meter switch, S1, is also provided on the unit. The alarm point value is predetermined and set. A high salinity condition is indicated initially by flashing of the red alarm light and sounding of the external audible alarms.

The alarm circuit can be traced from the salinity cell electrodes and compensator through the dual potentiometer, R1, to the primary of the signal transformer, T2, the secondary of which is connected to the control grid and cathode of the thyratron, V1. The plate and cathode of V1 are connected across the 115-volt, 60-Hz power supply in series with the flasher, H2, and the red alarm light, I2.

There are two circuits from the secondary of the power transformer, T1, through the salinity cell, dual potentiometer, R1, and primary of the signal transformer, T2. One circuit is through the electrodes, the lower arm of R1, the primary of T2, the upper arm of R1, the primary of T2, the lower arm of R1, and resistor R6. The conductance values of the salinity cell electrodes and compensator, which are applied to the secondary of T1 and to the two arms of the potentiometer, R1, determine the grid to cathode voltage of V1. The current flow through the two arms is in opposite directions or 180° out of phase, and the resultant voltage is impressed across the primary of T2.

For thyratron V1 to conduct, the voltage between the control grid and the cathode (from the secondary of T2) must be in phase with the plate-to-cathode voltage.

When the salinity condition of the cell is higher than the alarm setting, the resistance across the two electrodes is decreased and more current flows through the lower arm of R1, the primary of T2, the upper arm of R 1, and resistor R6. The resultant voltage is impressed across the grid and the cathode of V1 through transformer T2. This voltage is of the proper phase to cause V1 to conduct during the half cycles when the grid and plate voltages of V1 are positive. The circuit is completed from one side of line SB through the cathode and plate of V1, silence switch S2, rectifier CR4, flasher H2, rectifier CR3, red alarm I2, to the other side of line SBB.

The silencing switch, S2, when placed in the SILENT (down) position, clears the external alarm circuit for other incoming alarms and causes the red alarm light to light steadily. When the high salinity condition is corrected, the red alarm light again flashes to remind the operator to place the switch, S2, in the NORMAL (up) position to extinguish the red alarm light and clear the unit for future alarm signals.

The meter switch, S1, is a three-position, springloaded switch having a NORMAL (center) position, a TEST position, and a METER position. The meter switch, S1, when placed in the TEST position, disconnects resistor R5B in the salinity cell circuit, resulting in an unbalanced condition that causes the cell to behave as though a high salinity condition exists. This action energizes the alarm circuit, causing the red alarm light to flash and the alarm relay to sound the external alarm. The meter switch, S1, when placed in the METER position, connects the meter unit in the circuit of the associated salinity cell and a salinity reading is indicated on the meter.

VALVE POSITION AND METER TEST UNIT.— The valve position and meter test module (fig. 10-74) is provided with a green valve position indicator lamp and a meter test switch. The dual purpose of the unit is to indicate when the control valve is in the NORMAL or ABNORMAL position and to provide a means of testing the meter unit.

When the solenoid trip valve is in the NORMAL position, as shown, the green indicator lamp is illuminated steadily; when the control valve is in the ABNORMAL position, the green alarm light flashes; and when the control valve is reset manually, the green alarm light is again lighted steadily.

The meter test switch, when placed in the TEST position, connects the meter unit in a circuit simulating a known salinity condition (1.7 ppm) to check the calibration of the meter.

The valve position portion of the unit consists of the green indicator lamp, I3, and the flasher, H1, interconnected with the solenoid-operated valve. During normal operating conditions, the solenoid is energized from the line terminal SSB through the contacts of the power control relay, K1-1, terminal 1 of the SPDT switch, S4 (on the control valve), to line terminal SB. The green indicator lamp, I3, is illuminated steadily during this condition from line terminal SB, the contact arm of flasher H1, to line terminal SBB.

When art abnormal condition occurs, the power control relay, K1-1, is de-energized and its contact opens the circuit to the solenoid coil, which actuates switch S4. This action connects the heater and contact arm flasher H1 from line terminal SB, through terminal 2 of switch S4, to line terminal SBB, causing the green indicator light to flash.

The meter test portion of the unit consists of meter test switch S3, resistor R10, and potentiometer R11. Normally, the meter unit is not connected to a salinity cell. The meter test switch, S3, is a two-position, spring-loaded rotary switch having a NORMAL (enter) position and a TEST position. The rotary switch, s3, when placed in the TEST position, connects the movable windings, A and B, of the power-factor-type meter in a circuit comprising resistor R10 and potentiometer R11, the resistances of which duplicate the resistances of the electrodes and compensator. There are two circuits through the movable windings. One circuit is from line terminal SB, the right arm of potentiometer R11, terminal 4 of switch S3, resistor R10, to line terminal SBB. The other circuit is from line terminal SB, the left arm of potentiometer R11, terminal 6 of switch S3, resistor R10, to line terminal SBB. With the meter test switch in the TEST position, the meter should read 1.7 ppm.

RELAY UNIT.— The relay module (fig. 10-74) consists of an alarm relay, K2, and two 2-second delay flashers. (For simplicity, only one flasher is shown.) The flasher is used to delay the tripping time of the solenoid-operated valves. Normally, the current through the delay flasher contact circuit is not sufficient to open the flasher contacts. However, if terminal 5 of the relay unit is energized from an associated salinity cell, the flasher contact will open, de-energizing control power relay K1-1 and causing contacts K1-1 to open. This action de-energizes the valve control circuit, causing the valve to actuate.

The rectifier, CR2, allows a current to flow through the operating coil of alarm relay K2, from the plate of V1, through switch S2, in the NORMAL (up) position, and back to the other side of line SBB. Rectifier CR5, across the coil of K2, maintains the current flow through the coil during the non-conducting half cycles of V1, The contacts of relay K2 close to energize the external alarm circuit.

The silencing switch, S2, when placed in the SILENT (down) position, opens the circuit to the audible alarm and connects the plate of V1 to one side of the alarm light through CR2. As long as the salinity is higher than the alarm setting, CR2 allows a current to flow directly through the red alarm light, 12, which is lighted steadily. During this condition, CR3 prevents a large current flow through the heater of the flasher, H2, when the salinity decreases to a value at which V1 ceases to conduct the flasher heater voltage causes the red indicator light to flash as a reminder for the operator to place the silencing switch, S2, in the NORMAL (up) position.

Normally, the current flows through the relay module from the line terminal, SBB, the bimetallic arm of the delay flasher, the coil of the power control relay, K1-1, to the line terminal, SB. This current maintains power relay K1-1, operated so that its contacts are closed. (For simplicity, only one solenoid-operated valve is shown.)

10.29.0 SALINITY INDICATING EQUIPMENT
This section is applicable to the Salinity Indicating Equipment, Models: IC/SB-1-B-1D-05000M-1-S, IC/SB-1-B-1D-05000M-1-S-ICAS, IC/SB-1-B-1D-050M-1, IC/SB-1-B-1D-050M-1-ICAS, IC/SB-2-B-1D-005M-2-S, IC/SB-2-B-1D-005M-2-S –ICAS, IC/SB-1-10, IC/SB-2-1, IC/SB-2.

10.29.1 Equipment Description
The Salinity Indicating Equipment (Figures 10-76 and 10-77) continuously monitors the salinity of water at specific locations in the plants piping, and provides visual audible alarms when salinity levels exceed operator settable limits. A typical Salinity Indicating System consists of remotely located salinity sensors, and a centrally located Salinity Indicator Console. The salinity sensors are elongated cylinders with electrodes that protrude through standard screwed bonnet wedge gate valves into the water stream of the piping. The electrical conductance between two electrodes at the tip of the sensor varies directly with the salinity. An electrical signal is passed between the two electrodes, and the amplitude of this electrical signal reflects the salinity level. A thermistor in the sensor compensates automatically for the effect of temperature variation on the conductivity of the water. The electrical signal from the sensor is applied to the Salinity Indicator Console. Controls and indicators on the console permit the operator to read out the salinity level at any sensor location. In addition, the Salinity Indicator Console activates visual and audible alarms if the salinity level at any point exceeds a preset limit.

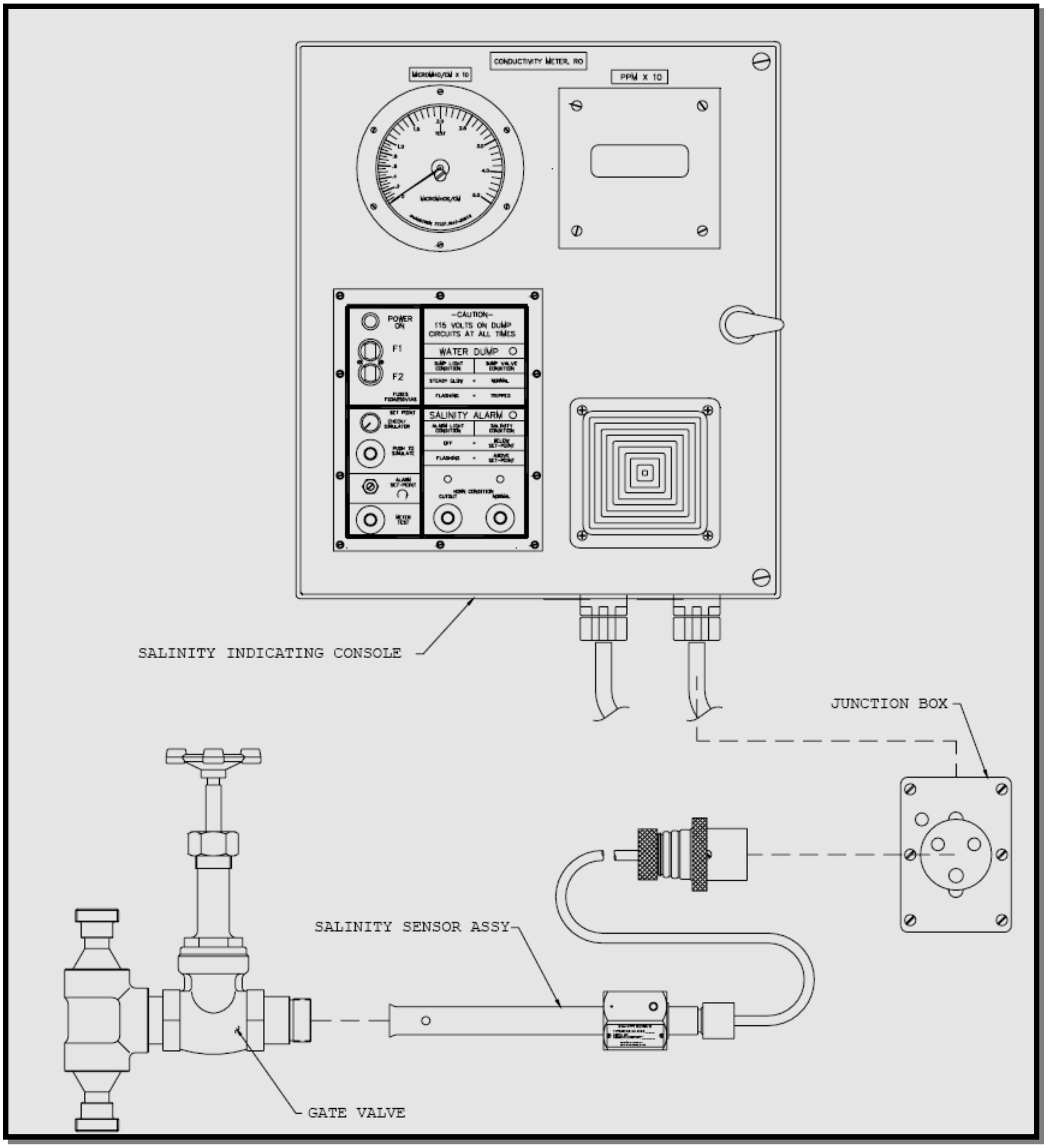


Figure 10-76.— Salinity Indicating Equipment (Typical).

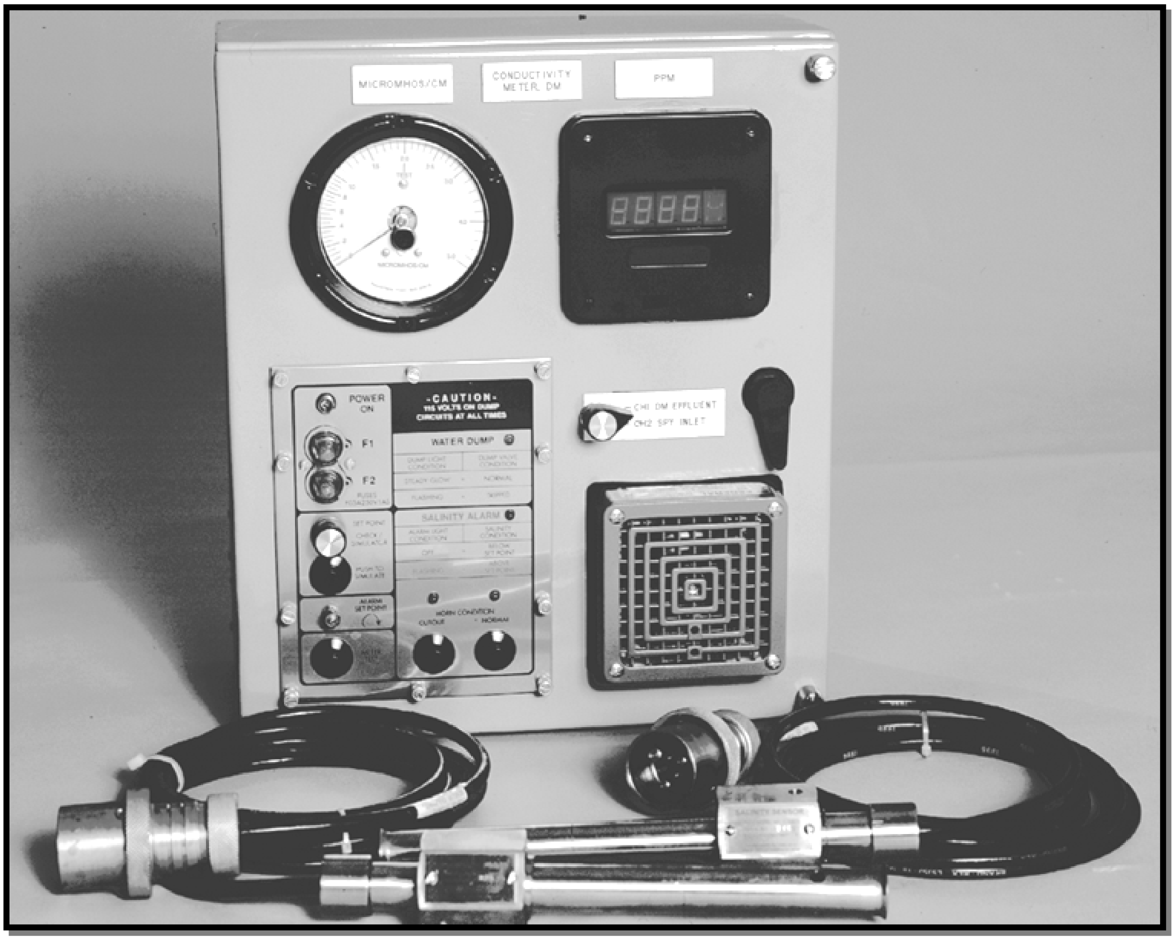


Figure 10-77.— Salinity Indicating Equipment (Typical).

Intended Use
The 12,000 GPD Reverse Osmosis Desalinator uses one (1) Console IC/SB-1-B-1D-05000M-1-S or IC/SB-1-B-1D-05000M-1-S-ICAS, and one (1) Sensor IC/SB-1-10. The RODM or Reverse Osmosis/Demineralizer uses one (1) Console IC/SB-1-B-1D-050M-1 or IC/SB-1-B-1D-050M-1-ICAS, with one (1) Sensor IC/SB-2-1. It also uses one (1) Console IC/SB-2-B-1D-005M-2-S or IC/SB-2-B-1D-005M-2-S-ICAS, with two (2) Sensors IC/SB-2.

Salinity indicating consoles ending with the “-ICAS” designation are to be used on ships that have an Integrated Condition Assessment System.

Salinity Sensor
Three types of salinity sensors, IC/SB-1-10, IC/SB-2-1, and IC/SB-2 are covered in this section. The IC/SB-1-10 has a cell constant of 10.0 and a bronze housing. The IC/SB-2-1 has a cell constant of 1.0 and a stainless steel, gr. 316 housing. The IC/SB-2 has a cell constant of 0.1 and a stainless steel, gr. 316 housing. The SB-1 and SB-2 sensors, although essentially similar in operation, differ in material construction. For this reason, these sensors cannot be interchanged at their locations in the piping. The IC/SB-2-1 and IC/SB-2 sensors differ in their cell constant and therefore should not be interchanged.

A salinity sensor consists of a hollow tube which is adapted at its salinity sensing end with two electrodes, and at its opposite end with a cable gland nut. Electrical conductors from the Salinity Indicating Console pass through the gland nut and hollow sensor tube to the electrodes.

The electrodes are supported by an adapter at the end of the sensor tube. The outer electrode is threaded onto the adapter and is thereby grounded to the ship’s hull when the salinity sensor is installed in the piping. The inner electrode is attached to a holder and is isolated from the outer electrode by a sealing insulator. Holes through the outer electrode permit the water stream in the piping to flow through the space between the conductive surfaces of the two electrodes. A temperature compensating thermistor network is not in direct contact with the water stream but makes good thermal contact through the thin wall of the inner electrode.

Salinity Indicator Console

The Salinity Indicator Console is a heavy gauge, rectangular box that houses the meters, controls, and circuit cards (Fig. 10-78). Four holes are provided on the back of the console for bulkhead mounting. Cable penetrations are made through the bottom of the console.

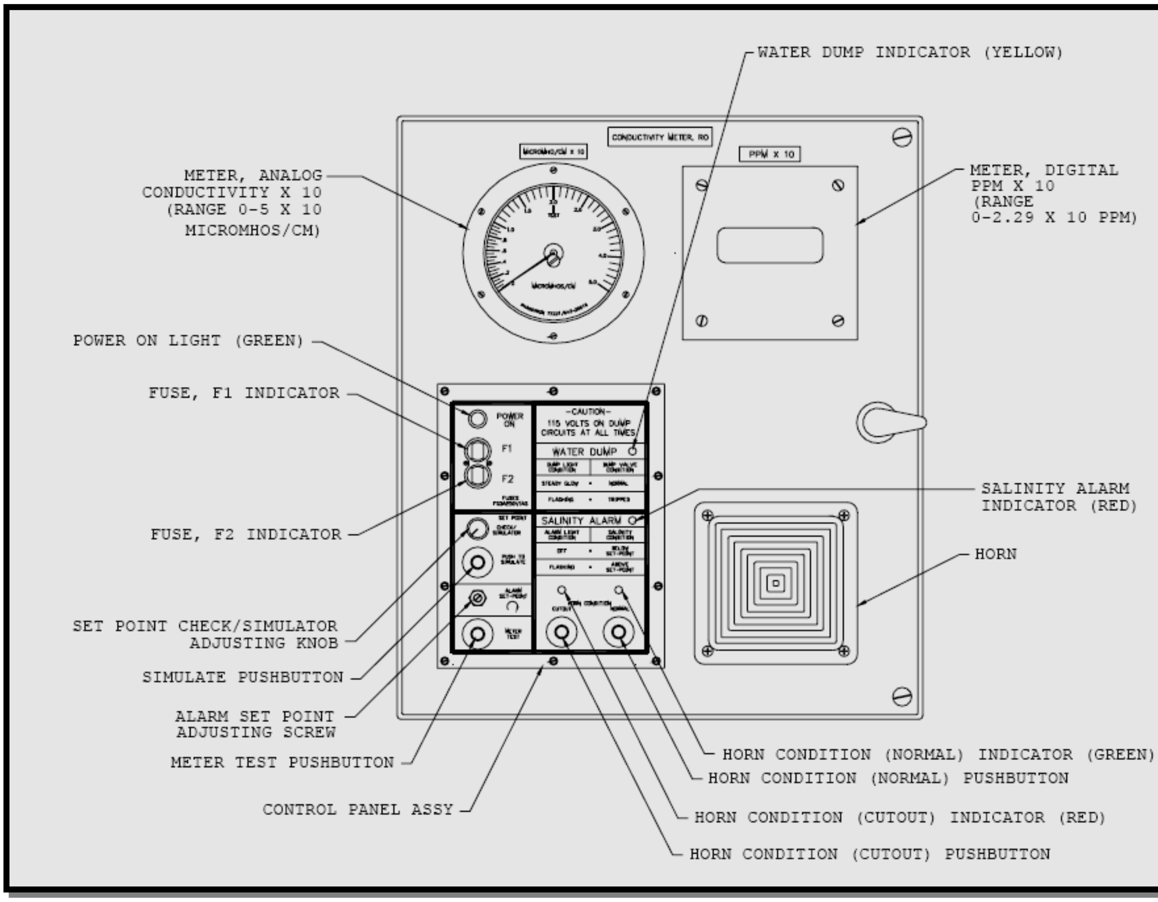


Figure 10-78.— Salinity Indicating Console (Typical).

All three types of consoles are constructed of stainless steel, grade 316L. The outside of the console is powder coated for additional protection from corrosion.

The interior of the console contains a printed circuit main board located in the box, and a printed circuit control board located on the door.

Main Circuit Board
The main circuit board, or main board, is mounted to a plate which is bolted to the back of the console. The main circuit board houses the following components: integrated circuits and various electronic circuit parts necessary for signal processing and control, a terminal strip to which all cable wires are connected, a pin connector for electrical connection to the control circuit board, potentiometer trimmers for meter adjustment, and two SCR's which provide switching for the dump circuits.

Control Panel Assembly
The control panel assembly (Fig. 10-78) consists of the following components: LED indicators for alarm and dump indication, pushbutton switches for horn cutout, a pushbutton switch for analog meter test, a potentiometer for alarm set point adjustment, an alarm set point simulator pushbutton switch and potentiometer, two fuses and housings for protection of the 110V AC circuit.

Control Panel Circuit Board
The Control Panel Circuit Board, is mounted to the rear of the Control Panel Assembly which is mounted to the door. The following components are mounted to the control panel circuit board: electronic circuit components necessary for signal processing and control; a transformer and rectifier for conversion of 110V AC to 12V DC; pin connectors, for connection to the Main Board and meters.

Analog Meter
The analog meter (Fig. 10-78) is mounted on the door of the console. The meter contains a calibrated dial which indicates conductivity levels. The scale is in micro-ohms/cm and is semi-logarithmic. The IC/SB-1-B-1D-05000M-1-S and IC/SB-1-B-1D-05000M-1-ICAS meter range is 0- 50 micro-ohms /cm x 100. The IC/SB-1-B-1D-050M-1, IC/SB-1-B-1D-050M-1-ICAS, IC/SB-2-B-1D-005M-2-S, and IC/SB-2-B-1D-005M-2-S-ICAS meter range are 0-5 micro-ohms /cm. A manual adjustment screw is provided on the face of the meter for zero adjustment.

Digital Meter
The digital meter (Fig. 10-78) is mounted on the door of the console. The IC/SB-1-B-1D-05000M-1-S and IC/SB-1-B-1D-05000M-1-S-ICAS meters has 4 ½ digits. The IC/SB-1-B-1D-050M-1, IC/SB-1-B-1D-050M-1-ICAS, IC/SB-2-B-1D-005M-2-S and IC/SB-2-B-1D-005M-2-S-ICAS meter have 3 1/2 digits. The meter provides readout of salinity in PPM (particles per million). The meters on the IC/SB-1-B-1D-05000M-1-S-ICAS and IC/SB-1-B-1D-050M-1-ICAS units have circuitry that provides a 4-20 mA linearlized output signal.

Salinity Alarm
The alarm circuit provides visual and audible indication of the water salinity level. If the salinity is above the pre-adjusted set point then the alarm indicator will flash and horn will alert the operator of the condition.

Dump Circuit
The dump circuit controls the dump valve which diverts water of high salinity to drain. The dump valve will automatically dump if the salinity is above the pre-adjusted set point.

4-20 mA Output
Models ending with the designation “-ICAS” are equipped with an optional 4-20 mA output that provides a linear signal of the sensor’s salinity reading. This signal can be used to monitor the performance of the desalinization equipment using an Integrated Condition Assessment System (ICAS).

10.30.0 TANK LEVEL INDICATOR (TLI) SYSTEMS
Tank level indicator systems provide an accurate measure of the fluid level within a tank, as well as sound an alarm, audible and/or visual, to indicate either a high or low fluid level. The fluid levels can be continuously indicated or in predetermined increments, depending on the type of equipment installed in the tank. This can be accomplished using various types of detection equipment, the most common of which is the magnetically operated reed switch. For the purposes of our discussion, we will talk about the magnetically operated reed switch.

The system consists of a level detector, which is installed in the tank, a receiver mounted outside the tank, and an alarm device. The types of alarm devices used varies depending on the system; however, they perform the same function.

The level detectors used in a tank level indicating system fall into two categories: level links and transmitters. Level links indicate the fluid level in increments. Transmitters provide continuous fluid level indications and are used in systems requiring greater accuracy.

The method of indication for level links and transmitters are the same. A permanent magnet, which moves with the fluid level, is enclosed in the float. When the permanent magnet becomes parallel to a switch, the switch closes. As it moves further on the stem, it will make the next switch before opening the former switch (make-before-break).

Transmitters and level links are sometimes used together. The actual combinations are determined by the size of the tank and its shape, as well as the desired type of level indication.

The electrical signals generated by the level links and transmitters are converted at the receivers and indicated on meters in gallons. Each meter is calibrated for a specific tank, and each tank is different in size and shape. The size and shape of the tank also accounts for the nonlinearity of the meter forces.

10.30.1 VEGA RADAR TLI

Ohmart/VEGA makes high-tech measuring instruments for a wide range of industries, including chemical, petrochemical, pharmaceutical, paper, steel, power, food and beverage, and marine gauging. It also makes level measuring instruments and fuel gauges for US Navy ships. Ohmart/VEGA produces measurement solutions for radar, ultrasonic, guided wave radar, capacitance and hydrostatic measuring instruments along with level gauges and a full line of point switches including vibrating level switches for liquids and solids.

The VEGA is a guided wave radar for interface detection that has the ability to measure the interface between two products, and to track top level and interface using a signal conditioning instrument. It is highly accurate and reliable. The VEGAFLEX 66 is a guided microwave sensor for high temperature applications. Able to measure conditions up to 482 degrees F, and 1,450 psi, the VEGA is also available with a single rod, cable, or a coaxial sensor configuration.

VEGA has all the current and newly emerging standards of signal processing, including continuous level and pressure measurement, 4-20 mA/HART (Highway Addressable Remote Transducer), 2-wire and 4-wire technology. HART is a digital protocol that is superimposed over a conventional 4-20 mA signal, which still carries the primary variable. This digital signal allows the simultaneous transmission of additional measurements to the control system that will enable advanced sensor monitoring and diagnostics. VEGA measuring instruments can be adapted to equipment already installed and works well with PLCs. VEGA instruments require the use of a laptop computer and a special connector for troubleshooting and alignment.

Guided wave radar has many benefits over traditional level measurement technologies. With no moving parts and easy to configure electronics, guided wave radar can eliminate many of the measurement and maintenance issues associated with mechanical float systems. With no influence from temperature or pressure shifts, and no errors caused by a shift in specific gravity, guided wave radar can reduce many measurement errors.

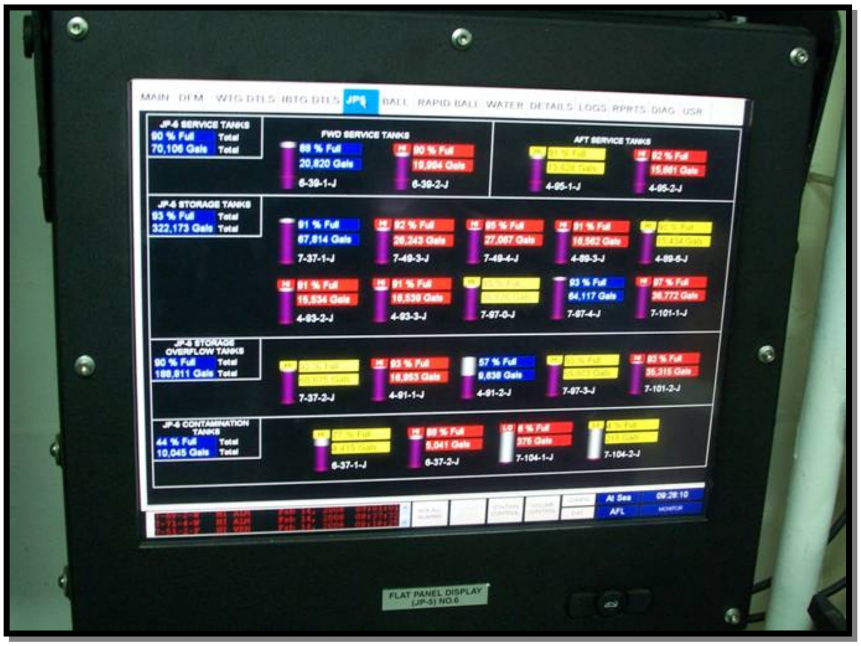


Figure 10-79.— VEGA Radar TLI Panel Display.

Figure 10-80.— Radar TLI Sensor Unit.
(The internal portion is shown separately to the right).

10.31.0 MAINTENANCE

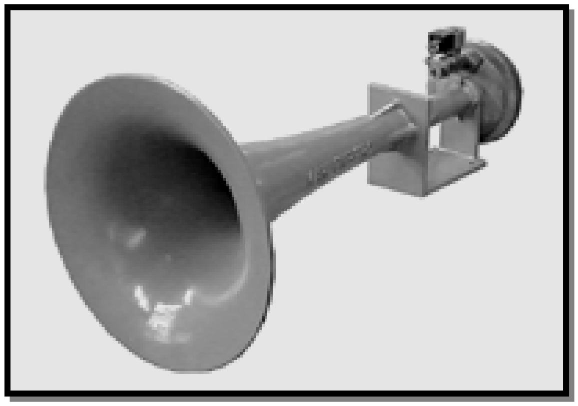
Preventive maintenance for the ship's order indicating and metering systems consists of routine tests, inspections, cleaning, and lubrication. All preventive maintenance should be accomplished according to current applicable MRCs.

Corrective maintenance for the systems consists mainly of replacing burned out illumination lamps and zeroing synchros. For detailed information concerning the maintenance of synchro systems and the zeroing of synchros, refer to Navy Electricity and Electronics Training Series (NEETS), NAVEDTRA 172-15-00-85, Module 15.

10.32.0 SUMMARY

In this chapter, we have described the purpose of the ship's order indicating and metering systems. We have identified and discussed the operation of the ship's control order and indicating systems and the various control consoles used with the systems. We have identified and discussed the operation of some of the various metering and indicating systems installed on Navy ships. We have briefly discussed some of the preventive and corrective maintenance measures associated with the ship's order indicating and metering systems.

11 AUXILIARY ELECTRICAL EQUIPMENT



Upon completion of this chapter you will be able to do the following:

- Describe the operating and testing procedures of the ship's whistle.
- Explain the requirements for performing maintenance on the ship's whistle.
- Describe the components, operating procedures, and maintenance procedures of the cathodic protection system.
- Describe the inspection, troubleshooting, and corrective maintenance procedures of auxiliary equipment.

11.0.0 INTRODUCTION

IC Electricians are required to maintain various types of auxiliary equipment aboard ship. This chapter will describe the components, operating procedures, and troubleshooting and maintenance procedures of some of the auxiliary equipment that you will be involved with. This chapter will also introduce you to cathodic protection systems installed on naval ships.

11.1.0 SHIP'S WHISTLE

As an IC Electrician, you will be required to do preventive maintenance and repairs on the ship's whistle. This is a relatively simple system, but it is of the utmost importance. The ship's whistle is used to signal other vessels of the maneuvers your ship may be doing. It is also used, in conditions such as heavy fog, to warn other ships of the location of your ship.

11.1.1 Location of Whistle

When a directional whistle is to be used as the only whistle on a ship, it is installed with its maximum intensity directed straight ahead. A whistle should be placed on a ship as high as practicable to reduce interception of the emitted sound by obstructions and to minimize risk of hearing damage to personnel. The sound pressure level of the ship's own signal at listening posts shall not exceed 110 dB(A), and so far as practicable should not exceed 100 dB(A).

11.1.2 Frequencies and Range

The fundamental frequency of the whistle signal lies between the 70- to 700-Hz range. The audibility range of the whistle signal is determined by those frequencies (which may include the fundamental and/or one or more higher frequencies) that lie within the 180 to 700 (+ 1 percent) range and that provide sound pressure levels specified in the following paragraph on intensity. The range of audibility is for information, and is the approximate range at which a whistle may be heard on its forward axis (90 percent probability) in conditions of still air on board a ship having the average background noise level at the listening posts. This shall be assumed to be 68 dB in the octave band centered on 250 Hz and 63 dB in the octave band centered on 500 Hz. Values given can be regarded as typical, but under conditions of strong wind or high ambient noise level at the listening post, range may be reduced. In practice, the range at which a whistle may be heard is variable and depends on weather conditions.

To ensure a wide variety of whistle characteristics, the fundamental frequency of a whistle must be between the following defined limits:

- 250 to 700 Hz, for a ship less than 75 meters (240 feet) long
- 130 to 350 Hz, for a ship 75 to 200 meters (240 to 650 feet) long
- 70 to 200 Hz, for a ship more than 200 meters (650 feet) long

11.1.3 Intensity

A whistle shall provide in the direction of maximum whistle intensity and at a distance of 1 meter from the whistle, a sound pressure level in at least one 1/3-octave band within the range of 180 to 700 Hz (+ 1 percent) as listed in table 11-1.

SHIP LENGTH (METERS)	1/3 – OCTAVE BAND LEVEL AT ONE METER	AUDIBILITY RANGE (NAULTICAL MILES)
200 OR MORE	143	2.0
75 TO 200	138	1.5
20 TO 75	130	1.0
LESS THAN 20	120	0.5

Table 11-1.—Intensity Level and Audibility Range.

11.1.4 Maintenance
Maintenance should be accomplished according to the applicable technical manual. All preventive maintenance should be accomplished according to the preventive maintenance card for the system aboard the ship at the time.

11.1.5 Ship's Whistle Equipment
The M-511 C Whistle Control is a fully enclosed, flush mount electronic device which provides for the automatic control of the ship's whistle. Besides serving as a fog signal timer for sounding codes in restricted visibility, the M-511C performs maneuvering codes, danger code, general alarm, and incorporates an at-will" push button. The M-511C Whistle Control contributes significantly to the safe operation of all vessels.

Restricted Visibility codes and other features of the M-511C:

- Five International / Inland Signal Codes, Cycle Times: 60, 90 or 120 seconds
    1. Vessel Underway
    2. Vessel Underway But Stopped
    3. Vessel Restricted in Ability to Maneuver
    4. Vessel Being Towed
    5. Vessel at Anchor
- Maneuvering Codes: Altering Course to Starboard, Port, Astern, Danger
- Start/Stop Automatic Function
- General Alarm Function (IMO/SOLAS) w/ accidental touch protection
- Integrated "At-Will" switch
- Red LED Illumination
- Waterproof console mount
- Can be integrated with additional push buttons and controls

Available in 12 or 24 Volt D.C., 115/230 A.C. Voltages 50 or 60 Hz

Figure 11-1.—Model M-511C Whistle Control.

11.2.0 CATHODIC PROTECTION SYSTEM

The next sections of this chapter will introduce you to cathodic protection systems installed on naval ships. There are two systems, the sacrificial anode and the impressed current. The two systems are different in both construction and operation.

Some technical terms used with this part of the chapter may be unfamiliar to you. These terms apply to cathodic protection systems, and are listed with their definitions in Appendix I, Glossary.

11.2.1 Cathodic Protection

Cathodic protection reduces the corrosion or deterioration of metal caused by a reaction with its environment (ship's hull and seawater). The chemical action that is created is similar to the electrochemical action of a battery or cell. Figure 11-2 shows a dry-cell battery circuit. So that you may understand the electrochemical theory shown in figure 11-2, you need to use the conventional theory where current flows from positive to negative. The positive current is indicated by a positive deflection of the voltmeter needle when the positive terminal of the meter is connected to the cathode (positive terminal) of the cell. As the electrochemical action continues, the process will eventually corrode, or consume, the anode that is providing the current to light the lamp. This process is called electrochemical action.

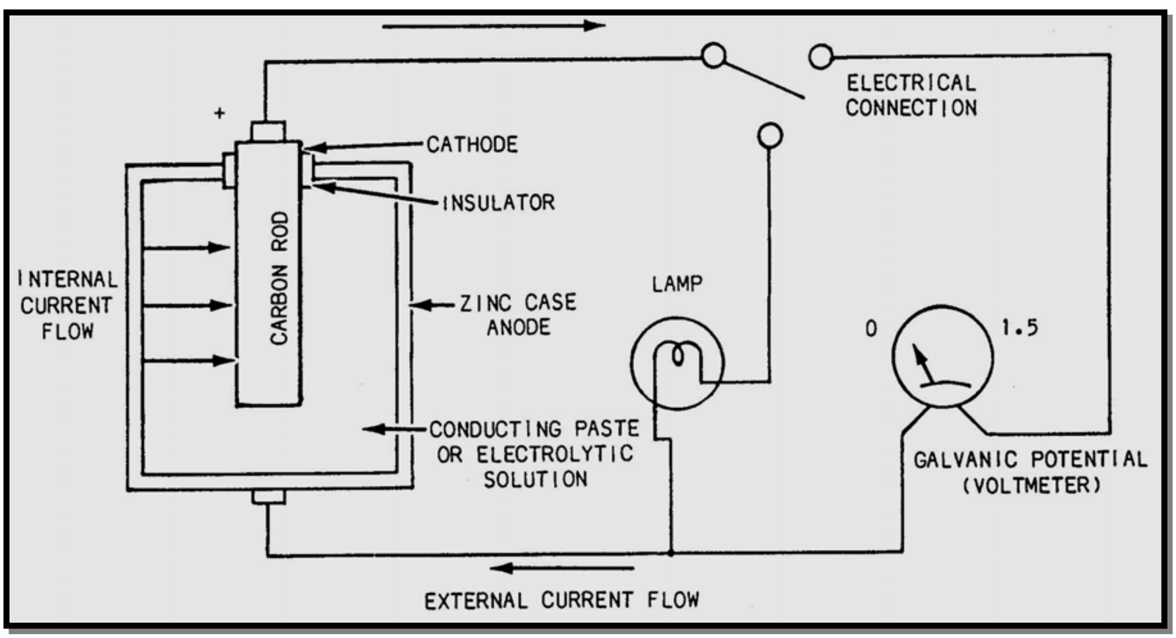


Figure 11-2.—Dry-cell battery circuit.

11.2.2 Electrochemical Action

In a marine environment, corrosion is an electrochemical process caused when two dissimilar metals are immersed in seawater, with the seawater acting as the electrolyte. This process is shown in the electrochemical corrosion cell (fig. 11-3). You must understand that in an electrochemical cell a metal that is more corrosion prone always has a higher driving voltage than the metal that is less corrosion prone. In cathodic protection, the more corrosion-prone metal is the anode (zinc) and the less corrosion-prone metal is the cathode (steel hull). The rate of corrosion is directly related to the magnitude of the potential difference and is referred to as the open- or half-cell potential of metals. Some of the factors affecting the amount of corrosion are stray currents, resistivity, and the temperature of the seawater.

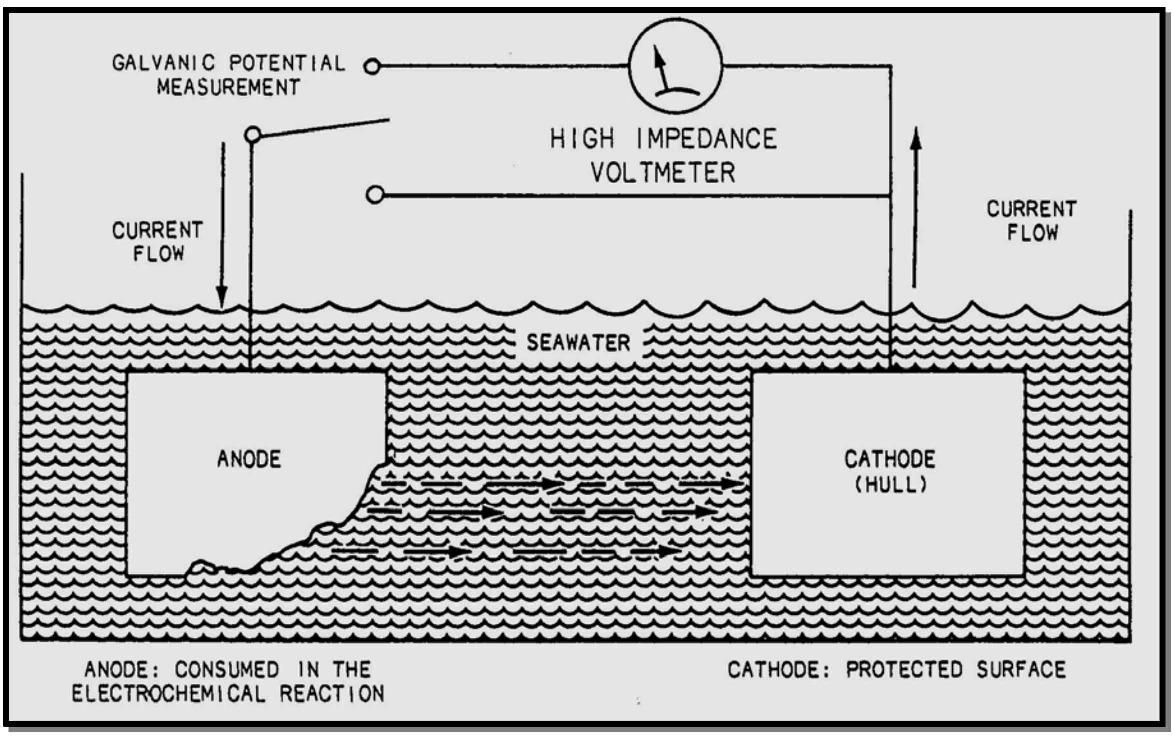


Figure 11-3.—Electrochemical corrosion cell.

Stray-current corrosion is caused by an external current leaving the hull of a vessel and entering the seawater. If the connection between the ship and welding machine is not correctly made (fig. 11-4) or no return lead to the welder is connected, you could have current flow between the ship's hull and the pier, causing corrosion to form on the hull.

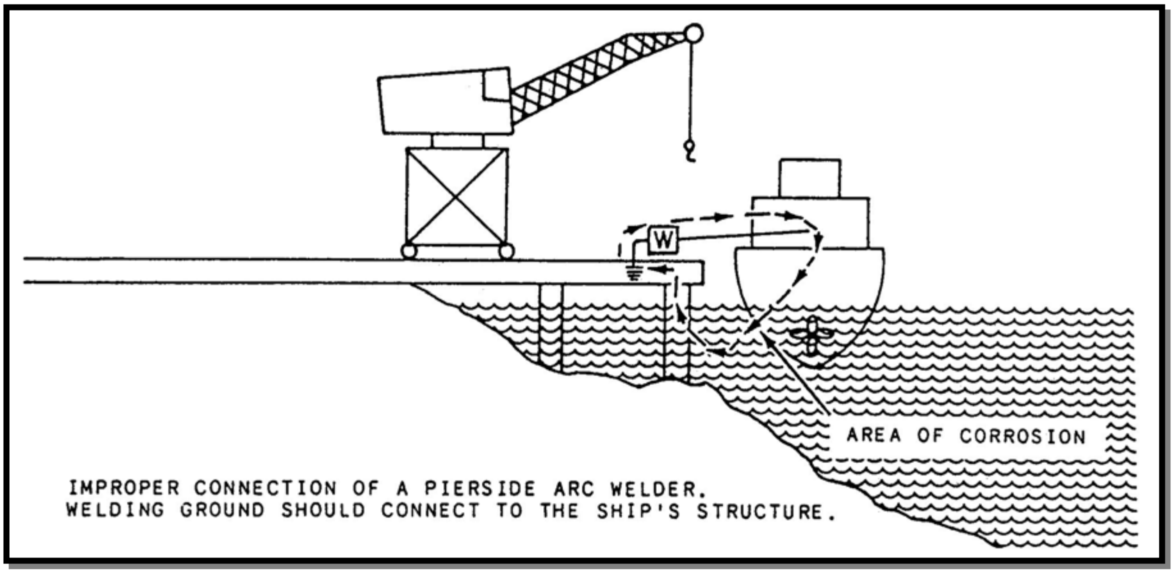


Figure 11-4.—Stray-current corrosion.

Seawater resistivity is the concentration of ions in seawater, which acts as a resistance to current flow between two dissimilar metals. Normal seawater generally has a nominal resistivity of 20 to 22 ohms/cm at a temperature of 20°C (68°F). In brackish or fresh water this resistivity may vary.

11.3.0 TYPES OF CATHODIC PROTECTION

There are two types of cathodic protection systems, the sacrificial anode and the impressed current. Each system will be addressed separately.

Sacrificial Anode System

The sacrificial anode system is based on the principle that a more reactive metal, when installed near a less reactive metal and submerged in an electrolyte such as seawater, will generate a potential of a sufficient magnitude to protect the less reactive metal. In this process, the more reactive metal is sacrificed. Sacrificial anodes attached to a ship's hull slowly oxidize and generate a current (see the electrochemical corrosion cell in fig. 11-2 that protects the hull and its appendages). This system does not have an onboard control of protecting current, and depends on the limited current output of the anode. This type of system requires anode replacement on a fixed schedule (usually every 3 years on naval ships). The system is rugged and simple, requires little or no maintenance, and always protects the ship.

TYPES OF SACRIFICIAL ANODES.— The following is a list of sacrificial anodes:

- Zinc
- Aluminum
- Magnesium
- Iron
- Steel waster pieces

Zinc Anodes.— Zinc anodes are used for anodic polarization on steel or aluminum surfaces. They have a half-cell potential of a negative 1.04 volts. They can be either bolted or welded to the hull. Welding is the preferred method because the anodes will have a secure electrical and mechanical attachment.

Aluminum Anodes.— Aluminum anodes are currently being tested and evaluated by the Naval Sea Systems Command (NAVSEA). The use of aluminum anodes requires prior NAVSEA authorization and design review. It is also necessary to obtain guidance from NAVSEA before preparing a cathodic protection system design using aluminum anodes.

CAUTION:
Do not use magnesium anodes on aluminum hulls. Production of an alkaline (basic corrosion product) may lead to serious corrosion of the aluminum metal structure. Aluminum is referred to as an amphoteric material because it is subject to deterioration by both acid and basic solutions.

Magnesium Anodes.— Magnesium anodes have a half-cell potential of about negative 1.5 volts. They are not used in seawater applications because of rapid loss of the anode material and overprotection due to the high driving voltage. They are used in fresh or brackish water areas where the resistivity of the electrolyte is relatively high and a higher driving voltage is required to produce the proper amount of polarizing current.

Iron Anodes.— Iron anodes are installed to increase the presence of iron ions in the water. This strengthens the formation of the oxide film produced on copper alloy surfaces.

Steel Waster Pieces.— Steel waster pieces are sleeves of mild steel installed at nonferrous metal junctions to protect sea valves and sea chests.

USES OF SACRIFICIAL ANODES.—Sacrificial anodes are used in small boats, mothballed ships, and submarines. They may be installed in piping systems, bilge pumps, valves, ballast tanks, fuel tanks, sewage collection holding tanks (CHTs), sonar domes, voids, and stem tubes.

ADVANTAGES OF SACRIFICIAL ANODES.—The following is a list of the advantages of sacrificial anodes:

- No external electrical power is required.
- They are relatively foolproof and little maintenance is required.
- They are easy to install.
- Hull protection is provided at all times until the anode is completely consumed.

DISADVANTAGES OF SACRIFICIAL ANODES.—The following is a list of the disadvantages of sacrificial anodes:

- The anode current is uncontrollable.
- Water turbulence around the hull increases the noise level.
- Frequent replacement is necessary when stray dc is present (especially when welding machines are used).
- Fuel consumption is increased.
- Replacement is usually necessary before scheduled overhaul (every 3 years).

Impressed Current Cathodic Protection System

The impressed current cathodic protection (ICCP) system (fig. 11-5) uses an external source of electrical power provided by a regulated dc power supply to provide the current necessary to polarize the hull. The protective current is distributed by specially designed inert anodes of platinum-coated tantalum. The principal advantage of an ICCP system is its automatic control feature, which continuously monitors and varies the current required for corrosion protection. If the system is secured, no corrosion protection is provided.

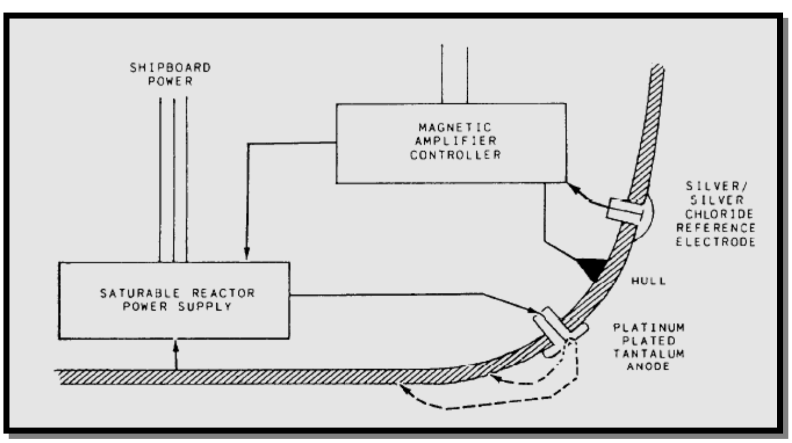


Figure 11-5.— Basic impressed current cathodic protection system.

COMPONENTS OF THE ICCP SYSTEM.—The following list of the components of the ICCP system:

- Power supply
- Controller
- Anodes
- Reference electrode
- Stuffing tube
- Shaft grounding assembly
- Rudder ground (including stabilizer if installed)
- Dielectric shield

Power Supply.— The power supply performs two functions. It converts available shipboard alternating current (at) to low-voltage direct current (dc) and provides a means of adjusting the value of current delivered to the anodes.

Controller.— The controller (fig. 11- 6) is used to monitor the control power supply outputs that maintain the hull at a preset potential versus the reference cell. The controller is a sensitive amplifier that creates an output signal proportional to the voltage difference between the reference (electrode-to-hull) voltage and the internally set voltage. The controller should be mounted in a readily accessible area.

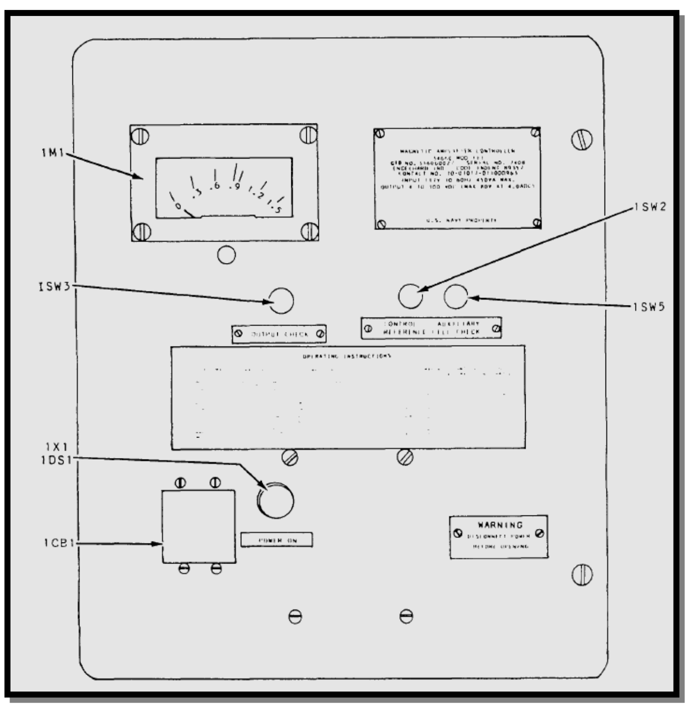


Figure 11-6.— Magnetic amplifier controller Mod III.

Anodes.— The anodes (fig. 11-7) are constructed of two platinum-coated tantalum rods mounted in an insulating glass-reinforced polyester holder. Anodes are bolted to the outside of the ship's hull. The direct current flows into the seawater through the platinum surface of the tantalum rods. The platinum surface of the anode corrodes very slowly. The replacement period for anodes is usually 10 years or longer. Anodes are available in the following three sizes: 2 feet (40 amperes), 4 feet (75 amperes), and 8 feet (150 amperes).

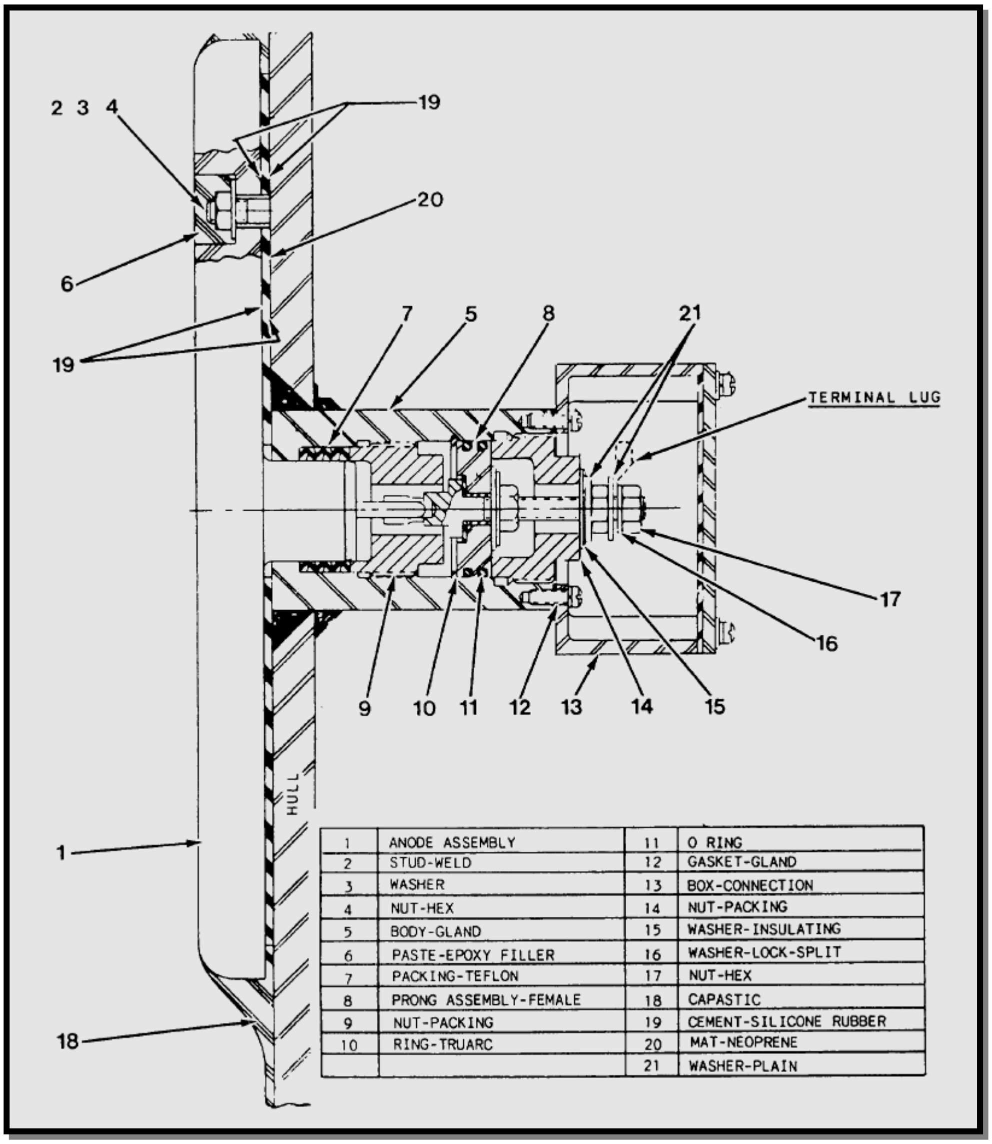


Figure 11-7.— Anode assembly.

Installation of the anodes should be placed to maintain a uniform potential throughout the underwater hull. The following is a list of anode locations:

- Placement should be at least 5 feet below the light-load waterline.
- One- and two-screw ships will have one set of anodes located more than 10 feet, but less than 50 feet, forward of the propeller plane.
- Four-screw ships will have two anodes located between the forward and after propeller planes, one port and one starboard.
- Anodes should be mounted in an area that experiences minimum water turbulence and that is protected from mechanical damage.
- Anode to anode, anode to electronic log equipment, and anode to reference cell separation should be a minimum of 40 feet.
- Anodes should not be installed within 15 feet of a sea chest or pipe discharge.

Reference Electrode.— The reference electrode (fig. 11-8) is a silver/silver chloride type constructed of a silver mesh screen that has been treated with silver chloride. It is bolted to the exterior hull of the ship and is insulated from the ship by a polyvinyl chloride holder. A stuffing tube is used to pass the cable from the electrode through the hull to the controller. The controller measures the potential of the hull versus the reference electrode, and signals the power supply to increase or decrease current output as required. This is to reduce the potential difference between the hull potential and the preset desired potential. Two reference electrodes are installed for each controller.
One reference electrode is selected for the primary control; the other reference electrode serves as an auxiliary to verify operation of the controlling cell and serves as a backup if failure of the primary cell occurs. Reference electrodes are generally located on each side of the hull, about halfway between the anode sites. Reference electrodes are usually replaced approximately every 10 to 12 years.

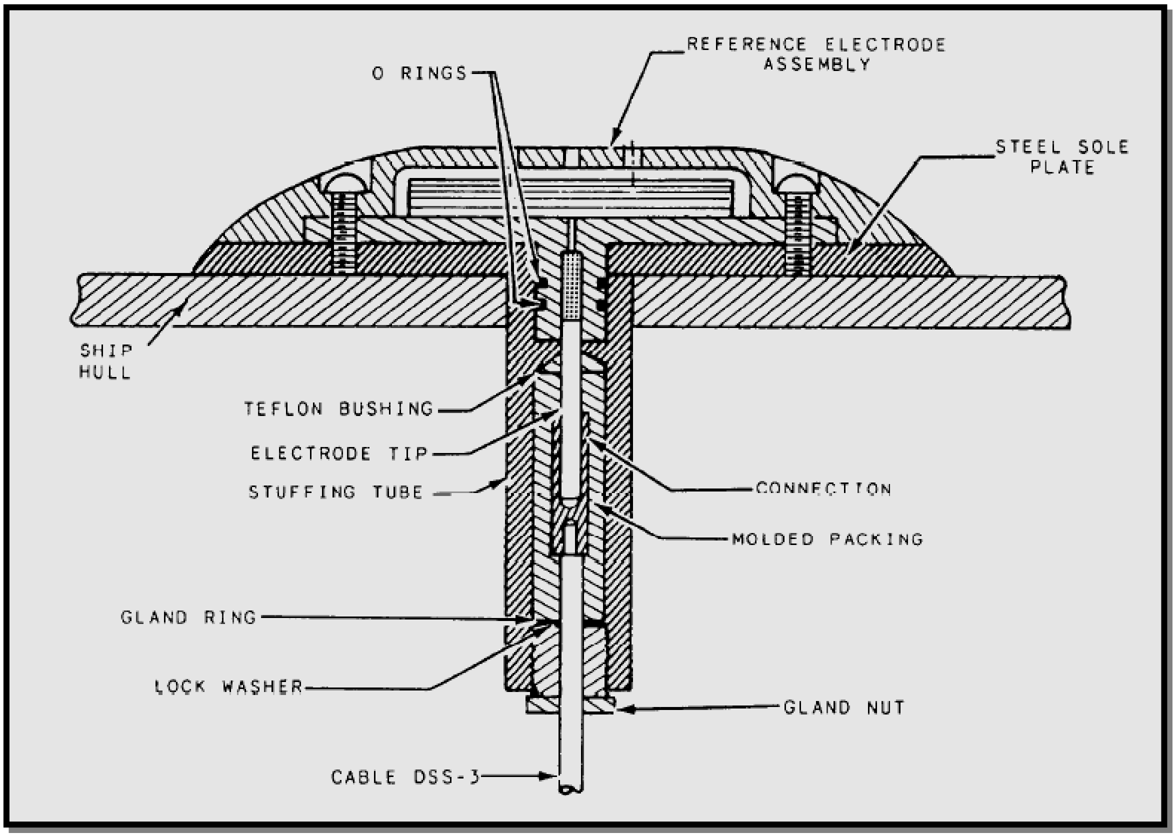


Figure 11-8.— Reference electrode assembly.

Stuffing Tube.— Stuffing tubes are required to insulate the electrical wires that pass through the hull to anodes or reference electrodes.

Shaft Grounding Assembly.— The shaft grounding assembly (fig. 11-9) consists of a silver-alloy band, ring-fitted on the propeller shaft. It is electrically bonded to the shaft and is usually located in the shaft alley. Silver-graphite brushes ride on the hard silver surface of the bands, electrically connecting the rotating propeller shaft to the hull. This assembly is necessary to permit the anode current that flows through the water to enter the propeller blades and return to the hull. A shaft grounding assembly is provided for each shaft. Ships of earner size or larger are fitted with two brush assemblies on the silver-alloy ring.

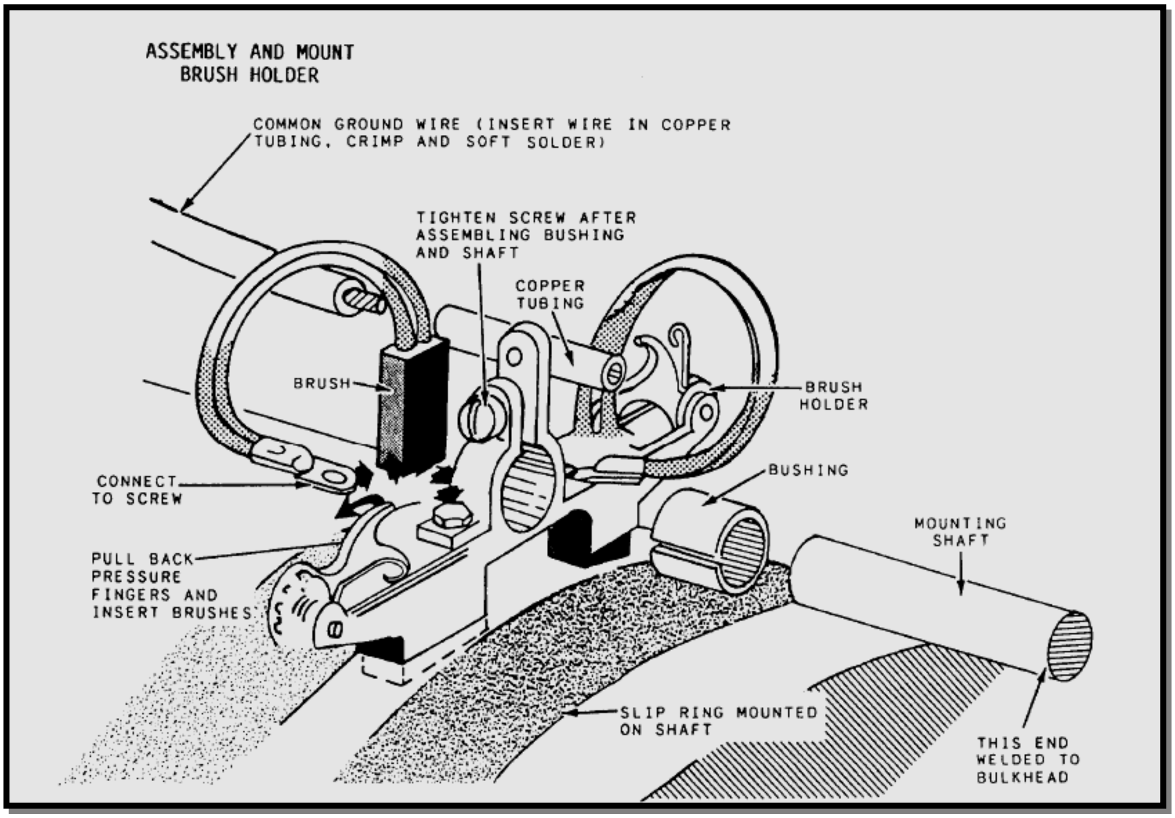


Figure 11-9.— Shaft grounding assembly.

Rudder Ground.— Rudders and stabilizers are grounded by brazing a braided, tinned-copper grounding strap, at least 1 1/2 inches wide, between the rudder stock and the hull. To permit full rotation of the rudder stock from port to starboard, a large loop is required in the ground strap.

Dielectric Shield.— The dielectric shield prevents shorting of the anode current to the hull and aids in wider current distribution. The dielectric shield is applied as a thick coating around each anode. It consists of a high-solids epoxy with a high-dielectric strength.

OPERATION.— The requirements for operating the ICCP system on ships is provided in the manufacturer’s technical manual. The system should be operated at all times, except during diving operations, equipment repair, planned maintenance, or drydocking. The system must be reactivated within 2 hours after the activity is completed. You must NEVER energize the system if the ship is out of the water (drydocked).

Before the reference electrode is connected to the controller, check the voltage between the reference electrode and the steel hull; it should be approximately 0.6 volt dc. The hull will be negative (-) and the reference electrode will be positive (+). If the voltage is zero, the reference electrode has an open lead, or the lead or electrode is shorted to the hull. When the voltage is 0.6 volt or higher, the ship is receiving cathodic protection from an external source, which could be zinc anodes or an electrical leakage.

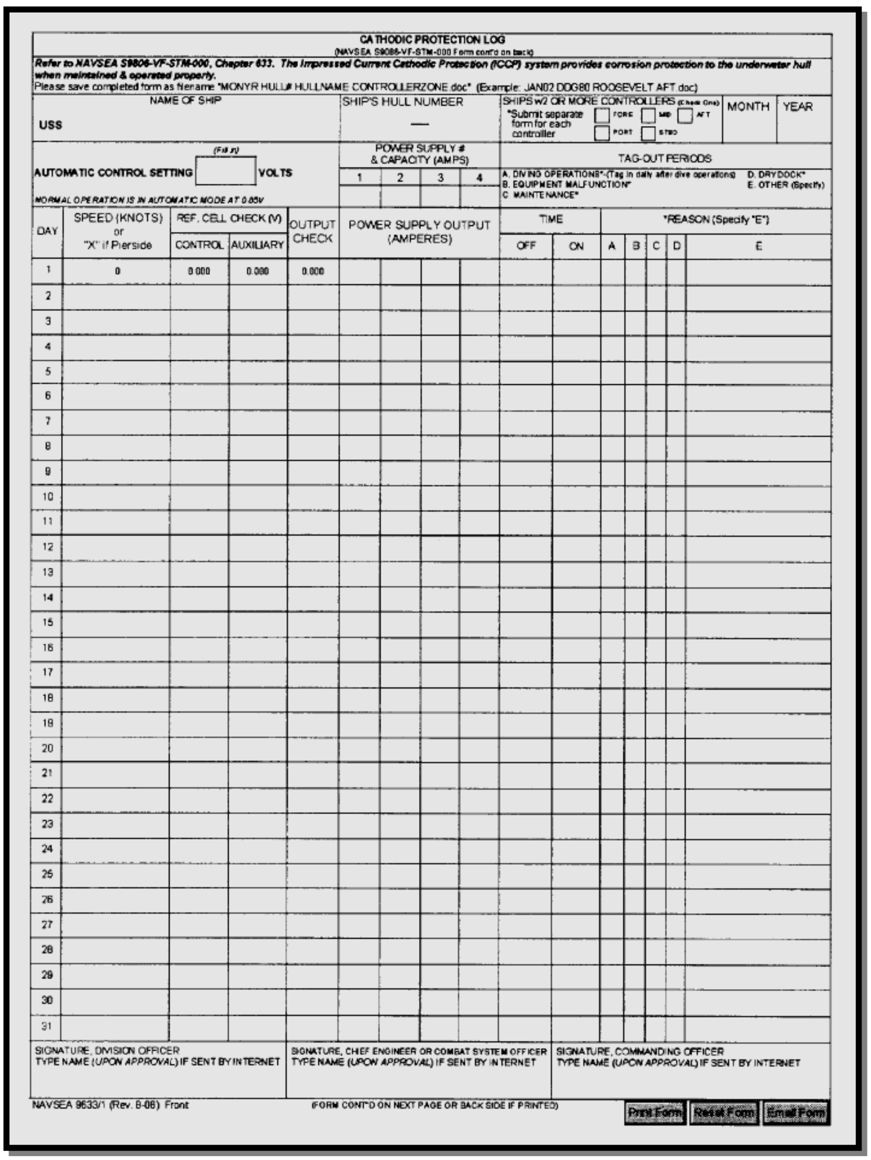
Inspect the controller and power supply wiring to ensure the unit is properly grounded. Before connecting the anode leads to the power supply, check for possible shorts. The voltage developed between a disconnected platinum anode and the steel hull will range from 1.0 to 2.0 volts dc. This can be read on a high-impedance voltmeter. The polarity of the anode is positive (+) and the polarity of the hull is negative (-). If this voltage is zero, you could have an open lead wire or a shorted anode. When the voltage reads between 2.0 to 5.0 volts, it indicates that the anode lead is immersed in seawater.

HULL POTENTIAL SETTING OF SHIPS IN SEAWATER.— The ICCP system is designed to operate automatically and requires a minimum amount of maintenance. The operator normally sets the hull potential at -0.85 volt. When the voltage between the hull and the reference electrode is more positive than the voltage set by the operator, the output of the controller increases. This causes an increase in the anode current output from the power supply until the voltage between the hull and the reference electrode approaches the set voltage. A voltage between the hull and the reference electrode that is negative to the set voltage causes a decrease in controller output, thereby decreasing the anode current output.

The optimum range of polarization or hull-to reference electrode potential for a ship with an ordinary steel hull is from a -0.80 to a -0,90 volt to the silver/silver chloride reference electrode. Increased anode current will result in hull potentials more negative than the optimum amount. Increasing the negative potential does not provide more protection. If exceeded, this will result in hydrogen generation at the hull surface.

HULL POTENTIAL SETTING OF SHIPS ENTERING BRACKISH OR FRESH WATER.—As a ship enters a port or bay that is river-fed, the resistivity of the water will change as the salinity changes. Operation of the ICCP system will be affected by the changing water resistivity. The operator will notice the ICCP system operating at higher voltage outputs and lower current outputs. The lower current output is caused by the higher impedance of the water. A higher voltage output is required to drive the same current in the higher resistivity electrolyte. The operator will record this condition on the ICCP log. Do not take action to correct this condition by equipment recalibration while the ship is in brackish water.

CATHODIC PROTECTION LOG.— Normal operating procedures require maintaining a Cathodic Protection Log of the ICCP system operation on NAVSEA Form 9633/1 (fig. 11-10, view A, and 11-10, view B). The readings will be recorded on these logs daily and submitted to NAVSEA monthly, Logs submitted to NAVSEA are analyzed to identify those systems that are not operating correctly. After analysis of the logs is complete, a response is sent to the ship or type command (TYCOM) indicating the operational status of the equipment as interpreted from the logs. This response will recommend corrective actions to be taken, if required.



CATHODIC PROTECTION LOG
(NAVSEA S9086-VF-STM-000 Form cont'd on back)

Refer to NAVSEA S9806-VF-STM-000, Chapter 633. The Impressed Current Cathodic Protection (ICCP) system provides corrosion protection to the underwater hull when maintained & operated properly.
Please save completed form as filename "MONYR HULL# HULLNAME CONTROLLERZONE.doc" (Example: JAN02 DDG80 ROOSEVELT AFT.doc)

NAME OF SHIP
USS

SHIP'S HULL NUMBER
—

SHIPS w2 OR MORE CONTROLLERS (Check One)
*Submit separate form for each controller
FORE MID AFT
PORT STBD

MONTH | YEAR

AUTOMATIC CONTROL SETTING (Fill in) VOLTS
NORMAL OPERATION IS IN AUTOMATIC MODE AT 0.85V

POWER SUPPLY # & CAPACITY (AMPS)
1 | 2 | 3 | 4

TAG-OUT PERIODS
A. DIVING OPERATIONS*-(Tag in daily after dive operations)
B. EQUIPMENT MALFUNCTION*
C. MAINTENANCE*
D. DRYDOCK*
E. OTHER (Specify)

DAY	SPEED (KNOTS) or "X" if Pierside	REF. CELL CHECK (V)		OUTPUT CHECK	POWER SUPPLY OUTPUT (AMPERES)				TIME		*REASON (Specify "E")				
		CONTROL	AUXILIARY						OFF	ON	A	B	C	D	E
1	0	0.000	0.000	0.000											
2															
3															
4															
5															
6															
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SIGNATURE, DIVISION OFFICER
TYPE NAME (*UPON APPROVAL*) IF SENT BY INTERNET

SIGNATURE, CHIEF ENGINEER OR COMBAT SYSTEM OFFICER
TYPE NAME (*UPON APPROVAL*) IF SENT BY INTERNET

SIGNATURE, COMMANDING OFFICER
TYPE NAME (*UPON APPROVAL*) IF SENT BY INTERNET

NAVSEA 9633/1 (Rev. 8-08) Front
(FORM CONT'D ON NEXT PAGE OR BACK SIDE IF PRINTED)
Print Form | Reset Form | Email Form

Figure 11-10.— Surface Ship ICCP Log (Analog Controller). (View A).

CATHODIC PROTECTION LOG-CONTINUATION
(NAVSEA S9086-VF-STM-000)

Refer to NAVSEA S9086-VF-000, Chapter 633, Impressed Current Cathodic Protection (ICCP) system provides corrosion protection to underwater hull when maintained and operated properly

CONTROLLER

- SHALL BE OPERATED IN AUTOMATIC CONTROL MODE AT ALL TIMES EXCEPT AS NOTED IN TAGOUT COLUMN ON FRONT OF LOG
- AUTOMATIC CONTROL SETTING FOR NORMAL OPERATION IS 0.85 VOLTS
- MANUAL CONTROLLER MODE IS A FIXED POWER SUPPLY CURRENT SETTING FOR PMS, TEST, OR OTHER SPECIAL CONDITIONS ONLY
- SENSITIVITY SWITCH IS (CHECK ONE) ☐ N/A ☐ LOW ☐ MEDIUM ☐ HIGH

POWER SUPPLY

- SHALL BE OPERATED AT ALL TIMES EXCEPT AS NOTED IN TAGOUT COLUMN ON FRONT OF LOG.

PMS

- ACCOMPLISH, MAINTENANCE INDEX PAGE 6332/001, ALL MAINTENANCE REQUIREMENT CARDS WITHIN THE PRESCRIBED SCHEDULE.

NORMAL OPERATION RANGES (MIN.-MAX.)

REFERENCE CELL CHECK CONTROL & AUXILIARY (VOLTS)	OUTPUT CHECK (VOLTS)	POWER SUPPLY CURRENT (AMPERES)
0.75-1.20	0.00-1.00	0-150 ± 10% for 150A POWER SUPPLY 0-300 ± 10% for 300A POWER SUPPLY

FORWARD LOGS MONTHLY (WITHIN 15 DAYS OF COMPLETION)

- VIA INTERNET: ICCP_Log nswccd fct@navy.mil
- VIA POSTAL SERVICE: COMMANDER, NAVAL SEA SYSTEMS COMMAND
  1333 ISAAC HULL AVENUE SE STOP 5131
  WASHINGTON NAVY YARD DC 20376-5131
  ATTN: SEA 05P23 A. SEELINGER

REFER QUESTIONS CONCERNING OPERATION AND MAINTENANCE TO
(In order of precedence)

1. APPLICABLE RMC	2. NSWCCD PHILA (CODE 614)	3. NAVSEA (SEA 05P23)

COMMENTS (If applicable)

NAVSEA 9633/1 (Rev. 8-06) Back

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Figure 11-10.— Surface Ship ICCP Log (Analog Controller). (View B).

Output Check.— A particularly significant value recorded on the log is the output check. The values recorded will range from practically zero to 1.0 volt, representing 100 percent current output. If the values range between 0.3 and 0.5 volt, the system is operating at 30 to 50 percent capacity.

Power Supply.—The daily current output is recorded for each power supply. Ampere values may vary, depending on the power supply, maximum output, and current demand. Two capacities of power supplies are used, 0 to 150 amperes and 0 to 300 amperes.

ICCP MAINTENANCE.— The ICCP maintenance will be performed according to the Planned Maintenance System (PMS). Take daily meter readings on the panel and record them on the log. A quarterly check must be performed on the shaft grounding assembly. Every 24 months the panel meters must be calibrated according to PMS requirements.

11.4.0 200 AMP ELECTRONIC GROUNDING UNIT

This section describes the operation, function, troubleshooting, maintenance, parts breakdown, and installation of the Electronic Grounding Unit (EGU).

Information in this section covers units with serial numbers B201.001, B201.002 and BS03.001. The EGU is the main component of the Active Shaft Grounding (ASO) system. Other components include brushes, slip rings, and interconnecting cables.

11.4.1 Equipment Description

The purpose of shaft grounding, either active or passive, is to minimize corrosion of the shaft, bearings and seals. The presence of dissimilar metals in the construction of the hull and propulsion system immersed in sea water creates the electrochemical reactions of a battery causing current to flow from the shaft through the bearings and seals and back to the hull. Another source of current flowing on the shaft is the impressed current cathodic protection (lCCP) system. These currents flowing along this path cause a potential difference between the shaft and hull. This potential difference causes corrosion to occur on the shaft, bearings, and seals. Grounding the shaft to the hull minimizes this potential difference and thereby minimizes the corrosion. The ASO system is shown in figure 11-11.

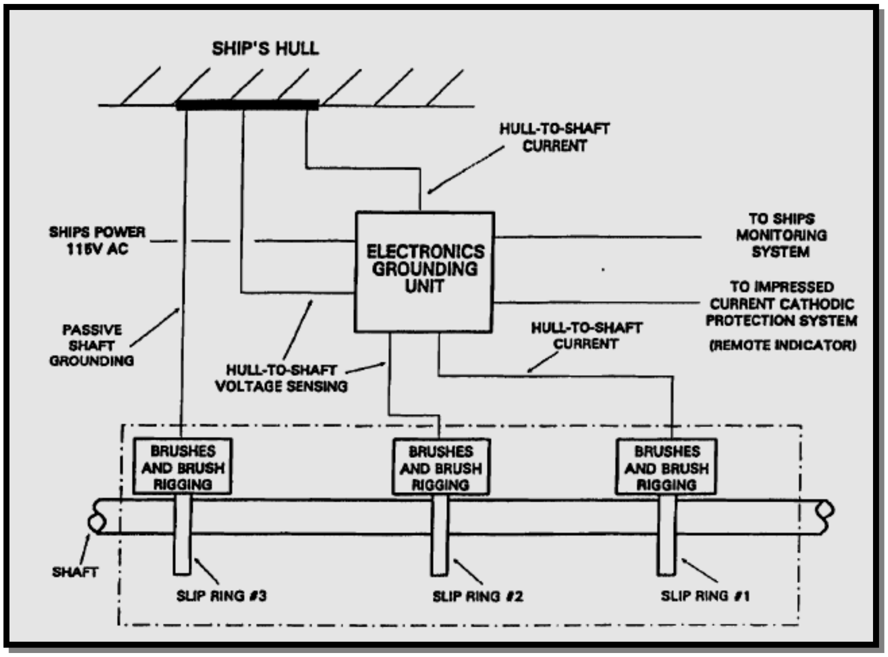

Figure 11-11.— Active Shaft Grounding System.

The EGU, cables, brushes, and slip rings are collectively known as the ASG system. The ASG system works in parallel with a passive grounding system consisting of a brush and slip ring assembly on the shaft connected by a cable to the hull. By providing a low impedance path for the shaft current, the ASG system minimizes shaft voltage and there fore corrosion. The EGU can provide an electrical current of up to200A in order to maintain the shaft voltage below 2 mV DC and 2 mV AC pp.

Physical Description

The EGU enclosure measures 24 in. wide by 24 in. high by 12 in. deep. The material of the enclosure is aluminum. The unit is splash proof and is intended to be bulkhead mounted to a wall with four *3/4* in. bolts. The EGU weighs 175 pounds, Dot including the weight of the input and output cables.

The internal frame of the unit is mounted on resilient shock mounts. This provides mechanical shock protection for items mounted on this frame. Power supplies, fan modules, and heatsink assemblies are mounted 00 this frame.

Front access is provided for maintenance of all parts and assemblies. A blank cable entrance plate, located at the bottom of the enclosure, is provided for installing all cables except the hull and shaft output cables. These two cables are connected through bulkhead strain relief connectors. No special tools are required for the removal of screws and nuts. The enclosure is designed to minimize electromagnetic interference.

The EGU is located in an aft compartment oft he ship in close proximity to the point where the propeller shaft enters the hull. This proximity minimizes voltage drops along the shaft. An illustration of the EGU is given in figure 11-12.

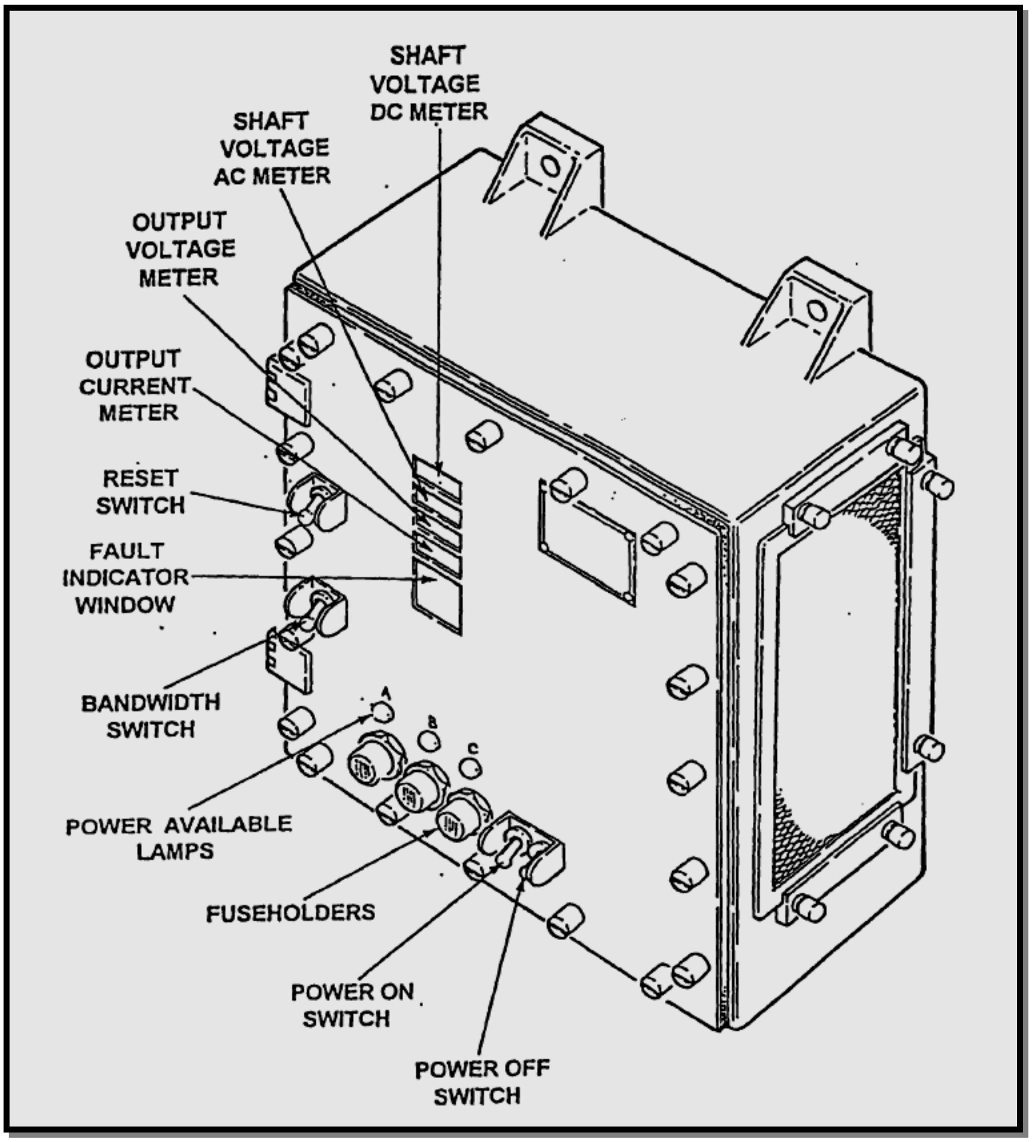

Figure 11-12.— Electronic Grounding Unit.

Reference data pertaining to the Electronic Grounding Unit is given in table 11-2.

Manufacturer	W.R. Davis Engineering Limited
Model	Electronic Grounding Unit
CID/RIC	211059189
Input power	115 VAC, 60 Hz, 3 ohm, ungrounded, 1.0 kW
Output current	0 -200 A
Output voltage	0 to -4 VDC
Shaft voltage control	DC: 2 mV max AC: 2 m V pp max Bandwidth: 0 – 200 Hz
Ambient operating temperature	-32 – 122 F
Relative humidity	0 -100 %

Table 11-2.— Reference Data.

The EGU is designed to operate without operator intervention. The recognition and correct usage of the controls and indicators will enable the EGU and the ASG system to operate effectively. Operational faults or failures are indicated by a series of display lamps or by abnormal meter readings. The EGU's major internal assemblies are of modular design to facilitate replacement should they fail. The EGU requires only simple maintenance to ensure operation with minimal down time.

Under normal operating conditions one properly trained operator is sufficient to ensure the EGU is functioning effectively and to detect and report failures. Preventive maintenance is also the responsibility of the operator.

Operator controls and indicators, located on the front panel and illustrated in figure 11-12, are described in the following paragraphs.

The EGU can be in one or three states: OFF, ON, or FAULT. Operator actions will cause the EGU to change states. For example, if the EGU is in the OFF state activating the POWER ON switch will cause the EGU to enter the FAULT state. The OFF state is indicated by the absence of meter and status display lights. The ON state is indicated by the EOU meters and status indicators having their normal readings. The FAULT state is indicated by either a red SHAFT OVERCURRENT or OVERTEMPERATURE status indicator. The EGU performs its intended function only in the ON state.

Controls and Indicators

The location, function, and method of operation of some controls and displays on the EGU are described in the following paragraphs (see table 11-3). All operator controls arc located on the front panel. Essential information displays are visible through the window on the front panel. The fault indicators for specific heatsink modules are located on the inside of the front panel. Access to these is restricted and can only be achieved by opening the enclosure. Only a qualified technician is permitted to access the interior of the enclosure with power present.

Item No.	Control or Indicator	Function
1	Fuse Holder	Fuse blown indication.
2	Power available lamps	Power available lights indicate the presence of 115 VAC power in the EGU.
3	Power ON Switch	Power to EGU internal circuits.
4	Power OFF Switch	Power to EGU internal circuits is removed.
5	RESET Switch	Switching from FAULT state to ON state.
6	Bandwidth Switch	Bandwidth selection (30Hz or 200Hz).
7	Fault Indicator Window (Five pairs of LEDs located on the printed circuit board below the meters and visible through the window on the front panel).	
	a. Overcurrent	Display the status of the output current.
	b. Overvoltage	Display the status of the shaft voltage.
	c. Shaft Negative	Display the polarity of the shaft voltage.
	d. Power Supply out of tolerance	Display the status of the four internal 4V power supplies.
	e. FET Module overtemperature	Display the status of the temperature on the four heatsink modules.
8	AMPS DC Output meter	Display the EGU output current.
9	V DC Output meter	Display the EGU output voltage.
10	mV AC SHAFT-HULL meter	Display the EGU shaft-hull AC voltage measured in mV peak-to peak.
11	mV DC SHAFT-HULL meter	Display the EGU shaft-hull DC voltage measured in mV.

Table 11-3.— Controls and Indicators.

Switches

Four toggle switches are located on the front panel. Protection against accidental deployment and damage is provided by a small metal guard at each switch location.

POWER ON Switch

Power to the EOU internal circuits is applied by activating the momentary toggle switch labeled POWER ON, located in the lower central area of the front panel (figure 11-12). Its function is to energize the main circuit relay, applying power to all internal circuits, and to place the EGU in the FAULT state. The switch is activated by pulling out, lifting and releasing the lever. This switch does not control the 115 VAC main supply voltage and is effective only when the circuit breaker supplying power to the EGU is closed as indicated by the POWER AVAILABLE indicators.

POWER OFF Switch

Power to the EGU internal circuits is removed by activating the momentary toggle switch, labeled POWER OFF, located in the lower central area of the front panel (figure 11-12). Its function is to de-energize the main circuit relay disconnecting power from all internal circuits, and placing the EGU in the OFF state. The switch is activated by pulling out, lifting and releasing the lever.

11.5.0 ELECTROHYDRAULIC STEERING GEAR

The steering gear is one of the most vital auxiliaries aboard ship. It must be thoroughly dependable and have sufficient capacity for maximum maneuverability. The types of steering gear listed in the sequence of their development are (1) steam, (2) electromechanical, and (3) electrohydraulic. Electrohydraulic steering gear was developed to meet the power requirements of naval vessels having large displacements and high speeds with attendant increase in rudder torques.

11.5.1 Construction

The majority of steering gear installations in new construction naval vessels are of the electrohydraulic type. The electrohydraulic steering system installed in one class of destroyer (fig. 11-13) consists essentially of (1) a ram unit, (2) a power unit, and (3) a remote control unit (not shown).

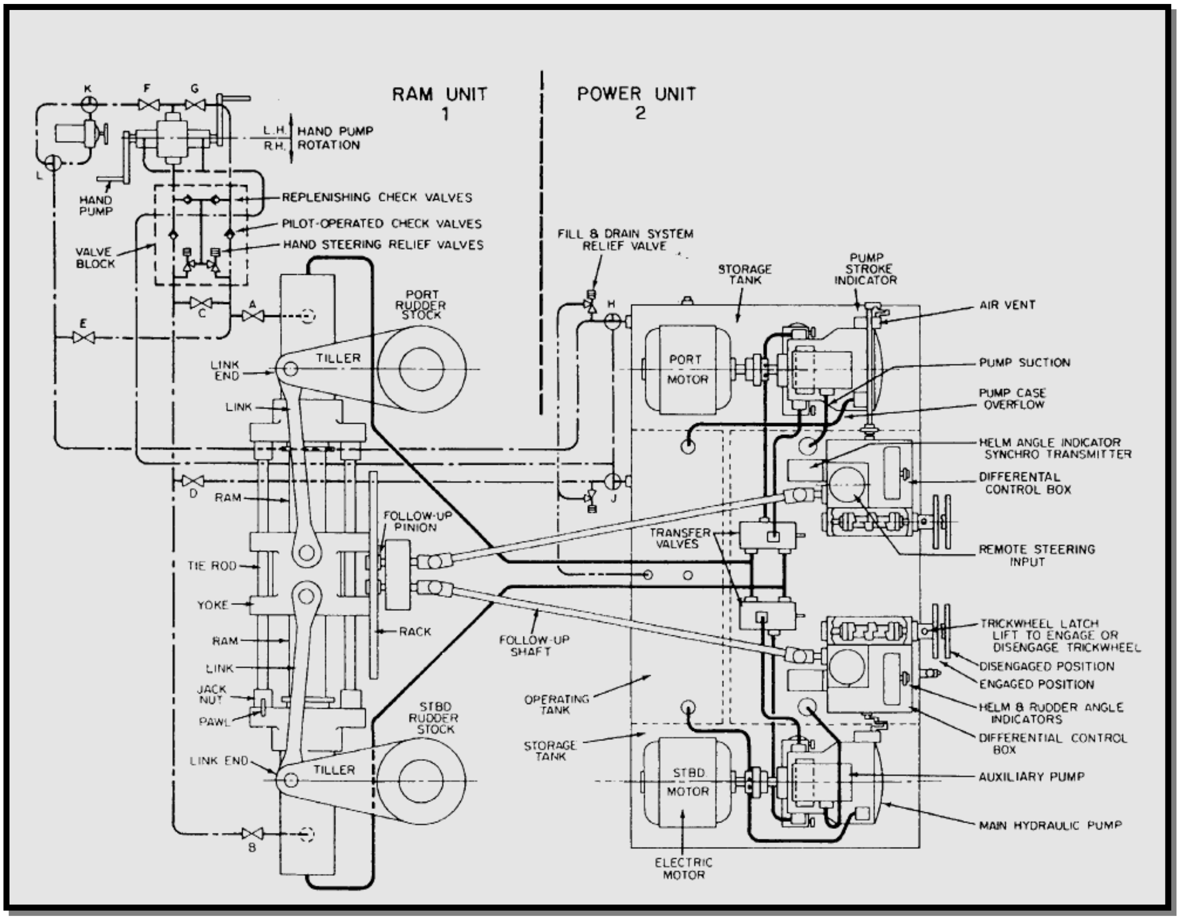

Figure 11-13.— Electrohydraulic steering.

Ram Unit

The ram unit is mounted athwartship and consists of a single ram operated by opposed cylinders. The ram is connected by links to the tillers of the twin rudders. When oil pressure is applied to one end of the operating cylinder, the ram will move, causing each rudder to move along with it. Oil from the opposite end of the cylinder is returned to the suction side of the main hydraulic pump in the power unit.

The tie rods that connect the two cylinders also serve as guides for a sliding crosshead attached to the ram to prevent the ram from rotating. The crosshead also provides mechanical limits to the ram travel at 42° of rudder angle. At this position the crosshead contacts the copper facing on the stop collars and prevents further movement.

A rack is attached to the ram and engages two gears. The rotation of these gears is transmitted to the respective differential control boxes through the follow-up shaft.

Power Unit

The power unit has two independent pumping systems. These include two motor-driven pumps, two 4-way transfer valves with operating gear, a relief valve, two differential control boxes, two trick wheels, and a hand emergency gear all mounted on a bedplate. The bedplate is the top of an oil reservoir. Steering power is derived from either pumping system acting alone. The system not in use serves as a standby source in case of an emergency.

The two pumps (port and starboard) are identical in size and design and are of the variable delivery axial piston type. Each main pump unit includes a built-in vane-type servo pump, pressure control and replenishing valves, and two main relief valves. Each main pump is stroked through a rotary servo control.

Each pump is driven by a 20-hp, 1200-rpm, 440-volt, 3-phase, 60-Hz induction motor through reduction gears and a flexible coupling.

The pumps of the power unit are connected to the ram cylinders by a high-pressure piping system. The two 4-way transfer valves are interposed in this piping, and their positions determine which pump is connected to the cylinders in the ram unit. The hand lever, which moves both valves simultaneously, is located on the power unit between the trick wheels. It has three latched positions. The latched positions are marked P, N, and S, which denote port pump connected, neutral (ram locked), and starboard pump connected, respectively.

The transfer valves, which are of the ported piston type, are mounted on the power unit bedplate between the motors. When the valves are in the neutral (ram locked) position, the ports of the pipes to the ram cylinders are blocked, and the two pipes from each pump are connected through ported passages in their respective valves. If either or both pumps are started and put on stroke, oil will circulate through the valve and back to the pump. Movement of the transfer valves in either direction connects the selected pump to the ram cylinders, and the opposite pump remains bypassed.

The drain pipes from the ram cylinders lead to the reversible hand pump. It provides a means for emergency steering under limited rudder torques. The relief valve in the emergency steering system is set at 500 psi. The oil flow is through pilot-operated blocking valves that prevent the ram from overhauling the pump and kicking back the handles. When you move the ram with the hand pump, set the main transfer valves in the ram locked position and open the drain valves beneath the cylinders.

The mechanical differential control box serves to correlate the signal from the ram follow-up assembly and the steering control system into one order to the hydraulic pump.

The stroking lever and output shaft on each differential control box actuate a rotary servo valve that controls the associated main pump on the power unit. In response to movements transmitted through the control box, the pump discharge is varied between zero and maximum, and in either direction of flow.

In normal steering from the pilothouse, a synchro transmitter is turned by the steering wheel. This synchro transmitter is electrically connected to a synchro receiver in the steering gear room. The synchro receiver is geared to the LOWER bevel gear in the differential control unit, and its rotation is transmitted through gearing to a cylindrical cam. A follower roller, which engages a groove in the cylindrical cam, is mounted on an arm keyed to the output shaft of the control box.

For example, assume that the rudder is amidships and it is desired to obtain 20° right rudder. The rotation of the lower bevel gear causes rotation of the cylindrical cam, which, in turn, imparts a motion to the servo control valve through the cam roller. This motion of the servo control valve puts the pump on stroke. Oil pressure is then applied in the port cylinder, forcing the ram to starboard to give right rudder.

A rack, attached to the ram, rotates the follow-up shaft, which is geared to the UPPER bevel gear in the differential control unit. The movement of the ram and rudders (in response to the stroking of the pump) causes the upper bevel gear to rotate in a direction opposite to that of the lower bevel gear. This action rotates the cylindrical cam in the opposite direction, tending to cancel the movement of the control input and bring the servo control valve back to the neutral position to return the pump stroke to neutral and stop the pumping of oil.

Thus, the rudders are at 20° right rudder, the cam is returned to neutral, and the pump is returned to zero stroke until further movement of the steering wheel causes repetition of the cycle. The same sequence occurs if the control is from the trick wheel in the steering compartment.

An engraved dial, graduated in rudder degrees, is mounted on top of the differential control box. Two concentric pointers (one geared to the control pump input and the other geared to the rudder follow-up) indicate the positions of the helm and rudders, respectively. A helm-angle synchro transmitter, also mounted on the differential control box, actuates a synchro receiver in the steering console in the pilothouse. This receiver positions a pointer to indicate to the helmsman the angle that is ordered rather than the actual rudder angle. The ordered angle is called the helm angle.

Remote Control System

The remote control system provides control from the pilothouse for normal steering. This system has a synchro transmitter mounted in the steering console and a synchro receiver mounted on each pump differential control box (port and starboard). A cable selector switch in the pilothouse and a similar switch in the steering compartment permit a choice between the port or starboard steering cables. The selection of the control cable is made by the operation of the cable selector switches in the pilothouse and in the steering gear room to the desired (port or starboard) position.

The synchro-receiver selector switch in the steering gear room is then set to connect the synchro receiver on the active power unit to the steering console synchro transmitter. The rotary motion of the synchro receiver is transmitted through gearing to the input of the differential control box (stroking mechanism previously described).

The helm-angle indicator synchro transmitters on the differential control boxes in the steering gear room are electrically connected to their associated steering-control synchro receivers. These transmitters, under all conditions of operation, actuate their associated helm-angle indicator synchro receivers in the pilothouse console through their associated cables.

The 120-volt, single-phase power for the remote control system is supplied to the steering power panel through a 450/120-volt transformer from the steering power transfer switchboard.

The 120-volt, single-phase power for the indicator synchro transmitters is supplied from the IC switchboard.

Magnetic Controller

The motor of each steering gear pump is provided with a non-reversing across-the-line starter and a maintained-contact master switch (fig. 11-14). The starter is supplied with 440-volt, 3-phase, 60-Hz power from the steering power transfer switchboard located in the steering gear room.

The pump motor on either power unit is started or stopped by operating the maintained-contact push button on the associated push-button station to the desired position. When the maintained-contact start push button is pressed, the circuit is completed to the contactor operating M coil of the line contactor. This action energizes the operating M coil and closes the contactor in the motor starter to connect the motor to the line. The motor will continue to run until the M coil is de-energized because of loss of voltage, tripping of the overload relay, or pressing of the stop push button.

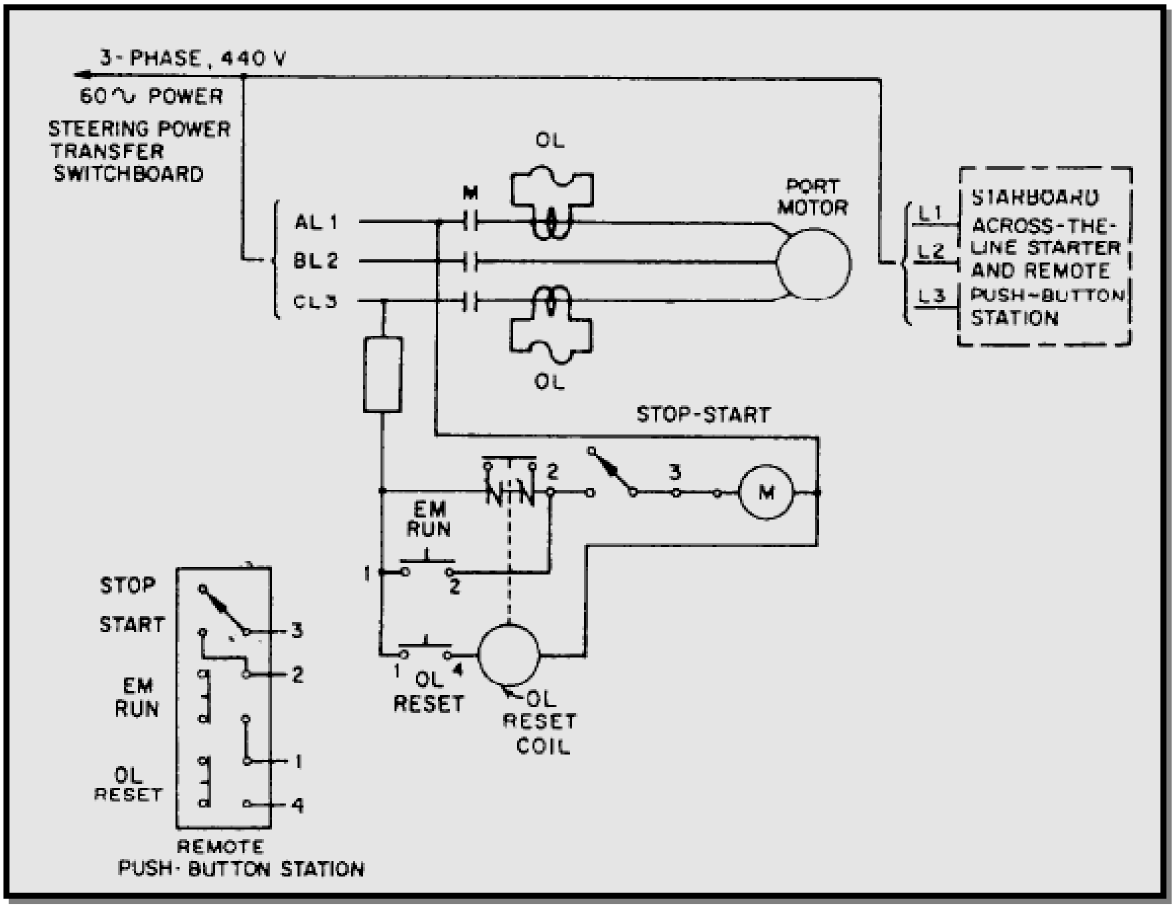

Figure 11-14.— Non-reversing across-the-line starter for steering gear pump motor.

The motor starter is provided with overload and low-voltage release (LVR) protection. The overload relays are of the thermal type, similar to those installed in the anchor windlass starter (discussed later in this chapter under the operation of the destroyer anchor windlass). The low-voltage release protection is provided by the maintained-contact master switch.

If the operating M coil is de-energized due to failure of the line voltage or tripping of an overload relay, the contactor will reclose and restart the motor when voltage is restored or when the overload relays are reset by the reset push button.

In an emergency you can run the motor (even though the overload relays have been tripped) by holding the EM-RUN push button closed with the START push button in the operated position. If the overload condition has not been corrected, the motor will operate only as long as the EM-RUN push button is held closed.

11.6.0 OPERATION AND MAINTENACE

Operating instructions and system diagrams are normally posted near the steering gear. The diagrams describe the various procedures and lineups for operation of the steering gear. Maintenance should be performed according to your ship's PMS requirements for steering gears.

11.7.0 MANUAL BUS TRANSFERS AND MOTOR CONTROLLERS

This section discusses the troubleshooting and maintenance procedures for manual bus transfers (MBTs) and motor controllers. To troubleshoot and maintain these components, you need to have an understanding of the characteristics, uses, and operating principles of the components. Because equipage in special power applications aboard ship is so diverse, little is said about troubleshooting or maintenance of MBT switches. In studying this chapter, you should remember to refer to the manufacturer's technical manual when troubleshooting the equipment and to the applicable maintenance requirement card (MRC) for maintenance requirements.

11.7.1 Manual Bus Transfer Switches

MBT switches are commonly used for nonvital equipment aboard ship. They consist of two make or break switches and a locking bar. To transfer from normal power to ship's emergency power, the locking bar must be manually loosened and moved before the positions of the switches can be changed. Troubleshooting should be done according to the technical manual associated with the equipment. Maintenance of the MBT switch should be done according to the applicable PMS cards.

11.7.2 Motor Controllers

Controllers are commonly used for starting large motors aboard ship to reduce the amount of current they require when started. The starting current of huge motors is usually several times higher than the running current. If controllers are not used for starting, motors and the equipment they drive may be damaged, or the operation of other equipment in the same distribution system may be affected adversely. By definition, a motor controller is a device (or set of devices) that serves to govern, in some predetermined manner, the operation of the dc or ac motor to which it is connected.

11.7.3 Types of Motor Controllers

A motor controller protects a motor from damage, starts or stops it, increases or decreases its speed, or reverses its direction of rotation.

<u>Manual</u>

A manual (nonautomatic) controller is operated by hand directly through a mechanical system. The operator closes and opens the contacts that normally energize and de-energize the connected load.

Magnetic

In a magnetic controller, the contacts are closed or opened by electromechanical devices operated by local or remote master switches. Normally, all the functions of a semiautomatic magnetic controller are governed by one or more manual master switches; automatic controller functions are governed by one or more automatic master switches, after it has been initially energized by a manual master switch. Either controller can be operated in the semiautomatic or automatic mode, depending on the mode of operation selected.

Across-the-Line

An across-the-line controller throws the connected load directly across the main supply line. This motor controller may be either manual or magnetic, depending on the rated horsepower of the motor. Normally, across-the-line dc controllers are used for starting small (fractional horsepower) motors. However, they also may be used to start average-sized, squirrel-cage induction motors without any damage. This is because these motors can withstand the high starting currents due to starting with full-line voltage applied. Most squirrel-cage motors drive pumps, compressors, fans, lathes, and other auxiliaries. They can be started “across the line” without producing excessive line-voltage drop or mechanical shock to a motor or auxiliary.

Dc Resistor

In a dc resistor motor controller, a resistor in series with the armature circuit of the dc motor limits the amount of current during starts, thereby preventing motor damage and overloading the power system. In some resistor controllers, the same resistor also helps regulate the speed of the motor after it is started. Other dc controllers use a rheostat in the motor shunt field circuit for speed control.

Ac Primary Resistor

In an ac primary resistor controller, resistors are inserted in the primary circuit of an ac motor for both starting and speed control. Some of these controllers only limit the starting currents of large motors; others control the speed of small motors, as well as limit the starting current.

Ac Secondary Resistor

In an ac secondary resistor controller, resistors are inserted in the secondary circuit of a wound-rotor ac motor for starting or speed control. Although they are sometimes used to limit starting currents, secondary resistor controllers usually function to regulate the speeds of large ac motors.

Static Variable-Speed

A static variable-speed motor controller consists of solid-state and other devices that regulate motor speeds in indefinite increments through a predetermined range.

Speed is controlled by either manual adjustment or actuation of a sensing device that converts a system parameter, such as temperature, into an electric signal. This signal sets the motor speed automatically.

Autotransformer

The autotransformer controller (or compensator) is an ac motor controller. It starts the motor at a reduced voltage through an autotransformer, and then it connects the motor to line voltage after the motor accelerates. There are two types of compensators: open transition and closed transition. The open-transition compensator cuts off power to the motor during the time (transition period) the motor connection is shifted from the autotransformer to the supply line. In this short transition period, it is possible for the motor to coast and slip out of phase with the power supply. After the motor is connected directly to the supply line, the resulting transition current may be high enough to cause circuit breakers to open. The closed-transition compensator keeps the motor connected to the supply line during the entire transition period. In this method, the motor cannot slip out of phase and no high transition current can develop.

Reactor

A reactor controller inserts a reactor in the primary circuit of an ac motor during starts, and later it short circuits the reactor to apply line voltage to the motor. The reactor controller is not widely used for starting large ac motors. It is smaller than the closed-transition compensator and does not have the high transition currents that develop in the open-transition compensator.

11.7.4 Types of Master Switches

A master switch is a device, such as a pressure or a thermostatic switch that governs the electrical operation of a motor controller. The switch can be manually or automatically actuated. Drum, selector, and push-button switches are examples of a manual master switch. The automatic switch is actuated by a physical force, not an operator. Examples of automatic master switches include float, limit, or pressure switches.

Depending on where it is mounted, a master switch is either local or remote. A local switch is mounted in the controller enclosure; a remote switch is not.

Master switches may start a series of operations when their contacts are either closed or opened. In a momentary contact master switch, the contact is closed (or opened) momentarily; it then returns to its original condition. In the maintaining contact master switch, the cent act does not return to its original condition after closing (or opening) until it is again actuated. The position of a normally open or normally closed contact in a master switch is open or closed, respectively, when the switch is de-energized. The de-energized condition of a manual controller is considered to be in the off position.

11.7.5 Overload Relays

Nearly all shipboard overload protection when motor controllers provide motor current is excessive. This protection is provided by either thermal or magnetic overload relays, which disconnect the motor from its power supply, thereby preventing the motor from overheating.

Overload relays in magnetic controllers have a normally closed contact that is opened by a mechanical device that is tripped by an overload current. The opening of the overload relay contact de-energizes the circuit through the operating coil of the main contactor, causing the main contactor to open, securing power to the motor.

Overload relays for naval shipboard use can usually be adjusted to trip at the correct current to protect the motor. If the rated tripping current of the relay does not fit the motor it is intended to protect, it can be reset after tripping so the motor can be operated again with overload protection. Some controllers feature an emergency-run button that enables the motor to be run without overload protection during an emergency.

11.7.5.1 Thermal Overload Relays

The thermal overload relay has a heat-sensitive element and an overload heater that is connected in series with the motor load circuit. When the motor current is excessive, heat from the heater causes the heat-sensitive clement to open the overload relay contact. This action breaks the circuit through the operating coil of the main contractor and disconnects the motor from the power supply. Since it takes time for the parts to heat up, the thermal overload relay has an inherent time delay, which allows the motor to draw excessive current at start without tripping the motor.

To make a coarse adjustment of the tripping current of thermal overload relays, change the heater element. Fine adjustment depends on the type of overload relay. To make a fine adjustment, change the distance between the heater and the heat-sensitive element. An increase in this distance increases the tripping current. You can make another form of adjustment by changing the distance the bimetal strip has to move before the overload relay contact is opened. Check the related technical manual for additional information and adjustments.

Thermal overload relays must be compensated; that is, constructed so the tripping current is unaffected by variations in the ambient (room) temperature. Different means are used for different types. Refer to the technical manual furnished with the equipment on which the controller is used for information on the particular form of compensation provided. There are four types of thermal overload relays: solder pot, bimetal, single metal, and induction.

Solder Pot

The heat-sensitive element of a solder-pot relay consists of a cylinder inside a hollow tube. The cylinder and tube are normally held together by a film of solder. In case of an overload, the heater melts the solder (thereby breaking the bond between the cylinder and tube) and releases the tripping device of the relay. After the relay trips, the solder cools and solidifies. The relay can then be reset.

Bimetal

In the bimetal relay, the heat-sensitive element is a strip or coil of two different metals fused together along one side. When heated, the strip or coil deflects because one metal expands more than the other. The deflection causes the overload relay contact to open.

Single Metal

The heat-sensitive element of the single-metal relay is a tube around the heater. The tube lengthens when heated and opens the overload relay contact.

Induction

The heater in the induction relay consists of a coil in the motor circuit and a copper tube inside the coil. The tube acts as the short-circuited secondary of a transformer and is heated by the current induced in it. The heat-sensitive element is usually a bimetal strip or coil. Unlike the other three types of thermal overload relays that may be used with either ac or dc, the induction type is manufactured for ac use only.

11.7.5.2 Magnetic Overload Relays

The magnetic overload relay has a coil connected in series with the motor circuit and a tripping armature or plunger. When the normal motor current exceeds the tripping current, the contacts open the overload relay. Though limited in application, one type of magnetic overload relay operates instantly when the motor current exceeds the tripping current. This type must be set at a higher tripping current than the motor-starting current because the relay would trip each time you start the motor. One use of the instantaneous magnetic overload relay is in motor controllers used for reduced voltage starting where the starting current peaks are less than the stalled rotor current.

The operation of a second type of magnetic overload relay is delayed a short time when the motor current exceeds the tripping current. This type of relay is essentially the same as the instantaneous relay except for the time-delay device. This is usually an oil dashpot with a piston attached to the tripping armature of the relay. Oil passes through a hole in the piston when the tripping armature is moved by an overload current. The size of the hole can be adjusted to change the speed at which the piston moves for a given pull on the tripping armature. For a given size hole, the larger the current, the faster the operation. The motor is thus allowed to carry a small overload current. The relay can be set to trip at a current well below the stalled rotor current because the time delay gives the motor time to accelerate to full speed before the relay operates.

By this time, the current will have dropped to full-load current, which is well below the relay trip setting.

In either the instantaneous or time-delay magnetic overload relays, you can adjust the tripping currents by changing the distance between the series coil and the tripping armature. More current is needed to move the armature when the distance is increased. Compensation for changes in ambient temperature is not needed for magnetic relays because they are practically unaffected by changes in temperature.

11.7.5.3 Overload Relay Resets

After an overload relay has operated to stop a motor, it must be reset before the motor can be started again. Magnetic overload relays can be reset immediately after tripping. Thermal overload relays must cool a minute or longer before they can be reset. The type of overload reset may be manual, automatic, or electric.

The manual, or hand, reset is usually located in the controller enclosure, which contains the overload relay. This type of reset usually has a hand-operated rod, lever, or button that returns the relay tripping mechanism to its original position, resetting interlocks as well, so the motor can be run again with overload protection. (An interlock is a mechanical or electrical device in which the operation of one part or mechanism automatically brings about or prevents the operation of another.)

The automatic type of reset usually has a spring- or gravity-operated device, resetting the overload relay without the help of an operator. The electric reset is actuated by an electromagnet controlled by a push button. This form of overload reset is used when it is desired to reset an overload relay from a remote operating point.

11.7.5.4 Overload Relay-Emergency Run

Motor controllers having emergency-run features are used with auxiliaries that cannot be stopped safely in the midst of an operating cycle. This type of feature allows the operator of the equipment to keep it running with the motor overloaded until a standby unit can take over, the operating cycle is completed, or the emergency passes.

NOTE: Use this feature in an emergency only. Do not use it otherwise.

Three methods of providing emergency run in magnetic controllers are an emergency run pushbutton, a reset-emergency run lever, or a start-emergency run push button. In each case, the lever or push button must be held closed manually during the entire emergency.

Figure 11-15 is a schematic diagram of a controller showing a separate EMERGENCY RUN push button with normally open contacts in parallel with the normally closed contact of the overload relay.

For emergency run operation, the operator must hold down this push button and press the START button to start the motor. While the emergency run push button is depressed, the motor cannot be stopped by opening the overload relay contact.

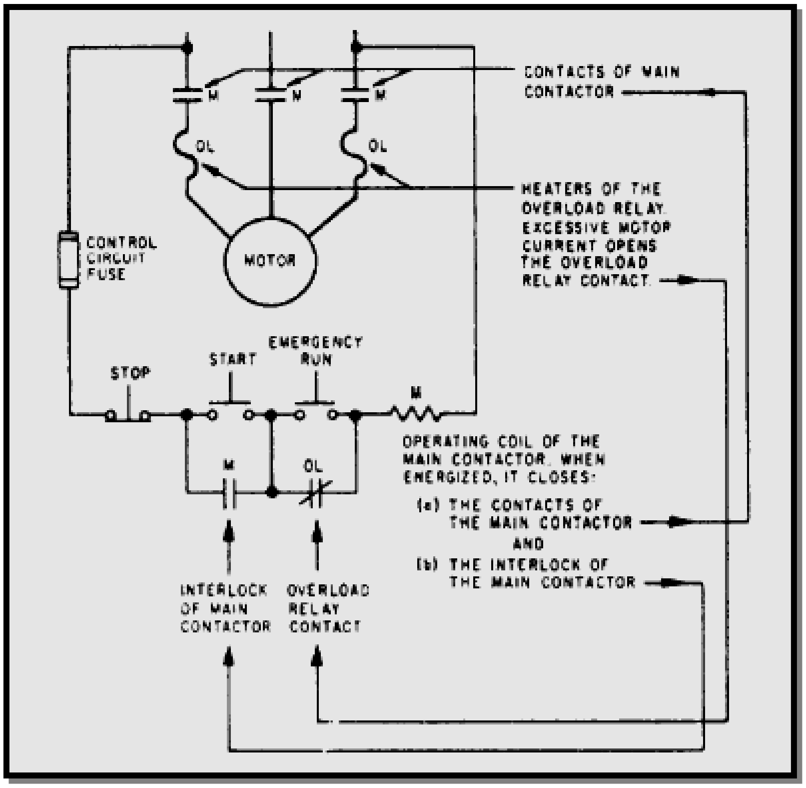

Figure 11-15.— Schematic of controller with emergency run push button.

A REST-EMERGENCY RUN lever is shown in figure 11-16. As long as the lever or rod is held down, the overload relay contact is closed. The start button must be momentarily closed to start the motor. Figure 11-17 shows a START-EMERGENCY RUN pushbutton. The motor starts when the button is pushed, and it continues to run without overload protection as long as it is held down. For this reason, push buttons that are marked start-emergency run should not be kept closed for more than a second or two unless the emergency run operation is desired.

Manual controllers also may be provided with an emergency run feature. The usual means is a start-emergency run push button or lever, which keeps the main contactor coil energized despite the tripping action of the overload relay mechanism.

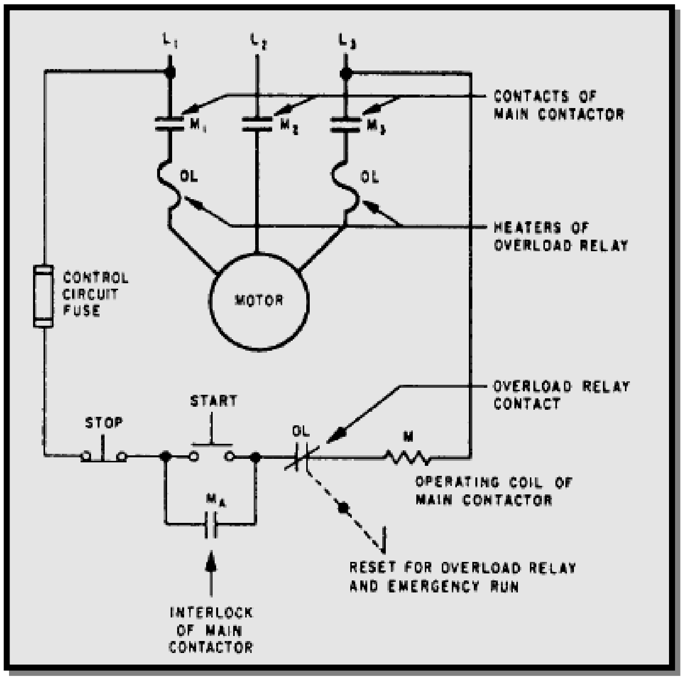

Figure 11-16.— Schematic of controller with reset-emergency run lever or rod.

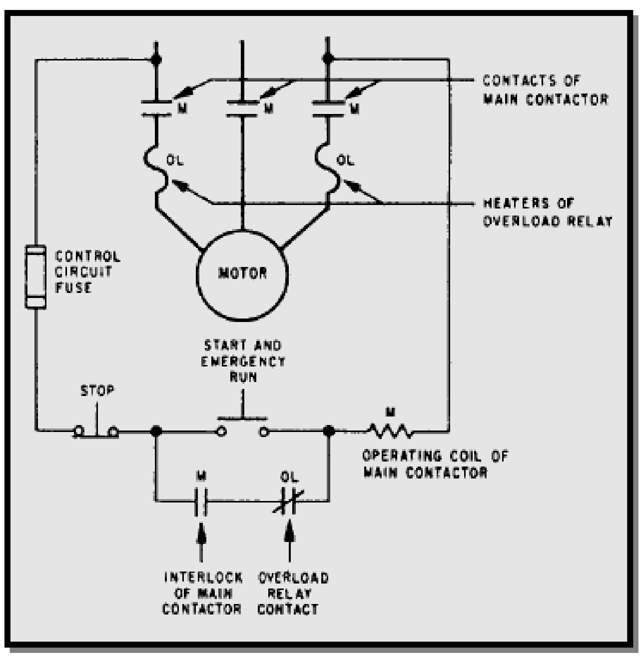

Figure 11-17.— Schematic of controller with start-emergency run push button.

Short Circuit Protection

Overload relays and contractors are usually not designed to protect motors from currents greater than about six times normal rated current of ac motors or four times normal rated current of dc motors. Since short-circuited currents are much higher, protection against short circuits in motor controllers is obtained through other devices. To protect against these short circuits, circuit breakers are installed in the power supply system, thereby protecting the controller, motor, and cables. Short-circuit protection is provided in controllers where it is not otherwise provided by the power distribution system or where two or more motors are supplied power but the circuit breaker rating is too high to protect each motor separately.

Short-circuit protection for control circuits is provided by fuses in the controller enclosure, which provides protection for remote push buttons and pressure switches.

Full-Field Protection

Full-field protection is required in the controller for a dc motor when a shunt field rheostat or a resistor is used to weaken the motor field and obtain motor speeds more than 150 percent of the speed at rated field current. Full-field protection is provided automatically by a relay that shunts out the shunt field rheostat for the initial acceleration of the motor, and then cuts it into the motor field circuit. In this way, the motor first accelerates to 100 percent or full-field speed, and then further accelerates to the weakened-field speed determined by the rheostat settings.

The controller for an anchor windlass motor provides stepback protection by automatically cutting back motor speed to relieve the motor of excessive load.

Low-Voltage Release (LVR)

When the supply voltage is reduced or lost altogether, an LVR controller disconnects the motor from the power supply, keeps it disconnected until the supply voltage returns to normal, and then automatically restarts the motor. This type of controller is equipped with a maintaining master switch.

Low-Voltage Protection (LVP)

When the supply voltage to an LVP controller is reduced or lost, the motor is disconnected from the line. Upon restoration of power, the motor will not start until you manually depress the start push button.

11.7.6 Magnetic Across-Line Controllers

A typical 3-phase, across-line controller is shown in figure 11-18. Figure 11-19 shows a small cubical contactor for a 5-horsepower motor. All contractors are similar in appearance, but they vary in size.

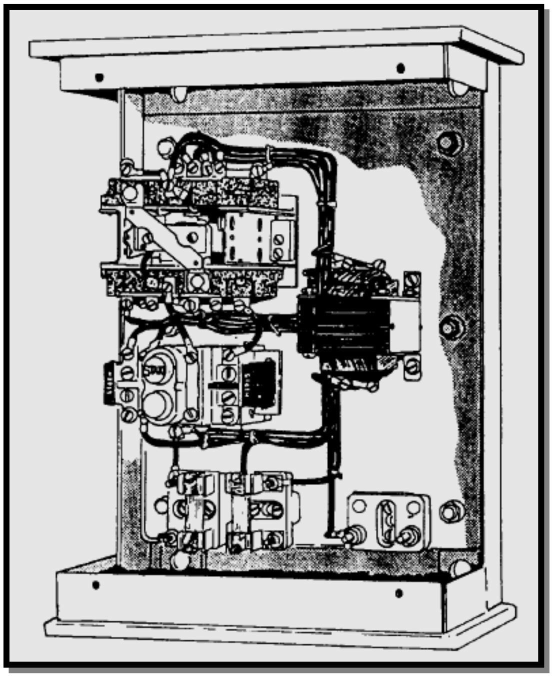

Figure 11-18.— Across-line, 3-phase controller.

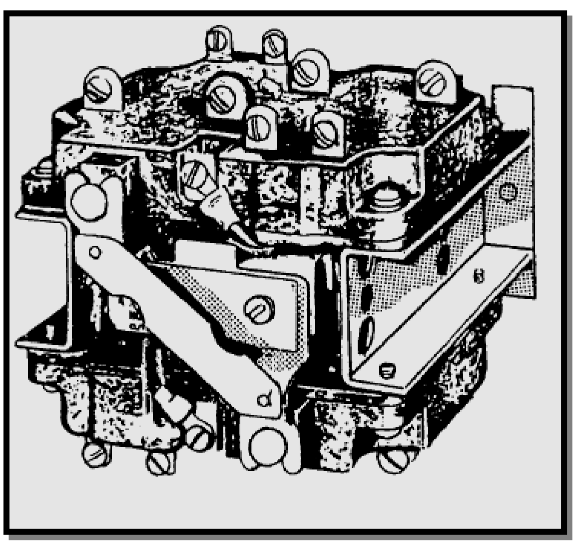

Figure 11-19.— Contactor for a 5-horsepower motor.

An elementary or schematic diagram of a magnetic controller is shown in figure 11-16. The motor is started by pushing tie strut button. The action completes the circuit from L_1 through the control fuse, stop button, start button, the overload relay contacts, OL, and the contactor coil, M to L_3. When the coil is energized, it closes line contacts M_1, M_2 and M_3 which connect the full-line voltage to the motor. The line contactor auxiliary contact, MA, also closes and completes a holding circuit for energizing the coil circuit after the start push button has been released.

The motor will continue to run until the contactor coil is de-energized by the stop push button, failure of the line voltage, or tripping of the overload relay, OL.

Reversing
The rotation of a three-phase induction motor is reversed by interchanging any two of the three leads to the motor. The connections for an ac reversing controller are shown in figure 11-20. The stop, reverse, and forward push-button controls are all momentary-contact switches. Note the connections to the reverse and forward switch contacts. (Their contacts close or open momentarily, then return to their original closed or opened condition.)

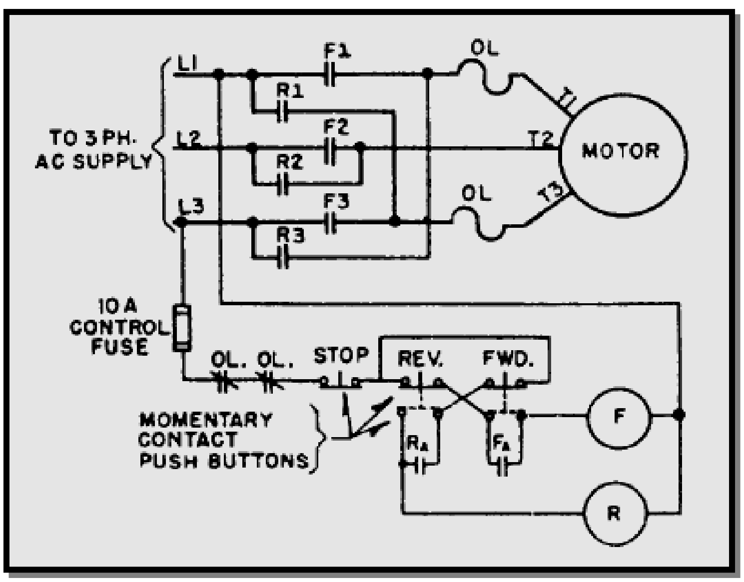

Figure 11-20.— Reversing ac controller.

If the forward pushbutton is pressed (solid to dotted position), coil F will be energized and will close its holding contacts $F_{A.}$ These contacts will remain closed as long as coil F is energized. When the coil is energized, it also closes line contacts F1, F2, and F3, which apply full-line voltage to the motor. The motor then runs in a forward direction.

If either the stop button or the reverse button is pressed, the circuit to the F contactor coil is broken, and the coil releases and opens line contacts F1, F2, F3, and maintaining contact F_A.

If the reverse pushbutton is pressed (solid to dotted position), coil R is energized and closes, holding contacts R_A and line contacts R1, R2, and R3. Note that contacts R1 and R3 reverse the connections of lines 1 and 3 to motor terminals T1 and T3. This causes the motor rotor to rotate in the reverse direction. The F and R contactors are mechanically interlocked to prevent troth being closed at the same time.

Momentary-contact push buttons provide LVP with manual restart in the circuit shown in figure 11-20. If either the For R operating coil is de-energized, the contactor will not reclose and start the motor when voltage is restored unless either the forward or reverse pushbutton is pressed. The circuit arrangement of the pushbuttons provides an electrical interlock that prevents the energizing of both coils at the same time.

Speed Control

When you desire to operate an ac motor at different speeds, you must use a controller with a circuit as shown in figure 11-21.

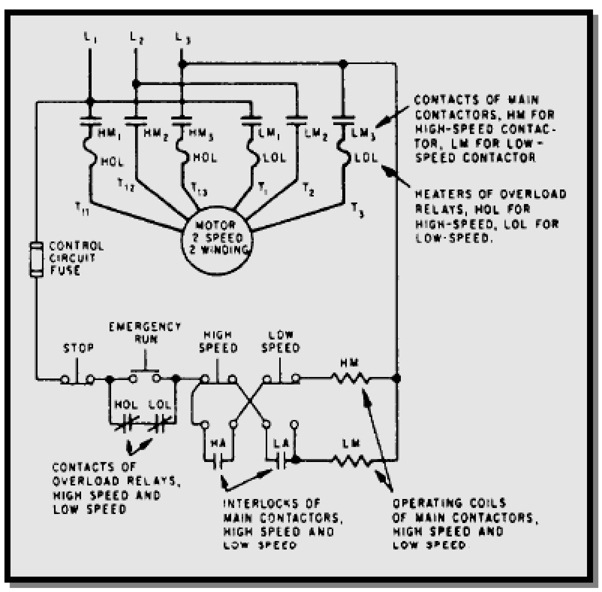

Figure 11-21.— Two-speed, ac controller.

An ac induction motor designed for two-speed operation may have either a single set of windings or two separate sets of windings, one for each speed. Figure 11-21 is a schematic diagram of the ac controller for a two-speed, two-winding induction motor. The low-speed winding is connected to terminals T_1, T_2 and T_3. The high-speed winding is connected to terminals T_{11}, T_{12} and T_{13}. Overload protection is provided by the low-speed overload (LOL) coils and contacts for the low-speed winding and the high-speed overload (HOL) contacts and coils for the high-speed winding. The LOL and HOL contacts are connected in series in the maintaining circuit, and both contacts must be closed before the motor will operate at either speed.

The control push buttons are the momentary contact type. Pressing the high-speed push button closes the high-speed contactor by energizing coil HM. The coil remains energized after the push button is released, closing holding contacts HA. The coil, HM, also closes main line contacts HM_1, HM_2 and HM_3 applying full-line voltage to the motor high-speed winding. The motor will run at high speed until coil HM is de-energized either by opening the stop switch, a power failure, or an overload.

Pressing the low-speed push button closes the low-speed contactor by energizing coil LM. The coil remains energized after the button is released, through the holding coil contacts, LA. The coil, LM, also closes the mainline contacts, LM_1, LM_2 and LM_3 which apply the full-line voltage to the low-speed motor winding. The motor will run at low speed until coil LM is deenergized. The LM and HM contractors are mechanically interlocked to prevent both from closing at the same time.

Autotransformer Controllers

A single-phase autotransformer has a tapped winding on a laminated core. Normally, only one coil is used on a core, but it is possible to have two autotransformer coils on the same core. Figure 11-22 shows the connections for a single-phase autotransformer being used to step down voltage. The winding between A and B is common to both the primary and the secondary windings and carries a current that is equal to the difference between the load current and the supply current.

Any voltage applied to terminals A and C will be uniformly distributed across the winding in proportion to the number of turns. Therefore, any voltage that is less than the source voltage can be obtained by tapping the proper point on the winding between terminals A and C.

Some autotransformers are designed so a knob-controlled slider makes contact with wires of the winding to vary the load voltage.

The directions for current flow through the line, transformer winding, and load are shown by the arrows in figure 11-22. Note that the line current is 2.22 amperes and that this current also flows through the part of the winding between B and C. In the part of the winding that is between A and B, the load current of 7 amperes is opposed by the line current of 2.22 amperes. Therefore, the current through this section is equal to the difference between the load current and the line current. If you subtract 2.22 amperes from 7 amperes, you will find the secondary current is 4.78 amperes.

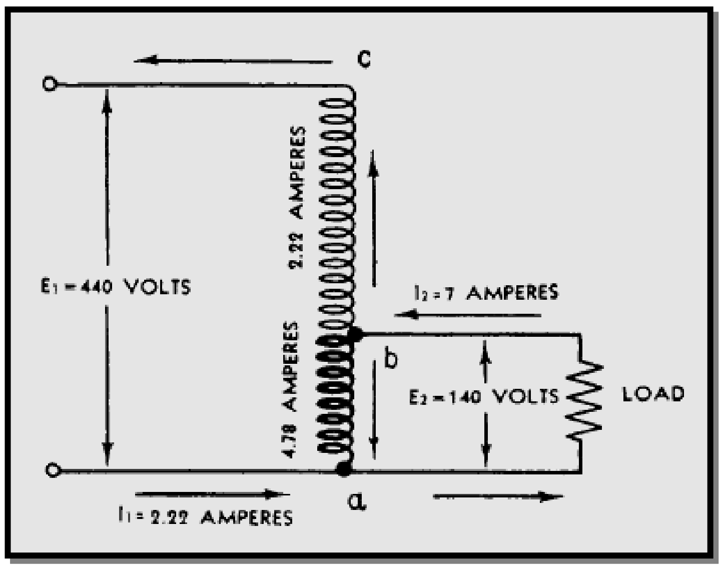

Figure 11-22.— Single-phase autotransformer.

Autotransformers are commonly used to start three-phase induction and synchronous motors and to furnish variable voltage for test panels. Figure 11-23 shows an autotransformer motor starter, which incorporates starting and running magnetic contractors, an auto transformer, a thermal overload relay, and a mercury timer to control the duration of the starting cycle.

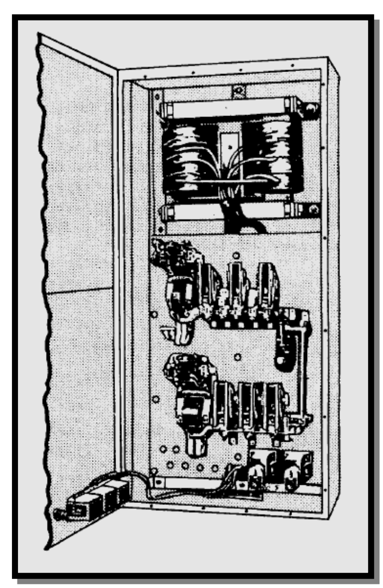

Figure 11-23.— Autotransformer controller.

Logic Controllers

Some of the controlled equipment that you will encounter uses logic systems for circuit control. For additional information in this area the Navy Electricity and Electronics Training Series (NEETS), module 13, is an excellent basic reference.

The basic concept of logic circuits is shown in figures 11-24 and 11-25. In figure 11-24, view A, an AND symbol is shown, which can be compared to the electrical circuit in figure 11-24, view B.

NOTE: Both switches, A AND B, must be closed to energize the lamp.

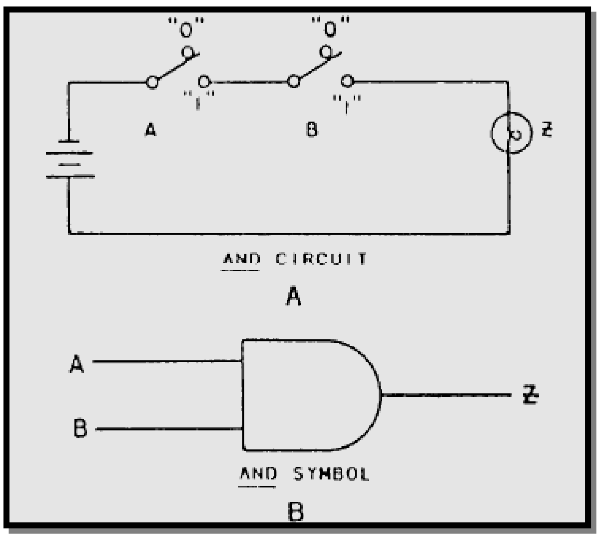

Figure 11-24.— AND symbol and circuit.

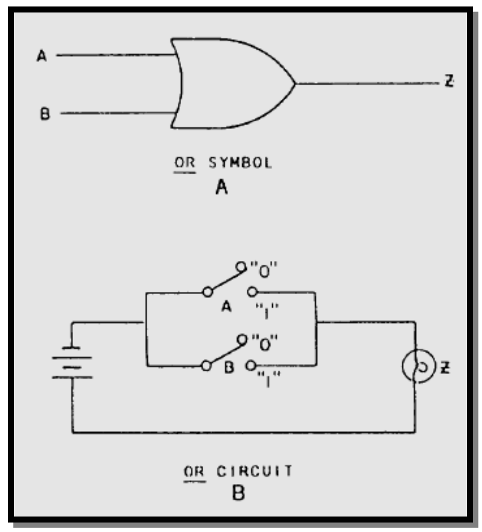

Figure 11-25.— OR symbol and circuit.

In figure 11-25, view A, art OR symbol is shown, which can be compared to the electrical circuit in figure 11-25, view B, where either switch A OR B needs to be closed to energize the lamp.

Using the characteristics of the AND and OR logic symbols, we will now discuss how they can be used in a logic controller.

One common application of logic control that is being incorporated on newer ships is the elevator system. Since this system is large and consists of many symbols, we will show only a small portion of this system.

Let us assume that the elevator platform is on the third deck and that you require it on the main deck—refer to figure 11-26. Three conditions must be met before the elevator can be safely moved. These conditions are detected by electronic sensors usually associated with the driven component. One of the conditions is that the platform must be on EITHER the second or third deck (on a certain deck as opposed to somewhere in between). If this condition is sensed, the OR symbol will have an input, and since only one input is needed, the OR symbol also will have an output.

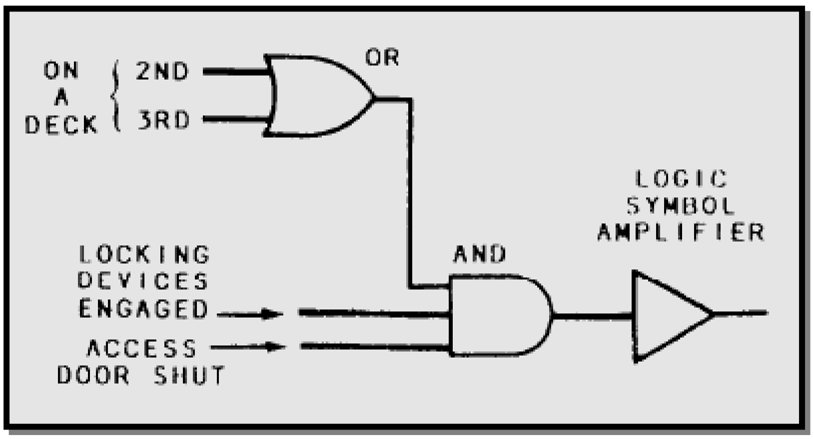

Figure 11-26.— Basic logic circuit.

The other two conditions to be met are that the locking devices must be engaged and the access doors must be shut. If the sensors are energized for these two conditions, the AND symbol will have the three inputs necessary to produce an output. This output will then set up a starting circuit, allowing the motor to be started at your final command.

The advantages of these electronic switches over mechanical switches are low power consumption, no moving parts, less maintenance, quicker response, and less space requirements. A typical static logic panel found aboard ship is shown in figure 11-27.

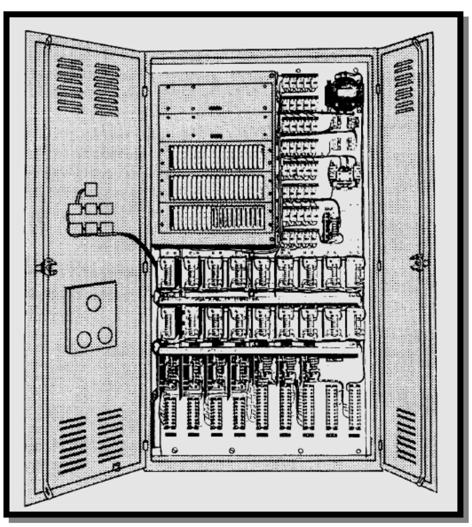

Figure 11-27.— A static logic panel for a cargo elevator.

Although there are logic symbols other than (AND) and (OR), they all incorporate solid-state devices. For more information on solid-state devices refer to NEETS, module 7.

11.7.7 DC Controllers

The starting of all dc motors, except those with fractional horsepower, requires a temporary placing of resistance in series with the armature circuit to limit the high current at start. The starting resistance cannot be removed from the line until the motor has accelerated in speed and the counter electromotive force has increased to limit the current to a safe value.

Auxiliary motors located below deck generally drive constant-speed equipment. A rheostat in the shunt field circuit may be provided to furnish speed control for motors operating with ventilation fans, forced draft blowers, and certain pumps where conditions may require operation at more than one speed.

Small motors use one stage of starting resistance in the line for a few seconds to limit the starting current. With larger motors, two or more stages of resistance are connected in the line at start and are cut out in steps as the motor accelerates to the running speed.

Motors used with cargo winches and other deck auxiliaries operate over a wide range of speeds. Since the speed of a dc motor with a constant load varies almost directly with the voltage, stages of line resistance are used to make speed changes and to limit the current at starting. These stages of line resistance are connected in various combinations, manually selected by a master switch operating with a magnetic controller. Thus, the operator directly controls the amount of resistance in the line and the resulting speed of the motor at all times.

One-Stage Acceleration

Figure 11-28 shows a typical dc controller. The connections for this motor controller with one stage of acceleration are shown in figure 11-29. The letters in parentheses are indicated on the figures. When the start button is pressed, the path for current is from the line terminal (L2) through the control fuse, the stop button, the start button, and the line contactor coil (LC), to the line terminal (L1). Current flowing through the contactor coil causes the armature to pull in and close the line contacts (LC1, LC2, LC3, and LC4).

When contacts LC1 and LC2 close, motor-starting current flows through the series field (SE), the armature (A), the series relay coil (SR), the starting resistor (R), and the overload relay coil (OL). At the same time, the shunt field winding (SH), is connected across the line and establishes normal shunt field strength. Contacts LC3 close and prepare the circuit for the accelerating contactor coil (AC). Contacts LC4 close the holding circuit for the line contactor coil (LC).

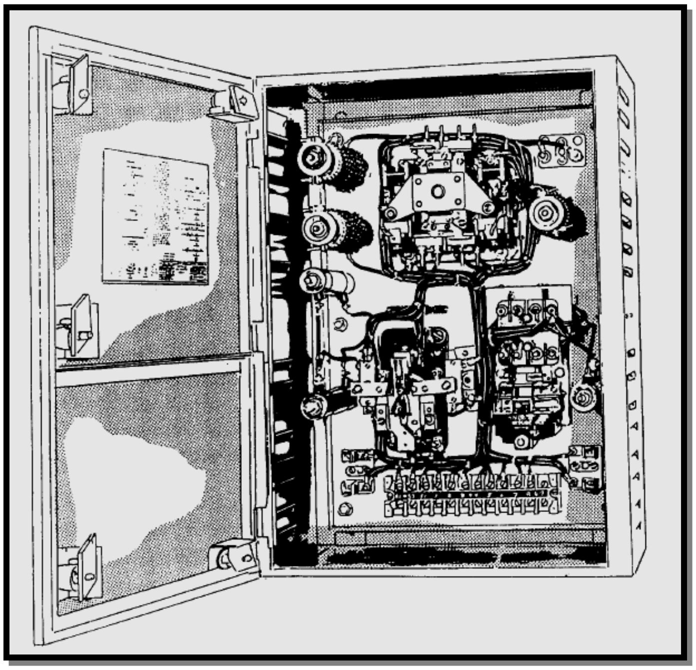

Figure 11-28.— A typical controller.

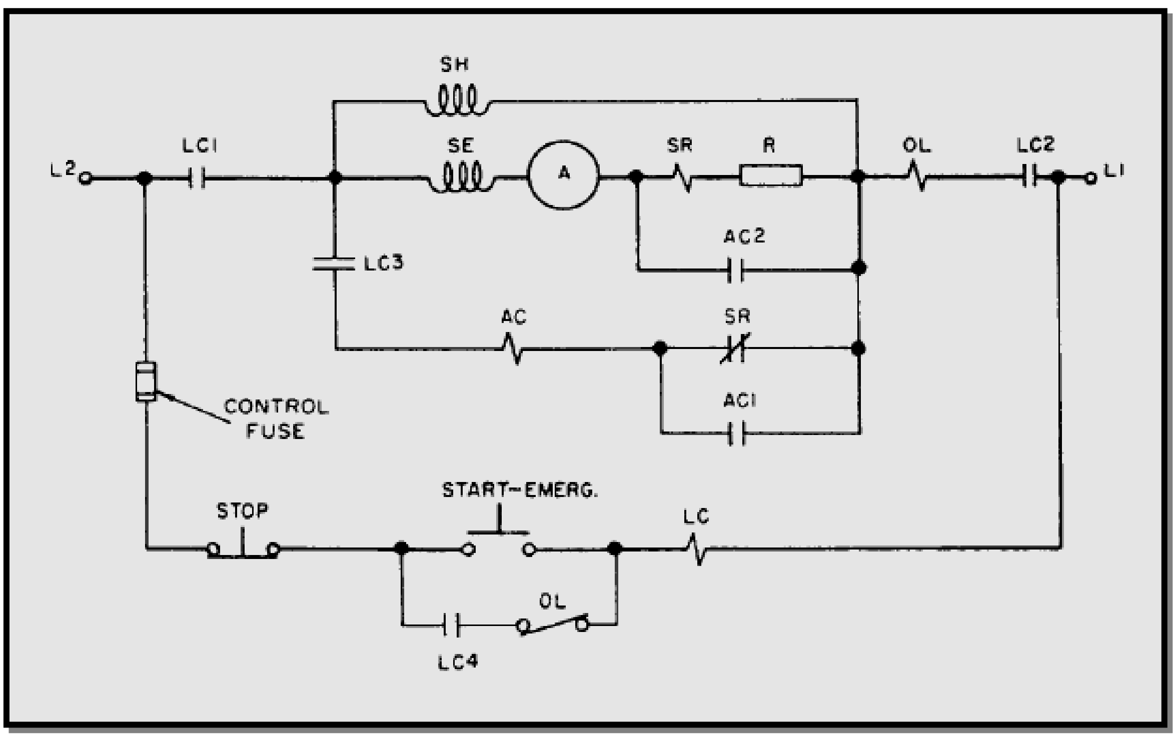

Figure 11-29.— A dc controller with one stage of acceleration.

The motor armature current flowing through the series relay coil causes its armature to pull in, opening the normally closed contacts (SR). As the motor speed picks up the armature current drawn from the line decreases. At approximately 110 percent of normal running current, the series relay current is not strong enough to hold the armature in; therefore, it drops out and closes its contacts (SR). These contacts are in series with the accelerating relay coil (AC) and cause it to pick up its armature, closing contacts AC1 and AC2.

Auxiliary contacts (AC1) on the accelerating relay keep the circuit to the relay coil closed while the main contacts (AC2) short out the starting resistor and the series relay coil. The motor is then connected directly across the line, and the connection is maintained until the STOP button is pressed.

If the motor becomes overloaded, the excessive current through the overload coil (OL) (at the top right of fig. 11-29) will open the overload contacts (OL) (at the bottom of fig. 11-29), disconnecting the motor from the line.

If the main contactor drops out because of an excessive drop in line voltage or a power failure, the motor will remain disconnected from the line until an operator restarts it with the start pushbutton. This prevents automatic restarting of equipment when normal power is restored.

Speed Control

Figure 11-30 illustrates a rheostat that is added to the basic controller circuit to obtain varying speed. If resistance is added in series with the shunt field the field will be weakened and the motor will speed up. If the amount of resistance in series is decreased, the field strength will increase, and the motor will slow down.

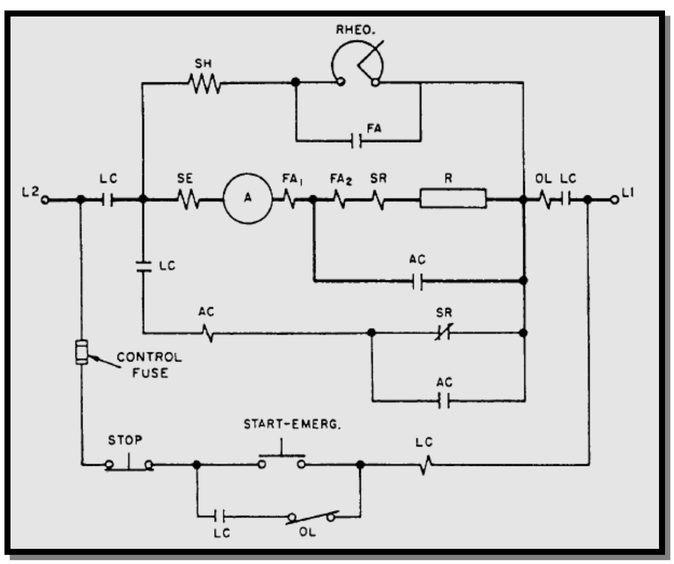

Figure 11-30.— A dc controller with shunt field rheostat.

Contacts FA (fig. 11-30) are closed during the acceleration period, providing fill shunt field strength. After the motor has accelerated to the across-the-line position, contacts FA open, placing the rheostat in the shunt field circuit to provide full field protection.

Reversing

In certain applications, the direction in which a dc motor turns is reversed by reversing the connections of the armature with respect to the field. The reversal of connections can be done in the motor controller by adding two electrically and mechanically interlocked contractors.

A dc motor reversing connection is shown in figure 11-31. Note there are two start buttons-one marked START-EMERG FORWARD and the other marked START-EMERG REVERSE. These buttons serve as master switches, and the desired motor rotation is obtained by pressing the proper switch.

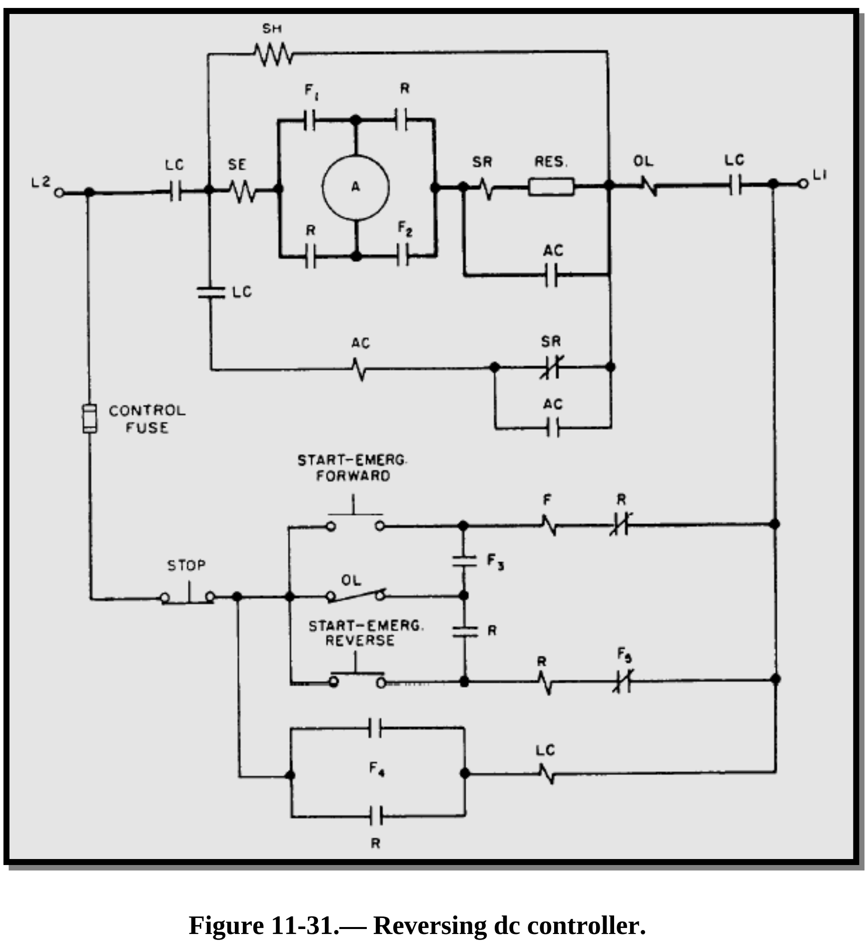

Figure 11-31.— Reversing dc controller.

Assuming that the forward button has been pressed, the line voltage will be applied through the button to the forward contactor coil (F). This pulls in the armature and closes the normally open contacts (F_1 and F_2) in the motor armature circuit, the forward contactor holding circuit contacts (F_3) and the line contactor circuit contacts (F_4) and opens the normally closed contacts (F_5) of the reverse contactor circuit. The normally closed contacts (F_5) are electrically interlocked open when the forward contactor (F) coil is energized.

After the line contactor is energized, acceleration is accomplished in the manner described previously.

Dc Contactor

A dc contactor is composed of an operating magnet energized by either switches or relays, fixed contacts, and moving contacts. It maybe used to handle the load of an entire bus, or a single circuit or device. Larger contacts must be used when heavy currents are to be interrupted. These contacts must snap open or closed to reduce contact arcing and burning. In addition to these, other arc-quenching means are used.

Blowout Coils

When a circuit carrying a high current is interrupted, the collapse of the flux linking the circuit will induce a voltage, which will cause an arc. If the spacing between the open contacts is small, the arc will continue once it is started. If the arc continues long enough, it will either melt the contacts or weld them together. Magnetic blowout coils overcome this condition by providing a magnetic field, which pushes the arc away from the contact area.

The magnetic blowout operation is shown in figure 11-32. It is important that the fluxes remain in the proper relationship. Otherwise, if the direction of the current is changed, the direction of the blowout flux will be reversed and the arc will actually be pulled into the space between the contacts.

When the direction of electron flow and flux areas shown in figure 11-32, the blowout force is upward. The blowout effect varies with the magnitude of the current and with the blowout flux. The blowout coil should be chosen to match the current so the correct amount of flux may be obtained. The blowout flux across the arc gap is concentrated by the magnetic path provided by the steel core in the blowout coil and by the steel pole pieces extending from the core to either side of the gap.

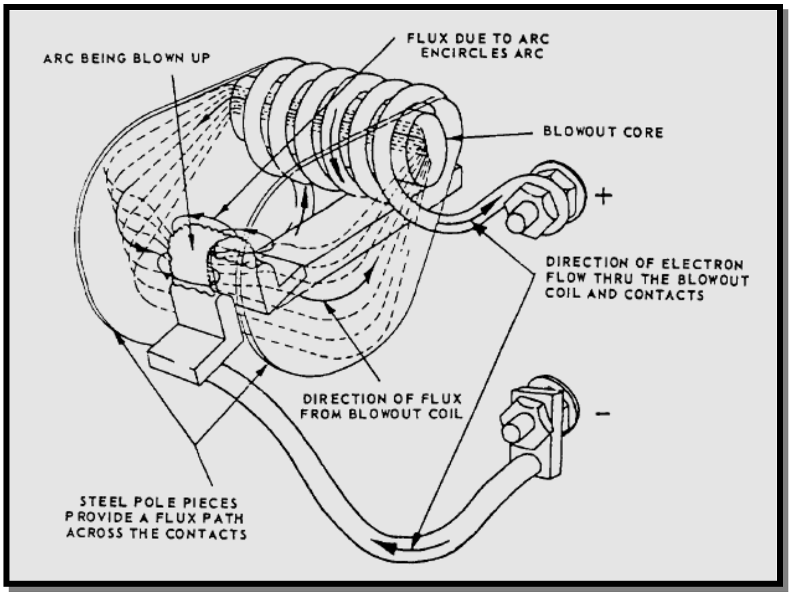

Figure 11-32.— Action of a magnetic blowout coil.

Arcing Contacts

The shunt contactor shown in figure 11-33 uses a second set of contacts (1) to reduce the amount of arcing across the main contacts (5 and 6) when closing. The numbers that are in parentheses are indicated on the figure.

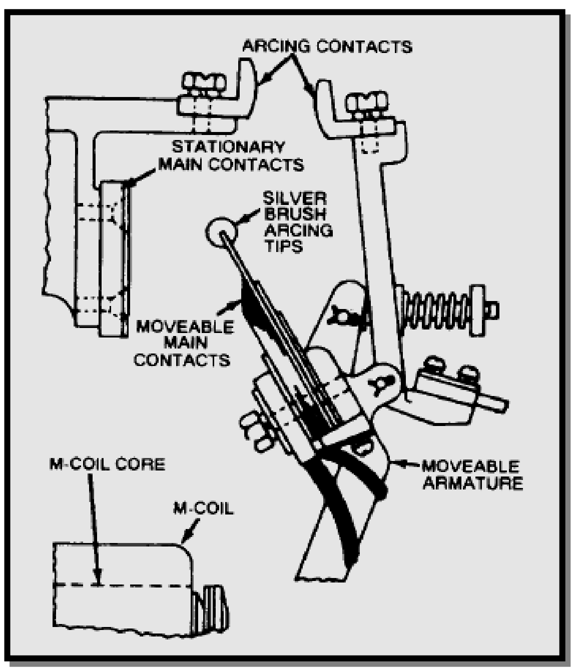

Figure 11-33.— Detailed view of arcing contacts.

Shunt-type contractors will handle up to 600 amperes at 230 volts. The blowout shield has been removed in this detailed view. The diagram shows the main sections of the contactor. The arcing contacts (1) are made of rolled copper with a heavy protective coating of cadmium. These contacts are self-cleaning because of the sliding or wiping action following the initial contact. The wiping action keeps the surface bright and clean, and thus maintains a low contact resistance.

The contactor is operated by connecting the coil (2) directly across a source of dc voltage. When the coil is energized the movable armature (3) is pulled toward the stationary magnet core (4). This action causes the contacts that carry current (5, 6, 7, and 1) to close with a sliding action.

The main contacts (5 and 6), called brush contacts, are made of thin leaves of copper, which are backed by several layers of phosphor bronze spring metal. A silver brush arcing tip (7) is attached to the copper leaves and makes contact slightly before the leaf contact closes. The stationary contact (5) consists of a brass plate, which has a silver-plated surface. Since the plating lowers the surface resistance, the contact surfaces should never be filed or oiled. If excessive current causes high spots on the contact, the high places maybe smoothed down by careful use of a fine ignition-type file.

You can check the operation and contact spacing by manually closing the contactor (be sure the power is off).

The lowest leaf of brush contact 6 should just barely touch contact 5. If the lower leaf hits the plate too soon, bend the entire brush assembly upward slightly.

The contact dimensions should be measured with the contactor in the OPEN position.

Refer to the manufacturer's instruction book when making these adjustments.

11.8.0 ELECTRIC BRAKES

An electric brake is an electromagnetic device used to bring a load to rest mechanically and hold it at rest. Aboard ship, electric brakes are used on motor-driven hoisting and lowering equipment where it is important to stop the motor quickly. The type of electric brakes used depends on whether the motor is ac or dc and whether a dc motor is series or shunt wound.

11.8.1 AC Solenoid Brake

The magnetic brake assembly shown in figure 11-34 is the main component of this electric brake. When the coil is energized, two armatures are pulled horizontally into the coil.

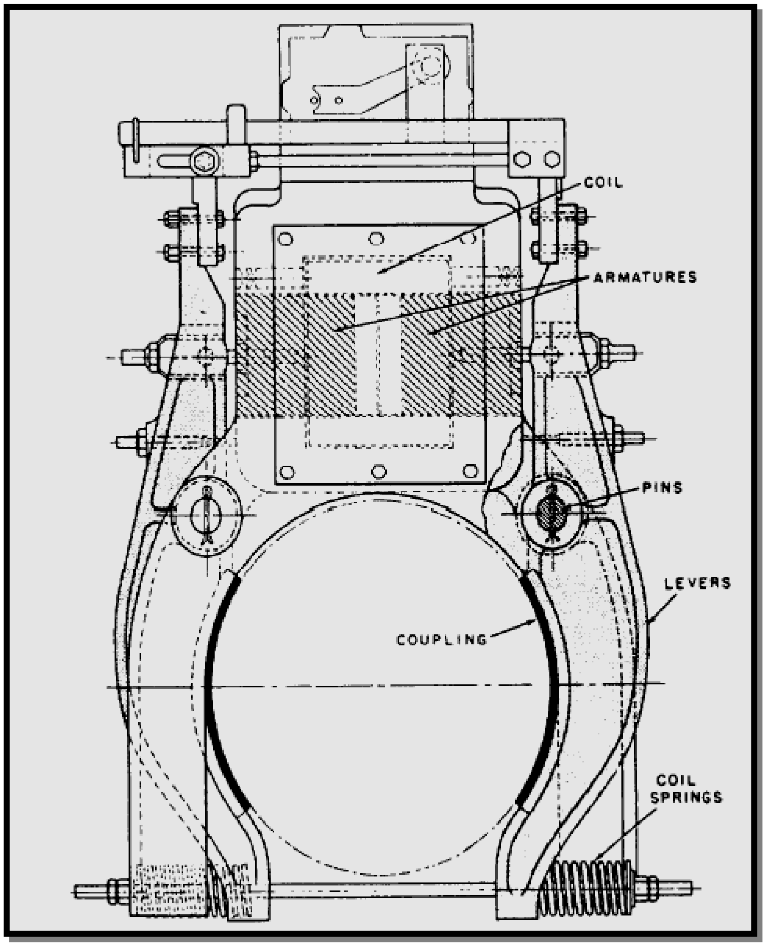

Figure 11-34.— Magnetic brake assembly.

The armatures are mechanically linked to the levers. The levers pivot on the pins. When the magnetic pull overcomes the pressure of the coil springs, the pressure of the brake shoes on the drum is removed, allowing the drum to turn. The drum is mechanically coupled to the motor shaft or the shaft of the device driven by the motor. The coil is connected to the voltage supply lines. The method of connecting the coil (series or parallel) is determined by the coil design. The magnetic brakes are applied when the coil is not energized. A spring or weight holds the band, disk, or shoes against the wheel or drum. When the coil is energized, the armature or solenoid plunger overcomes the spring tension and releases the brake.

The ac solenoid brake frame and solenoid are of laminated construction to reduce eddy currents, which are characteristic of ac systems. Because the magnetic flux passes through zero twice each cycle, the magnetic pull is not constant. To overcome this, shading coils are used to provide pull during the change of direction of the main flux. The principal disadvantage of an ac solenoid is that it draws a heavy current when the voltage is first applied.

11.8.2 AC Torque-Motor Brake

The torque-motor brake uses a specially wound polyphase, squirrel-cage motor in place of a brake release solenoid. The motor may be stalled without injury to the winding and without drawing heavy currents. Figure 11-35, view A, shows the complete mechanical arrangement of the torque-motor brake assembly, and figure 11-35, view B, is an enlarged view of the ball-jack assembly. This assembly is used with an anchor windlass.

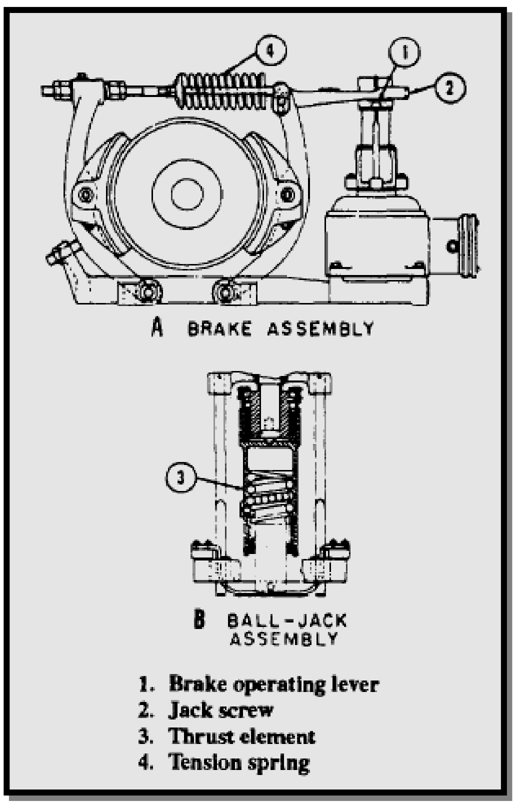

Figure 11-35.— Torque-motor brake and ball-jack assembly.

The mechanical connection between the torque motor shaft and the brake operating lever (1) is through a device called a ball-jack assembly, which converts the rotary motion of the torque-motor shaft to a straight line motion.

When power is applied to the torque motor, the shaft turns in a clockwise direction, resulting in an upward movement of the jack screw (2). The thrust element (3) in the jack screw pushes upward against the operating lever (1) to release the brake. As soon as the brake is fully released, the torque motor stalls across the line and holds pressure against the spring (4), keeping the brake released.

When the voltage supply to the torque motor is interrupted, the torque spring forces the brake shoes against the brake drum. This action stops and holds the windlass drive shaft.

The torque-motor brake can be released manually by raising the lever (1). However, the lever must be held manually in the UP position; otherwise, the brake will be applied.

Dc Dynamic Brake

Dynamic braking is similar to the slowing down of a moving truck by the compression developed in its engine. A dc motor also slows down when being driven by its load if its field remains excited. In this case, the motor acts as a generator and returns power to the supply, thereby holding the load. In an actual braking system, however, the dc motor is disconnected from the line. Its armature and field are connected in series with a resistor to form a loop. The field connections to the armature are reversed so the armature counter voltage maintains the field with its original polarity.

Figure 11-36 shows the connections in the dynamic braking system of a series-wound dc motor. The field switching is carried out by switches S1, S2, and S3, which are parts of a triple-pole double-throw (TPDT) assembly. These switches are magnetically operated from a controller. With the switch arms in position 1, the motor operates from the line. When the switch arms are in position 2, the resistor is connected in series with the field, and, at the same time, the field coil connection to the armature is reversed. Thus, as long as the armature turns, it generates a countervoltage, which forces current through the resistor and the series field. Although the direction of current flow through the armature is reversed (because of the countervoltage), the direction through the series field coil is not reversed. When operating in this way, the motor is essentially a generator that is being driven by the momentum of the armature and the mechanical load. Energy is quickly consumed in forcing current through the resistor, and the armature stops turning.

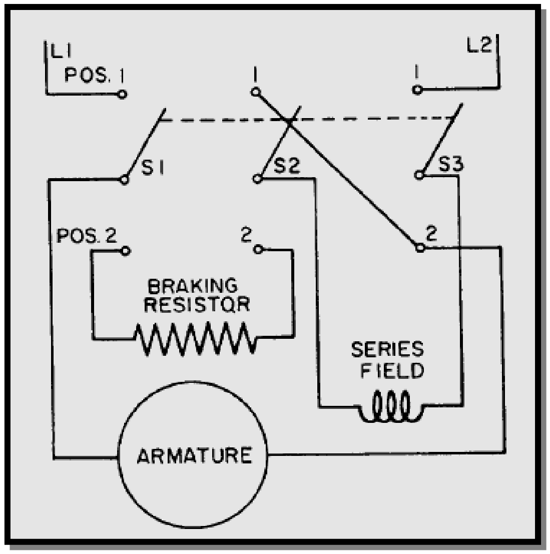

Figure 11-36.— Connections for dynamic braking of a series-wound dc motor.

The time required to stop the motor maybe varied with different resistor values. The lower the resistance, the faster the braking action. If two or more resistors are connected by switches, the braking action can be varied by switching in different load resistors. Usually, the same braking resistors that are used to stop the motor are also used to reduce the line voltage during acceleration.

When dynamic braking is used with a dc shunt wound motor, resistance is connected across the armature (fig. 11-37).

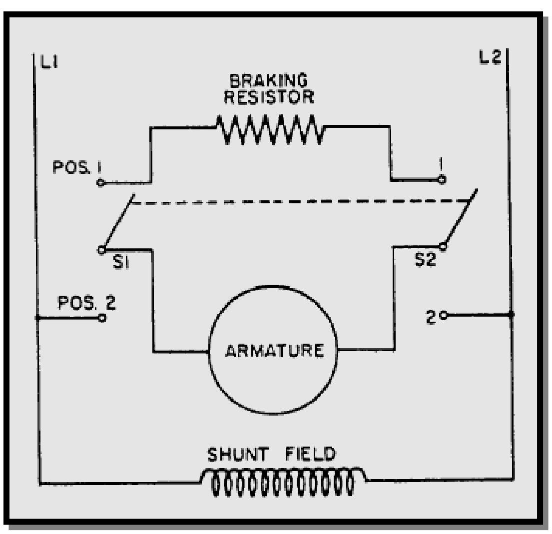

Figure 11-37.— Connections for dynamic braking of a shunt-wound dc motor.

Switches S1 and S2 are part of a double-pole double-throw (DPDT) circuit breaker assembly. When the switch arms are connected to position 2, the armature is across the line, and motor operation is obtained. When the switch arms are in position 1, the armature is disconnected from the line and connected to the resistor. The shunt field remains connected to the line. As the armature turns, it generates a countervoltage that forces the current through the resistor. The remainder of the action is the same as described for the circuit in figure 11-36.

Although dynamic braking provides an effective means of slowing motors, it is not effective when the field excitation fails or when an attempt is made to hold heavy loads; without rotation, the countervoltage is zero, and no braking reaction can exist between the armature and the field.

Dc Magnetic Brake

Magnetic brakes are used for complete braking protection. In the event of field excitation failure, they will hold heavy loads. A spring applies the brakes, and the electromagnet releases them.

Disk brakes are arranged for mounting directly to the motor end bell. The brake lining is riveted to a steel disk, which is supported by a hub keyed to the motor shaft. The disk rotates with the motor shaft.

The band-type brake has the friction material fastened to a band of steel, which encircles the wheel or drum and may cover as much as 90 percent of the wheel surface. Less braking pressure is required and there is less wear on the brake lining when the braking surface is large.

The dc brakes are operated by a solenoid similar in design to the ac solenoid brake (fig. 11-34), except that the dc brake construction is of solid metals and requires no lamination as does the ac magnetic brake.

11.9.0 CONTROLLER TROUBLESHOOTING

Although the Navy maintains a policy of preventive maintenance, sometimes trouble is unavoidable. In general, when a controller fails to operate, or signs of trouble (heat, smoke, smell of burning insulation, and so on.) occur, the cause of the trouble can be found by conducting an examination that consists of nothing more than using the sense of feel, smell, sight, and sound. On other occasions, however, locating the cause of the problem will involve more detailed actions.

Troubles tend to gather around mechanical moving parts and where electrical systems are interrupted by the making and breaking of contacts. Center your attention in these areas. See table 11-4 for a list of common troubles, their causes, and corrective actions.

When a motor-controller system has failed and pressing the start button will not start the system, press the overload relay reset push button. Then, attempt to start the motor. If the motor operation is restored, no further checks are required. However, if you hear the controller contacts close but the motor fails to start, then check the motor circuit continuity. If the main contacts do not close, then check the control circuit for continuity.

An example of troubleshooting a motor-controller electrical system is given in a sequence of steps that may be used in locating a fault (fig. 11-38). We will start by analyzing the power circuit.

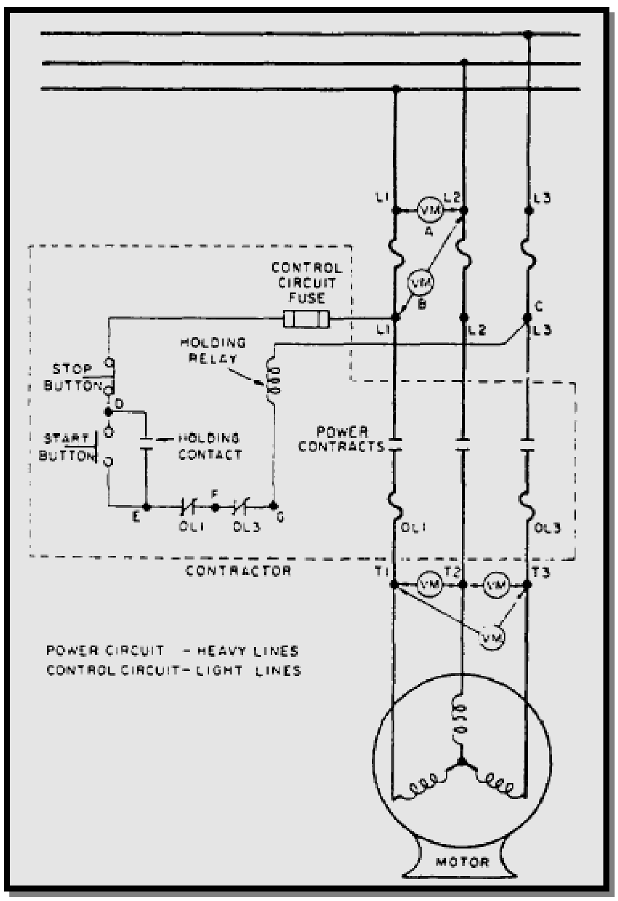

Figure 11-38.— Troubleshooting a 3-Phase magnetic line starter.

Contacts

Trouble	Probable Cause	Remedy
Contact chatter	Poor contact in control relay	Clean relay contact.
	Broken shading coil	Replace.
	Excessive jogging	Caution operator to avoid excessive jogging.
Overheated contact tips	Dirty contact tips	Clean and dress if necessary, according to chapter 300 or manufacturer's instructions.
	Sustained overloads	Find and remedy the cause of the overloads.
	Insufficient tip pressure	Clean and adjust.
	Loose connections	Clean and tighten.
Weak tip pressure	Wear allowance gone	Replace contacts and adjust.
	Poor tip adjustment	Adjust "gap" and "wipe."
	Low voltage, which prevents magnet sealing	Correct voltage condition.
Short tip life	Excessive filing or dressing	Follow manufacturer's instructions.
	Excessive jogging	Instruct operator in correct operation.
Welding or fusing	Abnormal starting currents	Operate manual controllers slower. Check automatic controllers for correct starting resistors and proper functioning of timing devices or accelerating relays.
	Rapid jogging	Instruct operator in correct operation.
	Short-circuit currents on contacts	Find and remedy causes of short circuits. Check feeder fuses for proper size and replace, if necessary.
Failure of the flexible conductors between fixed and moving parts of contactor	Improper installation.	See manufacturer's instructions.
	Worn out mechanically by large number of operations	Replace.
	Moisture or corrosive atmosphere.	Replace with flexible conductors suitable for application.
	Burned by arcing or overheating from loose, oxidized, or corroded connections	Clean and tighten connections.

Coils

Trouble	Probable cause	Remedy
Coil failure:		
(a) Not overheated	Moisture, corrosive atmosphere	Use correctly insulated coils.
	Mechanical damage	Avoid handling coils by the leads.
	Vibration or shock damage	Secure coils properly.
(b) Overheated	Overvoltage or high ambient temperature	Check current and application.
	Wrong coil	Use only the manufacturer's recommended coil.
	Too frequent use, or rapid jogging	Use correct operating procedure.
	Undervoltage, failure of magnet to seal in	Check circuit and correct cause of low voltage.
	Used above current rating	Install correct coil for application.
	Loose connections to coil, or corrosion or oxidation of connection surfaces	Clean and tighten connection.
	Improper installation	See manufacturer's instructions.

Table 11-4.— Troubleshooting Chart.

Electric brakes, solenoid or motor operated		
Trouble	**Probable cause**	**Remedy**
Worn or broken parts	High inertia loads, misapplication, excess temperature	Replace parts and refer to the technical manual for correct procedures.
Failure to hold load	Worn parts, out of adjustment, wrong brake lining	Replace parts with correct materials and adjust according to the technical manual.
	Grease or oil on brake drum	Clean thoroughly with approved solvent.
Failure to set	Out of adjustment, worn parts	Replace worn parts and adjust according to the technical manual.
	Mechanical binding	Clean and adjust.
	Coil not de-energized	Check circuit to make sure current is cut off.
Failure to release	Out of adjustment	Adjust according to the technical manual.
	Coil not energized	Check and repair circuit.
	Wrong coil	Replace with correct coil.
	Coil open or short circuited	Replace coil
	Motor will not run	Refer to the technical manual.
	Motor binds	Aline correctly, check bearings.

Magnets and mechanical parts		
Trouble	**Probable cause**	**Remedy**
Worn or broken parts	Heavy slamming caused by overvoltage or wrong coil	Replace part and correct cause.
	Chattering caused by broken shading coil or poor contact in control circuit	
	Excessive jogging	
	Mechanical abuse	
Noisy magnet	Broken shading coil	Replace.
	Magnet faces not true, result of mounting strain	Correct mounting.
	Dirt or rust on magnet face	Clean.
	Low voltage	Check system voltage and correct if wrong.
	Improper adjustment, magnet overloaded	Check and adjust according to the manufacturer's instruction.
Broken shading coil	Heavy slamming caused by overvoltage, magnet underloaded, weak tip pressure	Replace coil and correct the cause.
Failure to drop out	Gummy substances on magnet faces	Clean with approved solvent.
	Worn bearings	Replace.
	Nonmagnetic gap in magnet circuit	Replace magnet.
	Voltage not removed	Check coil voltage.
	Not enough mechanical load on magnet, improper adjustment	Adjust according to the manufacturer's instructions.

Table 11-4.Cont.— Troubleshooting Chart.

Overload relays		
Trouble	**Probable cause**	**Remedy**
Magnetic, instantaneous type:		
High or low trip	Wrong coil	Install correct coil.
	Mechanical binding, dirt, corrosion, etc.	Clean with approved solvent, adjust.
	Shorted turns (High trip)	Test coil, and replace if defective.
	Assembled incorrectly	Refer to manufacturer's instructions for correct assembly.
	Wrong calibration	Replace.
Magnetic, inverse time delay type:		
Slow trip	Fluid dirty, gummy, etc.	Change fluid and fill to correct level.
	Mechanical binding, corrosion, etc.	Clean with approved solvent, adjust.
	Worn or broken parts	Replace and adjust.
	Fluid too low	Drain and refill to correct level.
Thermal type:		
Failure to trip	Wrong size heater	Install correct size.
	Mechanical binding, dirt, corrosion etc.	Clean with approved solvent and adjust.
	Relay damaged by a previous short circuit	Replace.
Trips at too low temperature	Wrong size heater	Install correct size.
	Assembled incorrectly	See technical manual for correct assembly.
	Wrong calibration	Replace.
Failure to reset	Broken mechanism or worn parts	Replace.
	Corrosion, dirt, etc	Clean and adjust.
Burning and welding of control contacts	Short circuits in control circuits with fuses that are too large	Correct causes of short circuits and make sure that fuses are right size.
Turning relays, flux decay type:		
Too short time	Dirt in air gap	Clean.
	Shim too thick	Replace with thinner shim.
	Too much spring or tip pressure	Adjust according to the technical manual.
	Misalinement	Correct alinement, and remedy cause of misalinement.
Too long time	Shim worn too thin	Replace with thicker shim.
	Weak spring and tip pressure	Adjust according to the technical manual.
	Gummy substance on magnet face or mechanical binding	Clean with approved solvent and adjust.

Table 11-4.Cont.— Troubleshooting Chart.

11.9.1 Power Circuit Analysis

When no visual signs of failure can be located and an electrical failure is indicated in the power circuit, you must first check the line voltage and fuses. Place the voltmeter probes on the hot side of the line fuses as shown at position A. A line voltage reading tells you that your voltmeter is operational and that you have voltage to the source side of the line fuses, L1-L2. You also may check between L1-L3 and L2-L3. To check the fuse in line L1, place the voltmeter across the line fuse as shown at position B between L1-L2. A voltage reading shows a good fuse in L1. Likewise, check the other two fuses between L1-L3 and L2-L3. A no-voltage reading would show a faulty fuse.

If the line fuses check good, then check the voltage between terminals T1-T2, T2-T3, and T1-T3. The controller is faulty if there aren't voltmeter readings on all three of the terminal pairs, and you would then proceed to check the power contacts, overloads, and lead connections within the controller. However, if voltage is indicated at all three terminals, then the trouble is either in the motor or lines leading to the motor.

11.9.2 Control Circuit Analysis

Suppose the overload reset buttons have been reset and the start switch is closed. If the power contacts do not close, then the control circuit must be checked. The testing procedure is as follows:

1. Check for voltage at the controller lines, L1, L2, and L3.

2. Place the voltmeter probes at points C and D (fig. 11-38). You should have a voltage reading when the stop switch is closed and a no-voltage reading when the stop switch is open. The conditions would indicate a good stop switch.

3. Next, check the voltage between points C and E. If you get a no-voltage reading when the start switch is open and a voltage reading when the start switch is closed, then the start switch is good.

4. Place the voltmeter probes at C and F. A voltage reading with the start button closed would indicate a good OL1, but also would indicate an open OL3, an open relay coil, or an open connection to line 3.

5. Place the voltmeter probes at points C and G and close the start switch. A no-voltage reading indicates the OL3 contacts are open.

A faulty holding relay contact will be indicated when the system operates as long as the start switch is held in, but stops when the start switch is released.

When starting a three-phase motor and the motor fails to start and makes a loud hum, you should stop the motor immediately by pushing the stop button. These symptoms usually mean that one of the phases to the motor is not energized. You can assume that the control circuit is good since the main operating coil has operated and the maintaining contacts are holding the main operating contactor in. Look for trouble in the power circuit (the main contacts, overload relays, cable, and motor).

11.10.0 ELECTRICAL/ELECTRONIC WORKBENCHES

Electrical/electronic workbenches are used to work on energized electrical and electronic equipment. They are used individually and in workshops such as Electrical Repair, AIMD, Electronics, Avionics, and Calibration. Personnel safety is of primary concern during maintenance on energized equipment.

The workbenches are insulated from the top working surface and below to reduce the shock hazard to maintenance personnel.

Grounding Equipment

Metal workbenches shall be grounded to the hull and have equipment grounding leads. See Figure 11-39.

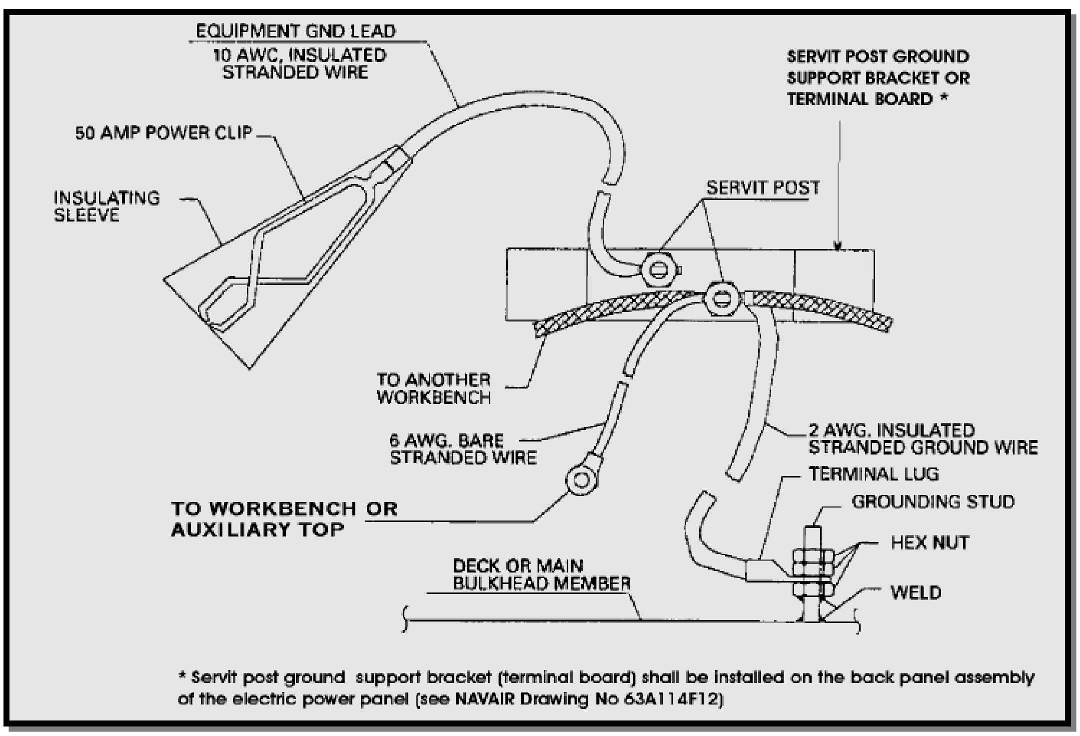

Figure 11-39.— Workbench Grounding.

Grounding studs shall be welded to the hull, if feasible, or to main members of the bulkhead. The ground stud connection shall be cleaned bright metal to metal to ensure electrical continuity. The ground wire shall be an insulated, stranded wire, size 2 AWG (green color insulation or marked with green colored tape or green colored adhesive labels), connected to the grounding stud. After the ground wire is installed, the grounding stud connection shall be painted the same color as the surrounding structure to prevent moisture penetration.

In existing installation, the ground wire can be other than green in color or designation. If the ground wire is replaced it shall be replaced with a wire insulation green in color or designation.

Each workbench section (cabinet, back panel, shelf and auxiliary table) shall be bonded to ground potential using bare, stranded wire, size 6 AWG bonding lead. The cable shall pass through the lower servit post of the grounding bracket.

Insulation

Electrical/Electronic workbenches are insulated from the top working surface to the deck. On some ships, surfaces above the top working surface, metal structures and objects adjoining the workbench and within the reach of the technician may be insulated. This is acceptable but is not required. Insulation materials above the top working surface or around the workbench shall be kept in good condition or removed if damaged.
The deck in front of the workbenches shall be covered with electrical grade matting.

Top Working Surface

The working surface insulation shall be 3/8 inch thick insulation and secured to the support surface with 1/4-20 nylon screws. Some ships have a laminate working surface that is glued to the top substructure and this is acceptable.

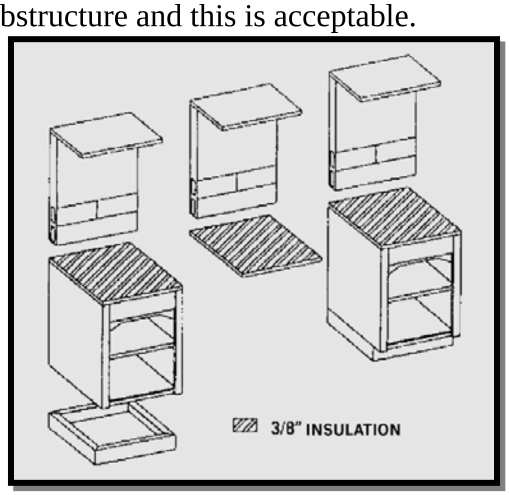

Figure 11-40.— Insulation.

Inspection and Repair

The insulation material shall be intact with no damage, cracks or joint separation that exposes underlying metal. If insulation is damaged or missing, replace with recommended material.

Exposed Metal Surfaces Below the Top Working Surface

Exposed metal surface below the top working surface shall be insulated with plastic laminate 1/32 inches to 1/8 inches thick. The use of other insulating materials on existing workbenches is acceptable. The surfaces to be covered are:

a. front surfaces of cabinet and auxiliary table.
b. knee surfaces under auxiliary table.
c. drawer fronts.
d. foundations (these may be covered with electrical grade matting.

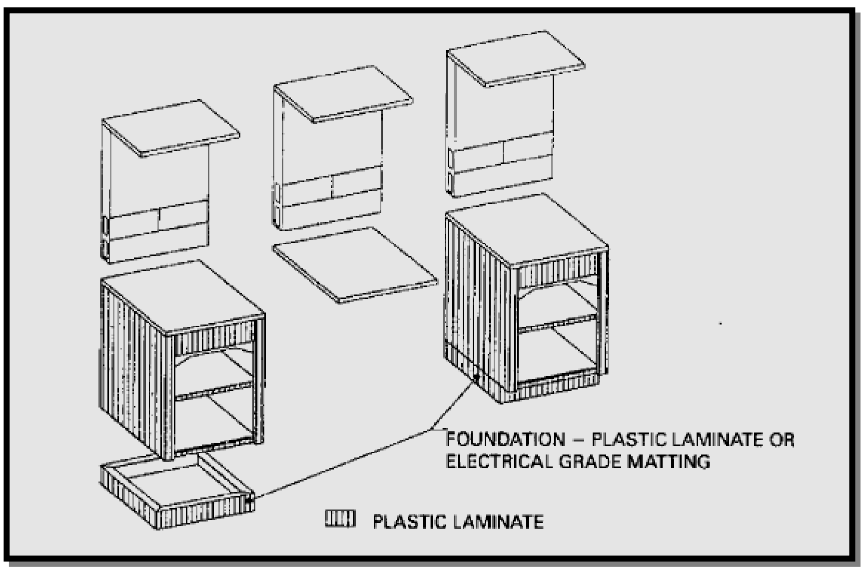

Figure 11-41.— Insulation.

Shelf Area

The insides of the drawers need not be covered. They are to remain closed while working on energized equipment. The shelf area beneath the drawer is normally open on the standard workbench.

An alternative to insulating the fronts of the shelves is to install a door over the opening. The door shall be nonconductive material in an appropriate thickness. It shall be attached with nylon or other nonconductive hardware.

Surrounding Deck Area

The object is to prevent persons working or observing at the workbench from providing a path to ground through the deck. Electrical grade sheet deck covering conforming to MIL-M-15562 , Type 1, shall be installed in front of insulated workbenches, in any kneehole, and if either end of the workbench is accessible to personnel, cover the deck at the end(s) of the workbench. No seams shall be within 3 feet of electrical/electronic workbenches. If this is unavoidable, seams shall be heat welded or chemically sealed to provide a continuous surface free of seams, craters or porosities.

Inspection and Repair

Ensure safety matting is attached to deck. Inspect matting for wear and fraying. Inspect seams. If matting is damaged or missing replace with MIL-M-15562, Type 1, material.

Attaching Metal Objects to Workbench Surfaces

Do not defeat the purpose of the insulation by attaching vices, locks, hasps, metal tie downs, or other metal hardware to the metal workbench through the insulation.

11.11.0 ELECTRICAL POWER CONNECTIONS

In order to minimize the electrical shock hazard and possible damage to equipment and ships power distribution system, all 120-volt, 60 hertz, single phase receptacle connectors (such as workbench receptacles) shall be the grounded type connected to single-phase circuits through isolating transformers on the basis of the following principles:

a. Circuits supplying receptacle connectors shall not supply other types of loads.

b. Isolating transformers shall be either 450/120-volt or 120/120-volt.

c. The minimum size transformer shall be 3kVA.

d. Each receptacle circuit shall be separately protected.

e. No more than 4 receptacle connectors shall be connected to a receptacle circuit. However, more than one receptacle circuit may be supplied by a single transformer.

Electrical Power Disconnect Switches

Power disconnect switches shall be provided to quickly disconnect workbench power (60Hz, 400Hz, DC). **The disconnect switch(es) shall not be located on the workbench.** Three basic types of disconnect circuits exist in the fleet.

a. Type 1, PREFERRED METHOD. A power disconnect switch (pushbutton station) shall be located just inside the access to the space. The switch shall disconnect ALL power (60Hz, 400Hz, DC) to workbench EPOPs and electrical receptacles. The pushbutton station (switch) shall be visible to personnel entering the space, readily accessible to safety observers and clearly identify which workbench(es) the pushbutton (switch) controls. The bulkhead mounted pushbutton station shall be located 48 to 54 inches above the deck, within a red-painted target. The pushbutton shall not be part of the normal protection devices for the workbench.

b. Type 2. In large workshops, multiple disconnect pushbuttons (switches) shall be wired so activation of any pushbutton (switch) will secure ALL power (60Hz, 400Hz DC) to ALL workbenches.

c. Type 3. Power panels (60Hz, 400Hz, DC) installed in the same compartment as the workbenches may be used as workbench power disconnects. The circuit breaker(s) inside the power panel(s) shall be clearly marked with a red target around them for easy identification. They shall be clearly marked as to which workbench(es) they control. If the power panel is in an adjacent compartment or is not readily accessible to the individual at the workbench, or a second party, a power disconnect switch (pushbutton station) shall be located just inside the access to the space.

<u>Workbenches and Test Switchboards</u>
Power for electrical/electronic workbenches and electrical test switchboards in the same compartment shall be controlled by the same power disconnect switch(es).

11.12.0 SIGNS AND LABEL PLATES
a. Above the electrical/electronic workbenches used for working on energized equipment post this sign.

b. Above workbenches that are ONLY USED TO WORK ON UNENERGIZED ELECTRICAL EQUIPMENT post this sign.

DANGER
WORKING ON ENERGIZED ELECTRICAL EQUIPMENT IS PROHIBITED ON THIS WORKBENCH

THIS IS NOT AN ELECTRICAL SAFE WORKBENCH

ALL POWER SOURCES EXCEPT 110V CONVENIENCE POWER HAVE BEEN DISABLED AT THIS WORKBENCH

c. Near the workbench post the following signs giving the approved method of rescuing personnel in contact with energized circuits.

DANGER
DO NOT ATTEMPT TO ADMINISTER FIRST AID OR COME INTO PHYSICAL CONTACT WITH AN ELECTRIC SHOCK VICTIM BEFORE THE POWER IS SHUT OFF

DANGER
REMOVAL OF PERSONNEL IN CONTACT WITH ENERGIZED ELECTRICAL CIRCUITS

DO NOT TRY TO REMOVE VICTIM WITH YOUR BARE HANDS

1. **DE-ENERGIZE THE CIRCUIT IF POSSIBLE**
2. **IF CIRCUIT CANNOT BE DE-ENERGIZED:**
   - **YOU MUST INSULATE YOURSELF FROM HIS ENTIRE BODY BY USING A NON-CONDUCTOR TO PUSH HIM FREE ON THE CONTACT**
   - **IF YOU ARE IN CONTACT WITH A LIVE CIRCUIT AND NO ONE IS NEARBY TO HELP, TRY TO BREAK THE CONTACT BY THROWING YOUR BODY.**

d. Adjacent to the workbench post Cardiopulmonary Resuscitation Placard and the WARNING sign.

e. Post this label plate near the emergency cut-off switch(es).

<u>Re-designation of Electrical Workbench to Mechanical Workbench</u>
Electrical workbenches can be converted and re-designated, as a mechanical workbench by the authority of the Ship’s Electrical Officer when it has been determined work on energized electrical equipment will no longer be performed on the workbench. Specific guidance for electrical/electronic workbenches can be found in NSTM Chapter 300, Appendix H.

11.13.0 SUMMARY
In this chapter, you were given information on auxiliary equipment, including the components, operating procedures, troubleshooting procedures, and maintenance procedures. You were also introduced to the fundamentals of cathodic protection systems, including their operation, logs, and maintenance as well as fundamentals of the various ac and dc motor and circuit control devices to enable you to maintain, troubleshoot, and repair the equipment successfully. Most equipment installed will have a manufacturer’s technical manual that should be used to adjust and repair the equipment following the recommended specifications. The *Naval Ships’ Technical Manual (NSTM),* chapter 302, will provide additional information of value to you.

APPENDIX –A
REFERENCES

NOTE: Although the following references were current when this NRTC was published, their continued currency cannot be assured. Therefore, you need to be sure that you are using the latest version.

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Rack Mount 12-Channel Audio Monitor Panel Vendor Manual

Mackenzie High Fidelity Multi-Channel Digital Audio Player Vendor Manual

Crestron 3500 Series Vendor Manual

SE165-BK-MMC-010, Marine Integrated Communications System, UM-ICSC-1338

SE101-BG-MMM-010, Intercommunication Stations LS-518D/SIC and LS-519E/SIC

SE182-AV-MMM-010, Data Multiplexing System AN/USQ-82(V)

S9436-A4-MMC-010, Alarm Switchboards IC/SM 4-2

SE168-AC-MMO-010, Indicator and Alarm System, Airflow IC/ASE-1

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S9514-FL-MMA-010, Refrigerant Monitor Parasense, Model 3300FSV-N

SE178-AM-MMM-010, Electromagnetic Log Voltage Simulator MK 1 Mod 0

SE178-AL-MMM-010, MK 6 Mod 0-2, Underwater Log Equipment (Electromagnetic Type)

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MK 4 Mod 2

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APPENDIX-B
GLOSSARY

ACID— A solution that contains an excess of hydrogen ions and exhibits a pH below the neutral value of 7.

ACTIVE— A state in which a metal tends to corrode (opposite to passive); freely corroding.

AIR-CORE TRANSFORMER— A transformer composed of two or more coils, which are wound around a nonmetallic core.

ALARM LOG— A record of quantities that are in an alarm condition only.

ALARM ACKNOWLEDGE— A push button that must be depressed to silence an alarm horn.

AMMETER— An instrument for measuring the amount of electron flow in amperes.

AMPERE— The basic unit of electrical current.

ANALOG DATA— Data represented in continuous form, as contrasted with digital data having discrete values.

ANNUNCIATOR— A device that gives an audible and a visual indication of an alarm condition.

ANODE— The positive electrode of an electrochemical device toward which the negative ions are drawn.

ANTIFOULING— The prevention of marine organism attachment or growth on a submerged metal surface through chemical toxicity. Achieved by the chemical composition of the metal, including toxins in the coating, or by some other means of distributing the toxin at the areas to be kept free of fouling.

APPARENT POWER— That power apparently available for use in an ac circuit containing a reactive element. It is the product of effective voltage times effective current expressed in volt-amperes. It must be multiplied by the power factor to obtain the true power available.

AQUEOUS— A term pertaining to water; an aqueous solution is a water solution.

ARMATURE— In a relay, the movable portion of the relay.

AVERAGE VALUE OF AC— The average of all the instantaneous values of one-half cycle of alternating current.

BASE— A solution that contains an excess of hydroxyl ions and exhibits a pH above the neutral value of 7.

BATTERY— A device for converting chemical energy into electrical energy.

BATTERY CAPACITY— The amount of energy available from a battery. Battery capacity is expressed in ampere-hours.

BELL LOG— A printed record of changes in the ship's operative conditions, such as speed or point of control.

BINARY UNIT— One of the two possible alternatives, such as 1 or 0, YES or NO, ON or OFF.

BLOCK DIAGRAM— A drawing of a system using blocks for components to show the relationship of components.

BURNISHING TOOL— A tool used to clean and polish contacts on a relay.

CARD— *See* PRINTED CIRCUIT BOARD.

CASUALTY— An event or series of events in progress during which equipment damage and/or personnel injury has already occurred. The nature and speed of these events are such that proper and correct procedural steps will only serve to limit equipment damage and/or personnel injury.

CATHODE— The general name for any negative electrode.

CATHODIC CORROSION— Corrosion of a metal when it is a cathode. Occurs on metals, such as A1, Zn, Pb, when the water solution turns strongly alkaline as a result of the normal cathodic reactions. It is a secondary reaction between the alkali generated and the amphoteric metal.

CATHODIC POLARIZATION— The change of the electrode potential in the negative direction due to current flow.

CATHODIC PROTECTION— A technique or system used to reduce or eliminate the corrosion of a metal by making it the cathode of an electrochemical cell by means of an impressed direct current or attachment of sacrificial anodes such as zinc, magnesium, or aluminum.

CELL— A single unit that transforms chemical energy into electrical energy.

CHARGE— A term representing electrical energy. A material having an excess of electrons is said to have a negative charge. A material having an absence of electrons is said to have a positive charge.

CIRCUIT— The complete path of an electric current.

CIRCULAR MIL— An area equal to that of a circle with a diameter of 0.001 inch. It is used for measuring the cross-sectional area of wires.

CLOCK— An instrument for measuring and indicating time, such as a synchronous pulse generator.

COMPONENT PARTS— Individual units of a subassembly.

COMPONENTS— Any electrical device, such as a coil, resistor, or transistor.

CONDITION— The state of being of a device such as ON-OFF or GO-NO-GO.

CONDUCTANCE— The ability of a material to conduct or carry an electric current. It is the reciprocal of the resistance of the material and is expressed in mhos or siemans.

CONDUCTIVITY— The ease with which a substance transmits electricity.

CONDUCTOR— (1) A material with a large number of free electrons. (2) A material that easily permits electric current to flow.

CONTINUOUS DISPLAY— An electrical instrument giving a continuous indication of a measured quantity.

CONTROL MODE— The method of system control at a given time.

CONTROL POWER— The power used to control or operate a component.

CONTROL SIGNAL— The signal applied to a device that makes corrective changes in a controlled process.

CONVERTER— A device for changing one type of signal to another; for example, alternating current to direct current.

CORROSION— The reaction between a material and its environment that results in the loss of the material or its properties; for example, the transformation of a metal, used as a material of construction, from the metallic to the nonmetallic state.

CORROSION POTENTIAL— The potential that a corroding metal exhibits under specific conditions of concentration, time, temperature, aeration, or velocity in an electrolytic solution and measured relative to a reference electrode under open-circuit conditions.

CORROSION PRODUCT— A product resulting from corrosion. The term applies to solid compounds, gases, or ions resulting from a corrosion reaction.

CORROSION RATE— The speed at which corrosion progresses. Frequently expressed as a constant loss or penetration per unit time. Common units used are roils penetration per year (mpy), millimeters penetration per year (mm/y), micrometers penetration per year (um/y). 1 mil = 0,001 inch, 1 mm = 0.001 meter, 1 um = 0.000001 meter.

COULOMB— A measure of the quantity of electricity. One coulomb is equal to 6.28 x 10]8 electrons.

COULOMB'S LAW— Also called the law of electric charges or the law of electrostatic attraction. Coulomb's law states that charged bodies attract or repel each other with a force that is directly proportional to the product of their individual charges and inversely proportional to the square of the distance between them.

COUPLE— A cell developed in an electrolytic solution resulting from electrical contact between two dissimilar metals; two dissimilar metals in electrical contact.

CPR— Cardiopulmonary resuscitation.

CROSS-SECTIONAL AREA— The area of a "slice" of an object. When applied to electrical conductors, it is usually expressed in circular roils.

CURRENT— The drift of electrons past a reference point. The passage of electrons through a conductor. Measured in amperes.

CURRENT CAPACITY— The hours of current that can be obtained from a unit weight of a galvanic anode metal. Usually expressed in ampere hours per pound (Ah/lb) or ampere hours per kilogram (Ah/kg).

CURRENT DENSITY— The current per unit area of surface of an electrode. Common units used are mA/ft2 (milliamperes per square foot), mA/m2 (milliamperes per square meter), A/ft2 (amperes per square foot), and A/m2 (amperes per square meter).

CURRENT EFFICIENCY— The ratio of the actual total current measured from a galvanic anode in a given time period and the total current calculated from the weight loss of the anode and the electrochemical equivalent of the anode metal, expressed as a percentage.

D'ARSONVAL METER MOVEMENT— A name used for the permanent-magnet moving-coil movement used in most meters.

DAMPING— The process of smoothing out oscillations. In a meter, damping is used to keep the pointer of the meter from overshooting the correct reading.

DEAD BAND— The range of values over which a measured variable can change without affecting the output of an amplifier or automatic control system.

DEMAND— To request a log printout or data display.

DIELECTRIC FIELD— The space between and around charged bodies in which their influence is felt. Also called electric field of force or an electrostatic field.

DIGITAL— A term pertaining to data in the form of digits.

DIGITAL CLOCK— A device for displaying time in digits.

DIRECT CURRENT— An electric current that flows in one direction only.

DOMAIN THEORY— A theory of magnetism based upon the electron-spin principle. Spinning electrons have a magnetic field. If more electrons spin in one direction than another, the atom is magnetized.

DRIFT— A slow change in some characteristics of a device, such as frequency, current, and direction.

DRY CELL— An electrical cell in which the electrolyte is not a liquid. In most dry cells, the electrolyte is in the form of a paste.

EDDY CURRENT— Induced circulating currents in a conducting material that are caused by a varying magnetic field.

EDDY CURRENT LOSS— Losses caused by random current flowing in the core of a transformer. Power is lost in the form of heat.

EFFICIENCY— The ratio of output power to input power, generally expressed as a percentage.

ELECTRIC CURRENT— The flow of electrons.

ELECTRICAL CHARGE (Q,q)— Electric energy stored on or in an object. The negative charge is caused by an excess of electrons; the positive charge is caused by a deficiency of electrons.

ELECTROCHEMICAL— The action of converting chemical energy into electrical energy.

ELECTROCHEMICAL CELL— (1) A system consisting of an anode and a cathode immersed in an electrolytic solution. The anode and cathode may be different metals or dissimilar areas on the same metal surface. (2) A cell in which chemical energy is converted into electrical energy under the condition of current flow between anode and cathode.

ELECTRODE— The terminal at which electricity passes from one medium into another, such as in an electrical cell where the current leaves or returns to the electrolyte.

ELECTRODE POTENTIAL— The difference in electrical potential between an electrode and the electrolytic solution with which it is in contact; measured relative to a reference electrode.

ELECTRODYNAMICS METER MOVEMENT— A meter movement using fixed field coils and a moving coil; usually used in watt meters.

ELECTROLYSIS— The process of changing the chemical composition of a material by passing an electric current.

ELECTROLYTE— A solution of a substance that is capable of conducting electricity. An electrolyte may be in the form of either a liquid or a paste.

ELECTROLYTIC CELL— A system in which an anode and cathode are immersed in an electrolytic solution and electrical energy is used to bring about electrode reactions. The electrical energy is thus converted into chemical energy. **(NOTE:** The term *electrochemical cell* is frequently used to describe both the electrochemical cell and the electrolytic cell.)

ELECTROLYTIC SOLUTION— A solution that conducts electric current by the movement of ions.

ELECTROMAGNET— An electrically excited magnet capable of exerting mechanical force or of performing mechanical work.

ELECTROMAGNETIC— The term describing the relationship between electricity and magnetism; having both magnetic and electric properties.

ELECTROMAGNETIC INDUCTION— The production of a voltage in a coil due to a change in the number of magnetic lines of force (flux linkages) passing through the coil.

ELECTROMOTIVE FORCE (emf)— The force (voltage) that produces an electric current in a circuit. The force that causes electricity to flow between two points with different electrical charges or when there is a difference of potential between the two points. The unit of measurement is volts.

ELECTRON— The elementary negative charge that revolves around the nucleus of an atom.

ELECTRON SHELL— A group of electrons that have a common energy level that forms part of the outer structure (shell) of an atom.

ELECTROSTATIC— Pertaining to electricity at rest, such as charges on an object (static electricity).

ELECTROSTATIC METER MOVEMENT— A meter movement that used the electrostatic repulsion of two sets of charged plates (one fixed and the other movable). This meter movement reacts to voltage rather than to current and is used to measure high voltage.

ELEMENT— A substance, in chemistry, that cannot be divided into simpler substances by any means ordinarily available.

EMBRITTLEMENT— Severe loss of ductility of a metal or alloy.

EMERGENCY— An event or series of events in progress that will cause damage to equipment unless immediate, timely, and correct procedural steps are taken.

EXTERNAL CIRCUIT— Wires, connectors, measuring devices, current sources, and so forth, that are used to bring about or measure the desired electrical conditions within the test cell. Also known in corrosion parlance as that part of an electrochemical cell external to the solution.

FAIL— The loss of the control signal or power to a component. Also, the breakage or breakdown of a component or component part.

FAIL POSITION— The operating or physical position to which a device will go upon loss of its control signal.

FEEDBACK— A value derived from a controlled function and returned to the controlling function.

FERROMAGNETIC MATERIAL— A highly magnetic material, such as iron, cobalt, nickel, or alloys.

FIELD OF FORCE— A term used to describe the total force exerted by an action-at-a-distance phenomenon, such as gravity upon matter, electric charges acting upon electric charges, magnetic forces acting upon other magnets or magnetic materials.

FIXED RESISTOR— A resistor having a definite resistance value that cannot be adjusted.

FLUX— In electrical or electromagnetic devices, a general term used to designate collectively all the electric or magnetic lines of force in a region.

FLUX DENSITY— The number of magnetic lines of force passing through a given area.

FREQUENCY METER— A meter used to measure the frequency of an ac signal.

FUNCTION— To perform the normal or characteristic action of something, or a special duty or performance required of a person or thing in the course of work.

GALVANIC CORROSION— Corrosion of a metal because of electrical contact with a more noble metal or nonmetallic conductor in a corrosive environment. Often used to refer specifically to bimetallic corrosion; sometimes called couple action.

GALVANIC COUPLE— Two or more dissimilar conductors, commonly metals, in electrical contact in the same electrolytic solution.

GALVANIC SERIES— A list of metals and alloys arranged according to their relative corrosion potentials in a given environment. Note that this may not be the same order as in the electromotive force series.

GALVANOMETER— A meter used to measure small values of current by electromagnetic or electrodynamics means.

GROUND POTENTIAL— Zero potential with respect to the ground or earth.

HALF-CELL— One of the electrodes and its immediate environment in an electrochemical cell; an electrode and environment arranged for the passage of current to another electrode for the measurement of its electrode potential; when coupled with another half-cell, an overall cell potential develops that is the sum of both half-cell potentials.

HENRY (H)— The electromagnetic unit of inductance or mutual inductance. The inductance of a circuit is 1 henry when a current variation of 1 ampere per second induces 1 volt. It is the basic unit of inductance. In radio, smaller units are used, such as the millihenry (mH), which is one-thousandth of a henry (H), and the microhenry (uH), which is one-millionth of a henry.

HERTZ (Hz)— A unit of frequency equal to one cycle per second.

HORSEPOWER (hp)— The English unit of power, equal to work done at the rate of 550 foot-pounds per second. Equal to 746 watts of electrical power.

HOT WIRE METER MOVEMENT— A meter movement that uses the expansion of a heated wire to move the pointer of a meter; measures ac or dc.

HYDRAULIC ACTUATOR— A device that converts hydraulic pressure to mechanical movement.

HYDROGEN BLISTERING— The formation of blister like bulges on or below the surface of a ductile metal caused by excessive internal hydrogen pressure. Hydrogen may be formed during cleaning, plating, corrosion, or cathodic protection.

HYDROGEN EMBRITTLEMENT— Severe loss of ductility caused by the presence of hydrogen in the metal; for example, through pickling, cleaning, or cathodic protection.

HYDROMETER— An instrument used to measure specific gravity. In batteries, hydrometers are used to indicate the state of charge by the specific gravity of the electrolyte.

HYSTERESIS— The time lag of the magnetic flux in a magnetic material behind the magnetizing force producing it, caused by the molecular friction of the molecules trying to align themselves with the magnetic force applied to the material.

HYSTERESIS LOSS— The power loss in an iron-core transformer or other ac device as a result of magnetic hysteresis.

INDUCED CURRENT— Current due to the relative motion between a conductor and a magnetic field.

INDUCED ELECTROMOTIVE FORCE— The electromotive force induced in a conductor due to the relative motion between a conductor and a magnetic field. Also called induced voltage.

INDUCED REACTANCE (XL)— The opposition to the flow of an alternating current caused by the inductance of a circuit, expressed in ohms.

INSULATION— (1) A material used to prevent the leakage of electricity from a conductor and to provide mechanical spacing or support to protect against accidental contact. (2) Use of material in which current flow is negligible to surround or separate a conductor to prevent loss of current.

INTERLOCK— A device that prevents an action from taking place at the desired time, but will allow the action when all required conditions are met.

ION— An electrically charged atom or group of atoms. Negative ions have an excess of electrons; positive ions have a deficiency of electrons.

JACKING GEAR— Electric motor-driven device that rotates the turbine shaft, reduction gears, and line shaft at a low speed.

KILO— A prefix meaning one thousand.

KINETIC ENERGY— Energy that a body possesses by virtue of its motion.

KIRCHHOFF’S LAWS— (1) The algebraic sum of the currents flowing toward any point in an electric network is zero. (2) The algebraic sum of the products of the current and resistance in each of the conductors in any closed path in a network is equal to the algebraic sum of the electromotive forces in the path.

LEAD-ACID CELL— A cell in an ordinary storage battery, in which electrodes are grids of lead containing an active material consisting of certain lead oxides that change in composition during charging and discharging. The electrodes or plates are immersed in an electrolyte of diluted sulfuric acid.

LINE OF FORCE— A line in an electric or magnetic field that shows the direction of the force.

LINEAR— Straight line relationship where changes in one function are directly proportional to changes in another function.

LOAD— (1) A device through which an electric current flows and which changes electrical energy into another form, (2) Power consumed by a device or circuit in performing its function.

LOGIC— A method for describing the existing condition of circuits and devices that can remain at only one of two opposite conditions at a particular time, such as ON or OFF, UP or DOWN, IN or OUT.

MAGNETIC FIELD— The space in which a magnetic force exists.

MAGNETIC POLES— The section of a magnet where the flux lines are concentrated; also where they enter and leave the magnet.

MAGNETISM— The property possessed by certain materials by which these materials can exert mechanical force on neighboring masses of magnetic materials and can cause currents to be induced in conducting bodies moving relative to the magnetized bodies.

MANUAL THROTTLE CLUTCH— Means of mechanically disconnecting the throttle hand-wheels, mounted on the engine-room console, from the reach rods that are connected to the throttle valves.

MEGA— A prefix meaning one million, also Meg.

MHO— Unit of conductance; the reciprocal of the ohm.

MICRO— A prefix meaning one-millionth.

MICROTESLA— Equal to one million teslas.

MILLI— A prefix meaning one-thousandth.

MODULE— Subassemblies mounted in a section.

MONITOR— One of the principal operating modes of a data logger that provides a constant check of plant conditions.

MONITORING POINT— The physical location at which any indicating device displays the value of a parameter at some control station.

MOVING-VANE METER MOVEMENT— A meter movement that uses the magnetic repulsion of the like poles created in two iron vanes by current through a coil of wire: most commonly used movement for ac meters.

MULTIMETER— A single meter combining the functions of an ammeter, a voltmeter, and an ohmmeter.

NEGATIVE TEMPERATURE COEFFICIENT— The temperature coefficient expressing the amount of reduction in the value of a quantity, such as resistance for each degree of increase in temperature.

NEUTRAL— In a normal condition, neither positive or negative. A neutral object has a normal number of electrons.

NO-BREAK POWER SUPPLY— A device that supplies temporary power to the console during failure of the normal power supply.

NOBLE— A state in which a metal tends not to be active; the positive direction of electrode potential.

NOBLE METAL— A metal that is not very reactive, such as silver, gold, or platinum, which may be found naturally in metallic form on earth.

NOBLE POTENTIAL— A potential toward the positive end of a scale of electrode potentials.

NONTRIP-FREE CIRCUIT BREAKER— A circuit breaker that can be held ON during an overcurrent condition.

NORMAL MODE— Operating condition at normal ahead speeds, differing from maneuvering, where certain functions, pumps, or valves are not required, while others are for proper operation of ship and machinery.

NULL POSITION— Condition where the output shaft is positioned to correspond to that which the input shaft has been set.

OCTAL CODE— Numeric system consisting of eight consecutive digits, 0 through 7.

OHM— The unit of electrical resistance. It is that value of electrical resistance through which a constant potential difference of 1 volt across the resistance will maintain a current flow of 1 ampere through the resistance.

OHM'S LAW— The current in an electric circuit is directly proportional to the electromotive force in the circuit. The most common form of the law is $E = IR$, where E is the electromotive force or voltage across the circuit, I is the current flowing in the circuit, and R is the resistance of the circuit.

OHMIC VALUE— Resistance in ohms.

ONE-LINE SCHEMATIC— A drawing of a system using only one line to show the tie-in of various components; for example, the three conductors needed to transmit three-phase power are represented by a single line.

ONE-LINE SKETCH— A drawing using one line to outline the general relationship of various components to each other.

OPEN-CIRCUIT POTENTIAL— The potential of an electrode measured with respect to a reference electrode when essentially no current flows to or from the electrode.

OPEN LOOP— A system having no feedback.

OPERATING CHARACTERISTICS— A combination of a parameter and its set point.

PARALLAX— The error in meter readings that results when you look at a meter from some position other than directly in line with the pointer and the meter face. A mirror mounted on the meter face aids in eliminating parallax error.

PARAMETER— A variable, such as temperature, pressure, flow rate, voltage, current, or frequency that may be indicated, monitored, checked, or sensed in any way during operation or testing.

PARALLEL CIRCUIT— Two or more electrical devices connected to the same pair of terminals so separate currents flow through each; electrons have more than one path to travel from the negative to the positive terminal.

PERIPHERAL— Existing on or near the boundary of a surface or area.

PERMEABILITY— The measure of the ability of a material to act as a path for magnetic lines of force.

pH— A logarithmic measure of the acidity or alkalinity of a solution. A value of 7 is neutral; low numbers are acid (1-6); large numbers are alkaline (8- 14). Each unit represents a tenfold change in concentration.

PHASE— The angular relationship between two alternating currents or voltages when the voltage or current is plotted as a function of time. When the two are in phase, the angle is zero, and both reach their peak simultaneously. When out of phase, one will lead or lag the other; at the instant when one is at its peak, the other will not be at peak value and (depending on the phase angle) may differ in polarity as well as magnitude.

PHASE ANGLE— The number of electrical degrees of lead or lag between the voltage and current waveforms in an ac circuit.

PHASE DIFFERENCE— The time in electrical degrees by which wave leads or lag another.

PHOTOELECTRIC VOLTAGE— A voltage produced by light.

PICO— A prefix adopted by the National Bureau of Standards meaning 10-12.

PIEZOELECTRIC EFFECT— The effect of producing a voltage by placing a stress, either by compression, expansion, or twisting, on a crystal and, conversely, producing a stress in a crystal by applying a voltage to it.

PILOT MOTOR— The small dc motor that drives the input shaft of an actuator.

POLARITY— (1) The condition in an electrical circuit by which the direction of the flow of current can be determined. Usually applied to batteries and other direct voltage sources. (2) Two opposite charges, one positive and one negative. (3) A quality of having two opposite magnetic poles, one north and the other south.

POLARIZATION— The effect of hydrogen surrounding the anode of a cell that increases the internal resistance of the cell.

POTENTIAL ENERGY— Energy due to the position of one body with respect to another body or to the relative parts of the same body.

POTENTIOMETER— A three-terminal resistor with one or more sliding contacts, which functions as an adjustable voltage divider.

POWER— The rate of doing work or the rate of expending energy. The unit of electrical power is the watt.

POWER SUPPLY— The module that converts the 115-volt, 60-hertz incoming power to ac or dc power at a more suitable voltage level.

PRIMARY WINDING— The winding of a transformer connected to the electrical source.

PRINTED CIRCUIT BOARD— Devices usually plugged into receptacles that are mounted in modules.

PRIORITY— The order established by the relative importance of the function.

PROTECTIVE FEATURE— The feature of a component or component part designed to protect a component or system from damage.

PROTECTIVE POTENTIAL— A term used in cathodic protection to define the minimum potential required to mitigate or suppress corrosion. For steel in quiescent seawater, a value of -0.80 volt to Ag/AgCl reference electrode is generally used.

RECIPROCAL— The value obtained by dividing the number 1 by any quantity.

RECTIFIER— A device used to convert ac to pulsating dc.

REFERENCE ELECTRODE— A half-cell of reproducible potential by means of which an unknown electrode potential can be determined on some arbitrary scale (for example, Ag/AgCl, SCE, Cu/CuSO4). A standard against which the potentials of other metal and nonmetallic conductor electrodes are measured and compared.

REFERENCE POINT— A point in a circuit to which all other points in the circuit are compared.

REFERENCE SIGNAL— The command signal that requests a specific final condition.

RELAY— An electromagnetic device with one or more sets of contacts that changes contact position by the magnetic attraction of a coil to an armature.

RELUCTANCE— A measure of the opposition that a material offers to magnetic lines of force.

REPULSION— The mechanical force tending to separate bodies having like electrical charges or like magnetic polarity.

RESIDUAL MAGNETISM— Magnetism remaining in a substance after removal of the magnetizing force.

RETENTIVITY— The ability of a material to retain its magnetism.

RHEOSTAT— (1) A resistor whose value can be varied. (2) A variable resistor that is used for the purpose of adjusting the current in a circuit.

RLC CIRCUIT— An electrical circuit that has the properties of resistance, inductance, and capacitance.

ROOT MEAN SQUARE (RMS)— The equivalent heating value of an alternating current or voltage, as compared to a direct current or voltage. It is 0.707 times the peak value of a sine wave.

ROTARY SWITCH— A multicontact switch with contacts arranged in a circular or semicircular manner.

RUSTING— Corrosion of iron or iron-base alloy to form a reddish-brown product known as rust, which is primarily hydrated iron oxide. A term properly applied only to ferrous alloys.

SCALING— Applying a factor of proportionality to data or signal levels.

SCHEMATIC CIRCUIT DIAGRAM— A circuit diagram in which component parts are represented by simple, easily drawn symbols. May be called schematic.

SCHEMATIC SYMBOLS— A letter, abbreviation, or design used to represent specific characteristics or components on a schematic diagram.

SECONDARY— The output coil of a transformer.

SELF-INDUCTANCE— The production of a counter electromotive force in a conductor when its own magnetic field collapses or expands with a change in current in the conductor.

SELSYN— Self-synchronizing device or synchromotor.

SENSING POINT— A physical and/or functional point in a system at which a signal maybe detected or monitored in an automatic operation.

SENSITIVITY— (1) For an ammeter, the amount of current that will cause full-scale deflection of the meter. (2) For a voltmeter, the ratio of the voltmeter resistance divided by the full-scale reading of the meter, expressed in ohms-per-volt.

SENSOR— A device that is sensitive to temperature, pressure, position, level, or speed.

SERIES CIRCUIT— An arrangement where electrical devices are connected so that the total current must flow through all the devices; electrons have one path to travel from the negative terminal to the positive terminal.

SERIES-PARALLEL CIRCUIT— A circuit that consists of both series and parallel networks.

SET POINT— The numerical value of a parameter at which an alarm is actuated.

SHIELD— A nonconducting coating, paint, or sheet that is used to beneficially change the current on a cathode or anode; normally used with impressed current or other high-potential cathodic protection systems to distribute the current beyond the immediate vicinity of the electrode.

SILICON CONTROLLED RECTIFIER PACKAGE— A device that furnishes controlled dc power to a device.

SINE WAVE— The curve traced by the projection on a uniform time scale of the end of a rotating arm, or vector. Also known as a sinusoidal wave.

SOLENOID— An electromagnetic device that changes electrical energy into mechanical motion; based upon the attraction of a movable iron plunger to the core of an electromagnet.

SOLID STATE— A class of electronics components, such as transistors, diodes, integrated circuits, silicon controlled rectifiers, and so forth.

SPAN— The distance between two points.

SPECIAL FUNCTION— A unique service performed by a system; usually above and beyond the direct design intent of the system.

STANDARD PRINT— A standard drawing, schematic, or blueprint produced in the applicable technical manual or other official technical publication.

STATUS LOG— A record of the instantaneous values of important conditions having analog values.

STRAY-CURRENT CORROSION— Corrosion caused by current flow from a source (usually dc) through paths other than the intended circuit or by extraneous currents in the electrolytic solution.

SYSTEM— The major functional section of an installation.

SYSTEM INTERRELATION— Specific individual operations in one system affecting the operation in another system.

TACHOMETER GENERATOR— A device for converting rotational speed into an electrical quantity or signal.

TESLA— The tesla is a measurement of magnetic flux, equivalent to 1 weber per square meter. One tesla is equal to 10,000 gauss.

TEST POINT— A position in a circuit where instruments can be inserted for test purposes.

THERMAL-MAGNETIC TRIP ELEMENT— A single circuit breaker trip element that combines the action of a thermal and a magnetic trip element.

THERMOCOUPLE METER MOVEMENT— A meter movement that uses the current induced in a thermocouple by the heating of a resistive element to measure the current in a circuit; used to measure ac or dc.

THETA (e)— The Greek letter used to represent phase angle.

THRESHOLD— The least value of current or voltage that produces the minimum detectable response.

TIME CONSTANT— (1) The time required to charge a capacitor to 63.2 percent of maximum voltage or discharge to 36.8 percent of its final voltage. (2) The time required for the current in an inductor to increase to 63.2 percent of maximum current of decay to 36.8 percent of its final current.

TOLERANCE— (1) The maximum error or variation from the standard permissible in a measuring instrument. (2) A maximum electrical or mechanical variation from specifications that can be tolerated without impairing the operation of a device.

TRACKING— One object or device moving with or following another object or device.

TRANSDUCER— A device that converts a mechanical input signal into an electrical output signal.

TRANSFORMER— A device composed of two or more coils, linked by magnetic lines of force, used to transfer energy from one circuit to another.

TRANSFORMER, STEP-DOWN— A transformer so constructed that the number of turns in the secondary winding is less than the number of turns in the primary winding. This construction will provide less voltage in the secondary circuit than in the primary circuit.

TRANSFORMER, STEP-UP— A transformer so constructed that the number of turns in the secondary winding is more than the number of turns in the primary winding. This construction will provide more voltage in the secondary circuit than in the primary circuit.

TRIP ELEMENT— The part of a circuit breaker that senses any overload condition and causes the circuit breaker to open the circuit.

TRIP-FREE CIRCUIT BREAKER— A circuit breaker that will open a circuit even if the operating mechanism is held in the ON position.

TRUE POWER— The power dissipated in the resistance of the circuit, or the power actually used in the circuit.

TURN— One complete loop of a conductor about a core.

TURNING GEAR— *See* JACKING GEAR.

TURNS RATIO— The ratio of the number of turns in the primary winding to the number of turns in the secondary winding of a transformer.

VOLT— The unit of electromotive force or electrical pressure. One volt is the pressure required to send 1 ampere of current through a resistance of 1 ohm.

VOLTAGE— (1) The term used to signify electrical pressure. Voltage is a force that causes current to flow through an electrical conductor. (2) The voltage of a circuit is the greatest effective difference of potential between any two conductors of the circuit.

VOLTAGE DIVIDER— A series circuit in which desired portions of the source voltage may be tapped off for use in equipment.

VOLTAGE DROP— The difference in voltage between two points. It is the result of the loss of electrical pressure as a current flows through a resistance.

WATCH STATION— Duties, assignments or responsibilities that an individual or group of individuals may be called upon to carry out; not necessarily a normally manned position with a “watch bill” assignment.

WATT— The practical unit of electrical power. It is the amount of power used when 1 ampere of dc flows through a resistance of 1 ohm.

WATT-HOUR— A practical unit of electrical energy equal to 1 watt of power for 1 hour.

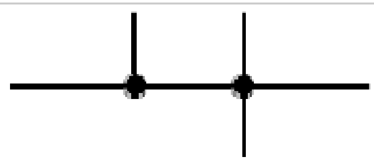
WATTAGE RATING— A rating expressing the maximum power that a device can safely handle.

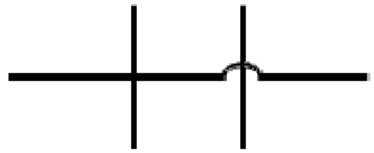
WEBER'S THEORY— A theory of magnetism that assumes that all magnetic material is composed of many tiny magnets. A piece of magnetic material that is magnetized has all of the tiny magnets aligned so that the north pole of each magnet points in one direction.

APPENDIX-C
ELECTRONIC SYMBOLS

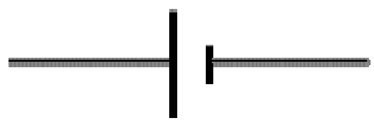
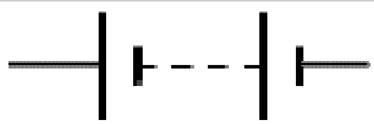
Circuit symbols are used in circuit diagrams which show how a circuit is connected together. The actual layout of the components is usually quite different from the circuit diagram. To build a circuit you need a different diagram showing the layout of the parts on stripboard or printed circuit board.

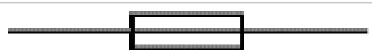
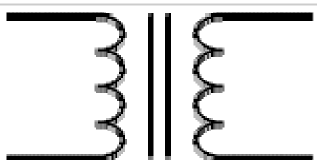
Wires and connections

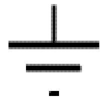
Component	Circuit Symbol	Function of Component
Wire		To pass current very easily from one part of a circuit to another.
Wires joined		A 'blob' should be drawn where wires are connected (joined), but it is sometimes omitted. Wires connected at 'crossroads' should be staggered slightly to form two T-junctions, as shown on the right.

Wires not joined		In complex diagrams it is often necessary to draw wires crossing even though they are not connected. I prefer the 'hump' symbol shown on the right because the simple crossing on the left may be misread as a join where you have forgotten to add a 'blob'!

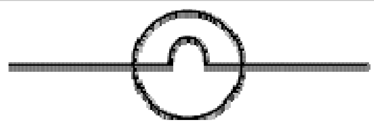
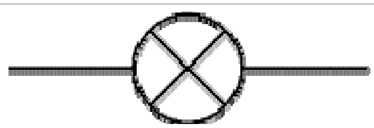
Power Supplies

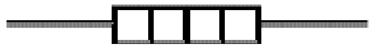
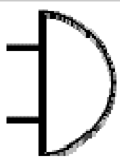
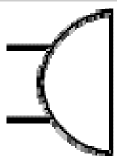
Component	Circuit Symbol	Function of Component
Cell		Supplies electrical energy. A single cell is often wrongly called a battery, but strictly a battery is two or more cells joined together.
Battery		Supplies electrical energy. A battery is more than one cell.

DC supply		Supplies electrical energy. DC = Direct Current, always flowing in one direction.
AC supply		Supplies electrical energy. AC = Alternating Current, continually changing direction.
Fuse		A safety device which will 'blow' (melt) if the current flowing through it exceeds a specified value.
Transformer		Two coils of wire linked by an iron core. Transformers are used to step up (increase) and step down (decrease) AC voltages. Energy is transferred between the coils by the magnetic field in the core. There is no electrical connection between the coils.

Earth (Ground)		A connection to earth. For many electronic circuits this is the 0V (zero volts) of the power supply, but for mains electricity and some radio circuits it really means the earth. It is also known as ground.

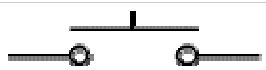
Output Devices: Lamps, Heater, Motor, etc.

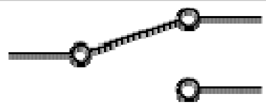
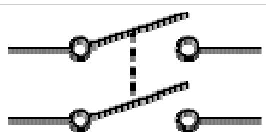
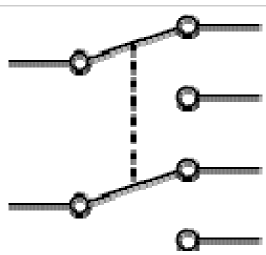
Component	Circuit Symbol	Function of Component
Lamp (lighting)		A transducer which converts electrical energy to light. This symbol is used for a lamp providing illumination, for example a car headlamp or torch bulb.
Lamp (indicator)		A transducer which converts electrical energy to light. This symbol is used for a lamp which is an indicator, for example a warning light on a car dashboard.

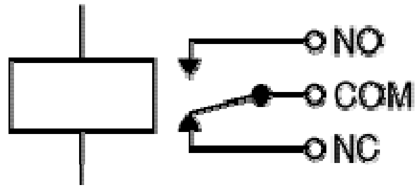
Heater		A transducer which converts electrical energy to heat.
Motor		A transducer which converts electrical energy to kinetic energy (motion).
Bell		A transducer which converts electrical energy to sound.
Buzzer		A transducer which converts electrical energy to sound.

Inductor (Coil, Solenoid)		A coil of wire which creates a magnetic field when current passes through it. It may have an iron core inside the coil. It can be used as a transducer converting electrical energy to mechanical energy by pulling on something.

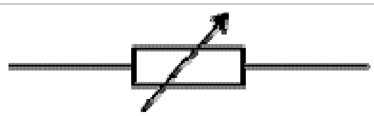
Switches

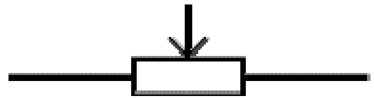
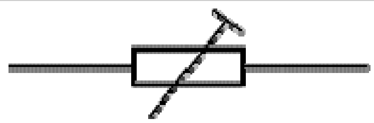
Component	**Circuit Symbol**	**Function of Component**
Push Switch (push-to-make)		A push switch allows current to flow only when the button is pressed. This is the switch used to operate a doorbell.
Push-to-Break Switch		This type of push switch is normally closed (on), it is open (off) only when the button is pressed.

On-Off Switch (SPST)		SPST = Single Pole, Single Throw. An on-off switch allows current to flow only when it is in the closed (on) position.
2-way Switch (SPDT)		SPDT = Single Pole, Double Throw. A 2-way changeover switch directs the flow of current to one of two routes according to its position. Some SPDT switches have a central off position and are described as 'on-off-on'.
Dual On-Off Switch (DPST)		DPST = Double Pole, Single Throw. A dual on-off switch which is often used to switch mains electricity because it can isolate both the live and neutral connections.
Reversing Switch (DPDT)		DPDT = Double Pole, Double Throw. This switch can be wired up as a reversing switch for a motor. Some DPDT switches have a central off position.

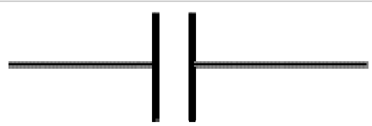
Relay		An electrically operated switch, for example a 9V battery circuit connected to the coil can switch a 230V AC mains circuit. NO = Normally Open, COM = Common, NC = Normally Closed.

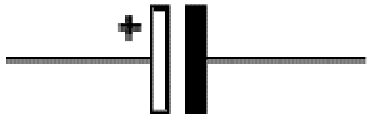
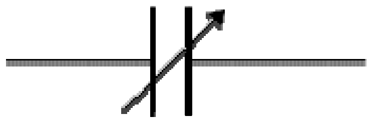
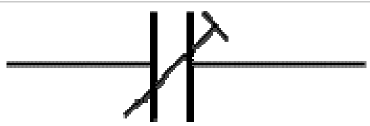
Resistors

Component	Circuit Symbol	Function of Component
Resistor		A resistor restricts the flow of current, for example to limit the current passing through an LED. A resistor is used with a capacitor in a timing circuit.
Variable Resistor (Rheostat)		This type of variable resistor with 2 contacts (a rheostat) is usually used to control current. Examples include: adjusting lamp brightness, adjusting motor speed, and adjusting the rate of flow of charge into a capacitor in a timing circuit.

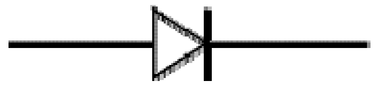
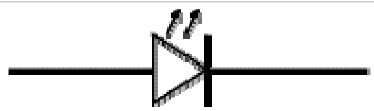
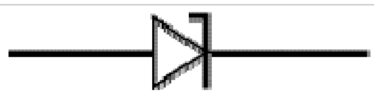
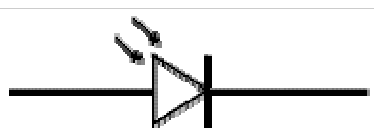
Variable Resistor (Potentiometer)		This type of variable resistor with 3 contacts (a potentiometer) is usually used to control voltage. It can be used like this as a transducer converting position (angle of the control spindle) to an electrical signal.
Variable Resistor (Preset)		This type of variable resistor (a preset) is operated with a small screwdriver or similar tool. It is designed to be set when the circuit is made and then left without further adjustment. Presets are cheaper than normal variable resistors so they are often used in projects to reduce the cost.

Capacitors

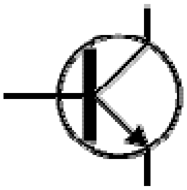
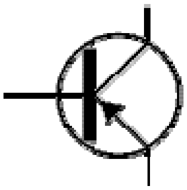
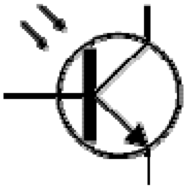
Component	**Circuit Symbol**	**Function of Component**
Capacitor		A capacitor stores electric charge. A capacitor is used with a resistor in a timing circuit. It can also be used as a filter, to block DC signals but pass AC signals.

Capacitor, polarized		A capacitor stores electric charge. This type must be connected the correct way round. A capacitor is used with a resistor in a timing circuit. It can also be used as a filter, to block DC signals but pass AC signals.
Variable Capacitor		A variable capacitor is used in a radio tuner.
Trimmer Capacitor		This type of variable capacitor (a trimmer) is operated with a small screwdriver or similar tool. It is designed to be set when the circuit is made and then left without further adjustment.

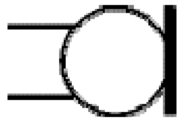
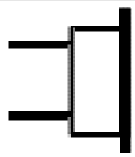
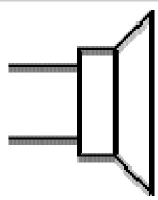
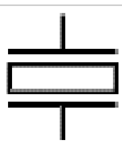
Diodes

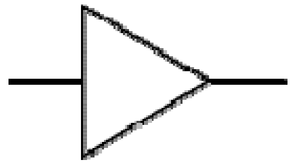
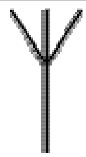
Component	**Circuit Symbol**	**Function of Component**
Diode		A device which only allows current to flow in one direction.
LED Light Emitting Diode		A transducer which converts electrical energy to light.
Zener Diode		A special diode which is used to maintain a fixed voltage across its terminals.
Photodiode		A light-sensitive diode.

Transistors

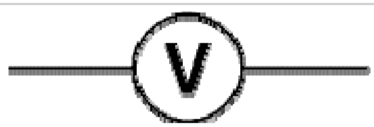
Component	Circuit Symbol	Function of Component
Transistor NPN		A transistor amplifies current. It can be used with other components to make an amplifier or switching circuit.
Transistor PNP		A transistor amplifies current. It can be used with other components to make an amplifier or switching circuit.
Phototransistor		A light-sensitive transistor.

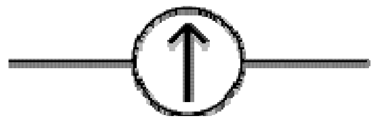
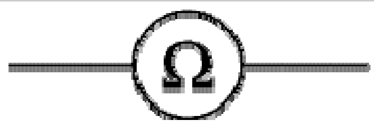
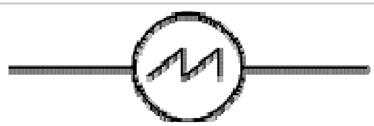
Audio and Radio Devices

Component	Circuit Symbol	Function of Component
Microphone		A transducer which converts sound to electrical energy.
Earphone		A transducer which converts electrical energy to sound.
Loudspeaker		A transducer which converts electrical energy to sound.
Piezo Transducer		A transducer which converts electrical energy to sound.

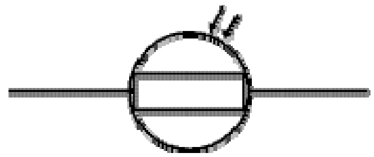
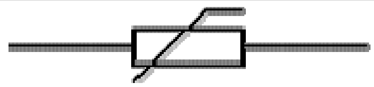
Amplifier (general symbol)		An amplifier circuit with one input. Really it is a block diagram symbol because it represents a circuit rather than just one component.
Aerial (Antenna)		A device which is designed to receive or transmit radio signals. It is also known as an antenna.

Meters and Oscilloscope

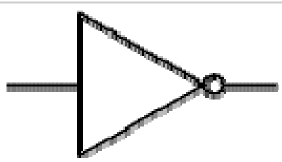
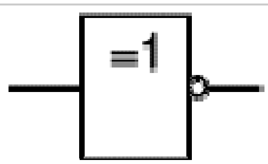
Component	Circuit Symbol	Function of Component
Voltmeter		A voltmeter is used to measure voltage. The proper name for voltage is 'potential difference', but most people prefer to say voltage!

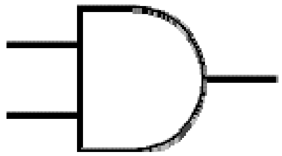
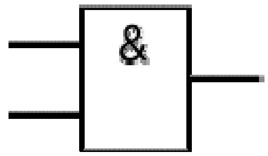
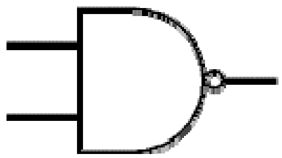
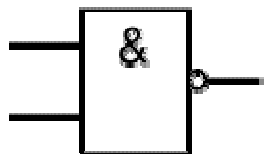
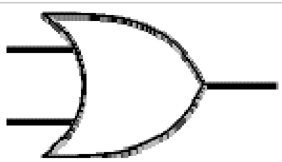
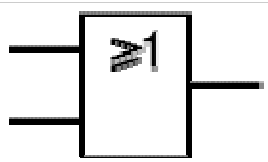
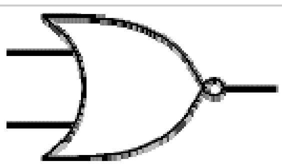
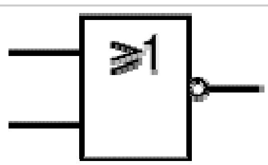
Ammeter		An ammeter is used to measure current.
Galvanometer		A galvanometer is a very sensitive meter which is used to measure tiny currents, usually 1mA or less.
Ohmmeter		An ohmmeter is used to measure resistance. Most multimeters have an ohmmeter setting.
Oscilloscope		An oscilloscope is used to display the shape of electrical signals and it can be used to measure their voltage and time period.

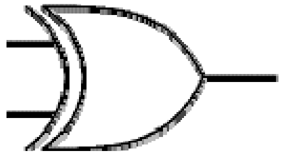
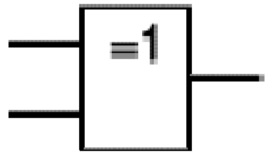
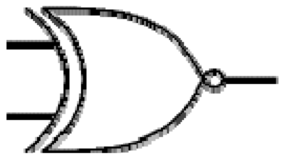
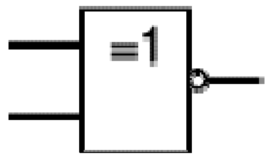
Sensors (input devices)

Component	Circuit Symbol	Function of Component
LDR		A transducer which converts brightness (light) to resistance (an electrical property). LDR = Light Dependent Resistor
Thermistor		A transducer which converts temperature (heat) to resistance (an electrical property).

Logic Gates

Gate Type	Traditional Symbol	IEC Symbol	Function of Gate
NOT			A NOT gate can only have one input. The 'o' on the output means 'not'. The output of a NOT gate is the inverse (opposite) of its input, so the output is true when the input is false. A NOT gate is also called an inverter.

AND			An AND gate can have two or more inputs. The output of an AND gate is true when all its inputs are true.
NAND			A NAND gate can have two or more inputs. The 'o' on the output means 'not' showing that it is a Not AND gate. The output of a NAND gate is true unless all its inputs are true.
OR			An OR gate can have two or more inputs. The output of an OR gate is true when at least one of its inputs is true.
NOR			A NOR gate can have two or more inputs. The 'o' on the output means 'not' showing that it is a Not OR gate. The output of a NOR gate is true when none of its inputs are true.

EX-OR			An EX-OR gate can only have two inputs. The output of an EX-OR gate is true when its inputs are different (one true, one false).
EX-NOR			An EX-NOR gate can only have two inputs. The 'o' on the output means 'not' showing that it is a Not EX-OR gate. The output of an EX-NOR gate is true when its inputs are the same (both true or both false).

Interior Communications Electrician, Volume 1
NAVEDTRA 14120A
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Textbook Assignment: Textbook Assignment: Chapter 1, "Electrical and General Safety Precautions.

ASSIGNMENT 1

1-1. Which of the following people is/are responsible for understanding and observing safety standards and regulations on board ship?

1. The commanding officer
2. The executive officer
3. All individuals
4. The chief engineer

1-2. Which of the following is a good safety practice?

1. Observe all posted operating instructions and safety precautions
2. Report any unsafe conditions or any equipment or material deficiency you think might be unsafe
3. Wear or use approved protective clothing or protective equipment
4. Each of the above

1-3. Which of the following statements concerning safety precautions is correct?

1. All applicable safety precautions should be committed to memory
2. A person should not worry about safety precautions because mishaps can and will happen
3. Safety precautions are designed primarily for persons who are unfamiliar with their equipment
4. It is important to understand the meanings of and reasons for safety standards

1-4. Which of the following publications specifically contains general shipboard safety precautions?

1. OPNAVINST 3120.32B
2. OPNAVINST 5100.19E
3. OPNAVINST 5100.23G
4. NAVEDTRA 10808-2

1-5. What color are (a) warning signs and (b) caution signs?

1. (a) Blue (b) green
2. (a) Green (b) blue
3. (a) Yellow (b) red
4. (a) Red (b) yellow

1-6. When are danger shock hazard signs used?

1. Where voltages are below 30 volts
2. Where voltages are between 30 and 100 volts only
3. Where voltages are between 30 and 500 volts
4. Where voltages are above 500 volts only

1-7. Warning plates are installed in small craft to warn personnel of what potential hazard?

1. Explosive vapors
2. High voltages
3. Wet decks
4. Oily decks

1-8. What color are (a) CAUTION tags and (b) DANGER tags?

1. (a) Red (b) yellow
2. (a) Yellow (b) red
3. (a) Red (b) orange
4. (a) Orange (b) yellow

1-9. When are CAUTION tags used?

1. When DANGER tags are not available
2. When equipment is secured for repairs
3. When temporary special instructions or unusual caution must be exercised to operate equipment
4. When operation of equipment could present a small danger to personnel

1-10. When are DANGER tags used?

1. When operation of equipment could injure personnel or damage equipment
2. When authorized by the commanding officer
3. When two or more repair groups are working on the same system
4. When repairing a major system

1-11. Which of the following statements is true concerning an instrument that is labeled OUT-OF-CALIBRATION?

1. It should be used with extreme caution
2. It should not be used
3. It should be repaired
4. It should be replaced

1-12. After a tag has been installed on a piece of equipment and the reason for the tag-out has been remedied, which of the following individuals may authorize the removal of the tag?

1. The division officer responsible for the equipment
2. The damage control assistant
3. The authorizing officer
4. The officer of the deck

1-13. Permission to work on an energized circuit must be approved by what person?

1. The engineering officer of the watch
2. The electrical officer
3. The engineer officer
4. The commanding officer

1-14. When you are working on energized equipment, which of the following safety precautions should you observe?

1. Be sure the equipment is grounded
2. Wear rubber boots
3. Make sure that a person qualified to administer mouth-to-mouth ventilation and cardiac massage is in the immediate area
4. Make sure that an insulated rope is tied around the worker’s wrist

1-15. What type of electrical distribution systems are found on Navy ships?

1. Grounded
2. Ungrounded
3. Resistively grounded
4. Capacitively ungrounded

1-16. Isolated receptacle circuits are designed to limit ground leakage currents to how many milliamperes?

1. 1
2. 10
3. 100
4. 1000

1-17. When checking continuity between the equipment and the ship's hull on a piece of equipment that uses a ground strap, what reference should you use to determine the allowable resistance to ground?

1. OPNAVINST 3120.3B
2. Manufacturer's technical manual
3. PMS card
4. Fathom

1-18. Why must you short-circuit the secondary of a current transformer before you disconnect the meter?

1. To prevent damage to the primary circuit
2. To prevent blowing the meter fuses
3. To prevent overloading the circuit
4. To prevent an extremely high voltage buildup

1-19. When, if ever, is it permissible to block open an interlock switch on a piece of equipment?

1. When performing PMS
2. When performing corrective maintenance
3. When authorized by the commanding officer for operational reasons
4. Never

1-20. To discharge capacitors in de-energized equipment, which, if any, of the following devices should you use?

1. A safety shorting probe
2. A ground strap
3. A screwdriver
4. None of the above

1-21. What class of rubber gloves should be selected if a person is to work around a piece of equipment rated at 5000 volts?

1. I
2. II
3. III
4. 0

1-22. When installing rubber floor matting, you should ensure there are no seams within what minimum distance of an electrical hazard?

1. 1 in.
2. 1 ft
3. 3 in.
4. 3 ft

1-23. Which of the following statements is correct?

1. Safety is unimportant in the use of power tools
2. Electrical power tools do not require cleaning or lubrication
3. Replace promptly any cable that has tears, chafing or exposed conductors, and any damaged plug
4. Metal electrical power tools do not require grounding

1-24. Why should a dummy outlet be installed near a workbench?

1. To test the grounding conductors on portable power tools
2. To serve as an extra test bench receptacle
3. To furnish power at frequencies other than the service frequencies of the ship
4. To furnish power at voltages other than the service voltages of the ship

1-25. What is an acceptable resistance reading for the ground connection between the ship's hull and metal frame of a portable electric drill?

1. Less than 1 ohm
2. 1 ohm or less
3. More than 1 ohm but less than 10 ohms
4. 10 ohms

1-26. Under normal usage, the maximum length of an extension cord used with portable tools should NOT exceed what total number of feet?

1. 25
2. 50
3. 75
4. 100

1-27. The current coil of a wattmeter or an ammeter must be connected in what way?

1. In parallel with the load
2. Across the power source terminals
3. In series with the load
4. In series with a shunt

1-28. In signal generators and oscilloscopes, how are the effects of moisture minimized?

1. By the storage box
2. By the cloth cover
3. Both 1 and 2 above
4. By the built-in heaters

1-29. Before being used on electronic equipment, metallic tools should be insulated by wrapping with what material?

1. Several layers of rubber or vinyl plastic tape
2. Two layers of rubber or vinyl plastic tape, half-lapped
3. Three layers of rubber or vinyl plastic tape, half-lapped
4. Four layers of rubber or vinyl plastic tape, half-lapped

1-30. To clean a soldering iron of excessive solder, which of the following procedures should you use?

1. Shake the soldering iron
2. Wipe the soldering iron across a piece of canvas
3. Wipe the soldering iron across a damp sponge
4. Use a brush

1-31. If cared for properly, lead-acid storage batteries should last for what maximum period of time?

1. Less than 1 year
2. 1 or 2 years
3. 3 years
4. 4 or more years

1-32. The charging rate of a lead-acid storage battery being charged should be lowered under which of the following circumstances?

1. If the battery begins to gas
2. If the temperature of the battery reaches 125°F (52°C)
3. Both 1 and 2 above
4. When the battery has finished charging

1-33. What is the proper procedure for mixing electrolyte?

1. Pour the acid slowly into the water
2. Pour the acid quickly into the water
3. Pour the water slowly into the acid
4. Pour the water quickly into the acid

1-34. Where are alkaline storage batteries used?

1. Emergency supply for gyrocompasses
2. Emergency supply for automatic telephone exchanges
3. Bus failure alarms
4. Test equipment

1-35. Dry-cell batteries should be removed when the equipment they are used with is going to remain idle for what minimum length of time?

1. 1 wk
2. 2 wk
3. 1 mo
4. 2 yr

1-36. To remove large fragments of a broken radioactive tube, which, if any, of the following items should you use?

1. Forceps
2. Wet cloth
3. Vacuum cleaner
4. None of the above

1-37. Why should you always be extremely cautious when handling a CRT?

1. Because its glass envelope encloses a radioactive gas
2. Because its glass envelope encloses a compressed gas that may escape rapidly through the glass seal
3. Because its glass envelope encloses a high vacuum and may implode under atmospheric pressure
4. Because its glass envelope encloses a high pressure and may explode in direct sunlight

1-38. Before disposing of a CRT, you should break off the tip of the glass vacuum seal with what device?

1. Pliers
2. Screwdriver
3. Forceps
4. Hammer

1-39. What is the proper method for disposing of aerosol dispensers?

1. Puncture the dispenser
2. Burn in an incinerator
3. Break off the nozzle
4. Put in an approved waste receptacle

1-40. Which of the following solvents should NEVER be used for cleaning electrical equipment?

1. Water-based solvents
2. Inhibited methyl chloroform
3. 1, 1, 1-trichloroethane
4. Carbon tetrachloride

1-41. What is the preferred grade of insulating varnish used in the Navy?

1. CA
2. CB
3. CC
4. CD

1-42. Which of the following materials should NEVER be used to clean contacts?

1. Emery cloth/paper
2. Silver polish
3. Sandpaper
4. Burnishing tools

1-43. Before going aloft, personnel must obtain written permission from which of the following persons?

1. The electrical officer
2. The engineer officer
3. The officer of the deck
4. The ship's Boatswain's Mate

1-44. When working aloft aboard ship, you must always be equipped with which of the following items?

1. Special gloves
2. A sound-powered telephone
3. A safety harness and safety lanyard
4. A life preserver

1-45. Which of the following personal electrical equipment is authorized for use aboard ship?

1. Electric shavers
2. Electric heating pads
3. Electric fans
4. Electric tools

1-46. A fire breaks out in a piece of electrical equipment. What is the first thing you should do?

1. Sound an alarm
2. Secure all ventilation to the space
3. De-energize the piece of equipment
4. Attack the fire with the nearest extinguishing agent

1-47. What type of fire-extinguishing agent should be used on an electrical fire?

1. Potassium bicarbonate (PKP)
2. Soda acid
3. Carbon dioxide (CO_2)
4. Foam

1-48. Low-voltage (115 volts and below) circuits are NOT dangerous because they do not cause death.

1. True
2. False

1-49. The victim of electrical shock by a portable drill should be freed of contact with the drill as quickly as is safely possible for the rescuer. Which of the following is a quick and safe way to free the victim?

1. Turn the drill switch off
2. Cut the drill’s power cable
3. Pull the fuses at the distribution box
4. Unplug the drill

1-50. A fireman suffers an electrical shock caused by contact with stationary equipment that CANNOT be de-energized quickly. In pulling the person free of contact with the equipment, under dry conditions, how should you take hold of the victim?

1. By one arm or one leg
2. By one arm and one leg
3. By both arms or both legs
4. With your own belt without the buckle

1-51. What is the purpose of artificial ventilation?

1. To restore the heart's function
2. To provide a method of air exchange
3. To clear an upper air passage obstruction
4. To clear a lower air passage obstruction

1-52. Artificial ventilation should be administered to which of the following persons?

1. One who has received an electrical shock and is breathing shallow
2. One who is knocked unconscious from an electrical shock and is bleeding
3. One who has been rescued from an electrical shock and has a fast pulse
4. One who has stopped breathing naturally due to an electrical shock

1-53. To be effective, cardiopulmonary resuscitation (CPR) must be started within what maximum length of time after a victim has suffered a cardiac arrest?

1. 5 minutes
2. 6 minutes
3. 3 minutes
4. 4 minutes

1-54. A wound that is often complicated by crushing of the tissues is classified as what type of wound?

1. A laceration
2. An incision
3. An abrasion
4. A puncture

1-55. When the direct-pressure method is used on a victim and fails to stop the bleeding, what action should you take?

1. Apply a tourniquet
2. Use the pressure point method only
3. Use both the direct-pressure method and the pressure-point method
4. Wait for trained medical personnel to arrive

1-56. What burns are for the most part NOT caused by heat?

1. Radiation
2. Chemical
3. Electrical
4. Thermal

1-57. What is the most important factor in determining the seriousness of a burn?

1. The extent of the body surface burned
2. The cause of the burn
3. The depth of the burn
4. The degree of the burn

1-58. Which of the following is a characteristic symptom of a second-degree burn?

1. Reddened skin
2. Blistered skin
3. Charred skin
4. Mild pain

1-59. Hazardous noise areas are areas that produce continuous and intermittent sound levels greater than what minimum level?

1. 54 dB(A)
2. 64 dB(A)
3. 74 dB(A)
4. 84 dB(A)

1-60. A worker should wear double hearing protection when working around noise sources above what minimum sound level?

1. 94 dB(A)
2. 100 dB(A)
3. 104 dB(A)
4. 140 dB(A)

1-61. Exposure of personnel to excessive heat, humidity, and thermal radiation while under a continued work load can result in which of the following conditions?

1. Heat stress
2. Heat stroke
3. Heat exhaustion
4. Each of the above

1-62. A heat stress survey must be ordered when the temperature in a space exceeds what minimum level?

1. 80°F
2. 90°F
3. 100°F
4. 110°F

Textbook Assignment: Chapter 2. “Switches, Protective Devices, and Cables.

ASSIGNMENT 2

2-1. To what does the rating of a switch refer?

1. The numbers of poles and throws
2. The numbers of poles and positions
3. The minimum allowable voltage and current of the circuit in which the switch is to be used
4. The maximum allowable voltage and current of the circuit in which the switch is to be used

2-2. Switch contacts should be opened and closed slowly to minimize arcing.

1. True
2. False

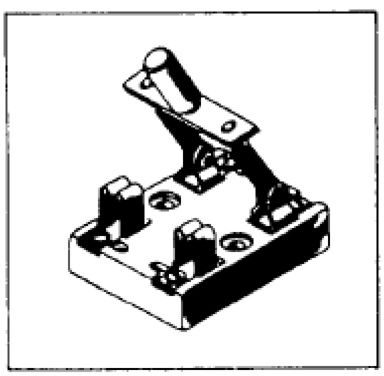

Figure 2A

IN ANSWERING QUESTION 2-3, REFER TO FIGURE 2A.

2-3. The single-throw switch has what total number of poles?

1. One
2. Two
3. Three
4. Four

2-4. What are the (a) voltage and (b) amperage ratings of the various types of toggle switches?

1. (a) 20 volts to 600 volts (b) 1 amp to 30 amps
2. (a) 10 volts to 500 volts (b) 10 amps to 50 amps
3. (a) 1 volt to 300 volts (b) 1 amp to 300 amps
4. (a) 5 volts to 400 volts (b) 20 amps to 600 amps

2-5. What is the normal contact arrangement of a push-button switch?

1. Make type
2. Break type
3. Either 1 or 2 above, depending on the type of switch
4. Make-break type

2-6. What does the first number in a rotary snap switch designation indicate?

1. The number of poles
2. The current rating
3. The switching action
4. The mounting style

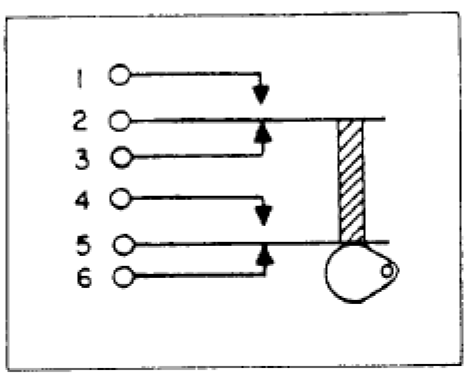

Figure 2B

IN ANSWERING QUESTION 2-7, REFER TO FIGURE 2B.

2-7. When the switch is operated, what terminals are connected together?

1. 2 and 3; 5 and 6
2. 1 and 3; 4 and 6
3. 1 and 2; 4 and 5
4. 1 and 2; 4 and 6

2-8. A type J multiple rotary switch with five sections has what total number of (a) stationary contacts and (b) movable contacts?

1. (a) 8 (b) 2
2. (a) 2 (b) 8
3. (a) 40 (b) 10
4. (a) 10 (b) 40

2-9. In the type 3JR switch, what total number of movable wiper contacts are there per section?

1. One
2. Two
3. Three
4. Four

2-10. What is the purpose of the stop deck of a JR switch?

1. It enables the switch to be installed with a non-uniform number of sections
2. It enables the switch to be connected to an independent source of ac power
3. It enables the switch to be set to a desired number of positions
4. It enables the switch to be used on dc circuits only

2-11. How does the JL switch compare to the JR switch?

1. The JR switch deck is smaller in diameter than the JL switch deck
2. The JL switch deck is larger in diameter than the JR switch deck
3. The JL switch is rated the same as the JR switch
4. The mounting of the JR switch is different than the JL switch

2-12. What kind of contacts are used in JA switches?

1. Silver-to-brass
2. Silver-to-bronze
3. Silver-to-copper
4. Silver-to-silver

2-13. The JF switch replaces what type of switch?

1. JR
2. Toggle
3. JA
4. Push-button

2-14. What type of interiors are used in most lever-operated switches?

1. J
2. JR
3. JA
4. JF

2-15. What means is used to distinguish the collision alarm switches on a submarine?

1. A round head
2. A square head
3. A star-shaped head
4. A triangle-shaped head

2-16. How is a typical pressure-operated switch similar to a typical temperature-operated switch?

1. Both are single-pole, single-throw, and quick-acting switches
2. Both contain a bellows or diaphragm that works against an adjustable spring
3. Both contain contacts that are closed automatically by an adjustable spring when a preset value of the operating condition is reached
4. Each of the above

2-17. How is the operating point of a cam-operated mechanical switch varied?

1. By adjusting the angular positions of the cams with respect to the shaft
2. By adjusting the position of the microswitch in relation to the cam
3. By adjusting the length of the lever arm
4. By adjusting the contact gap of the microswitch

2-18. How many pairs of terminals are used in water switches?

1. One
2. Two
3. Six
4. Four

2-19. How is the liquid-level float switch changed from normally open to normally closed?

1. By interchanging the connections
2. By replacing the encapsulated reed switch
3. By turning over the magnetic core
4. By turning over the encapsulated reed switch

2-20. Which of the following troubles is caused by excessive tightening of the packing gland nut on a watertight rotary switch?

1. Improper positioning of the switch
2. Warped seal
3. Scored shaft
4. Each of the above

2-21. When servicing a pair of copper contacts (one slightly burned, the other badly burned), which of the following procedures should you follow?

1. Replace both contacts
2. Clean both contacts with emery cloth
3. Replace the badly burned contact, and clean the other contact with fine sandpaper
4. Replace the badly burned contact, and clean the other contact with emery cloth

2-22. You should NOT attempt to remove the tarnish that forms on silver contacts for which of the following reasons?

1. Because you could damage the contacts
2. Because removal will cause the contacts to arc excessively
3. Because the tarnish improves the operation of the contacts
4. Because tarnished contacts should always be replaced not cleaned

2-23. What should you use to dress small light contacts?

1. A cloth moistened with an approved solvent
2. An approved lubricant
3. An emery cloth
4. A burnishing tool

2-24. How is the coil of a relay that is designed for shunt connection wound?

1. With a large number of turns of small wire
2. With a small number of turns of large wire
3. With a large number of turns of large wire
4. With a small number of turns of small wire

2-25. What is the purpose of the shorted turn used in ac relays?

1. To reduce heating
2. To reduce eddy currents
3. To reduce inductive reactance in the relay coil
4. To reduce chatter

2-26. How are control relays classified?

1. Open
2. Semi-sealed
3. Sealed
4. Each of the above

2-27. What causes the bimetallic strips of a thermal relay to bend when heat is applied?

1. Expansion of the restore spring
2. Magnetic induction
3. Difference in expansion rates of the strips
4. Lag coil or slug influencing their magnetic properties

2-28. What two windings are used in a latch-in relay?

1. Trip coil and the set coil
2. Set coil and the reset coil
3. Reset coil and the trip coil
4. Latch coil and the unlatch coil

2-29. To close the contacts of an ac shunt relay, a voltage must be applied to what component(s)?

1. The operating coil
2. The magnetic frame
3. The armature
4. The main contacts

2-30. What type of relay has multiple sets of contacts?

1. Clapper
2. Thermal time delay
3. Latch-in
4. AC shunt

2-31. What total number of adjustments are there on a two-coil, series-type relay?

1. One
2. Two
3. Three
4. Four

2-32. What type of relays are also known as contractors?

1. Series
2. Shunt
3. Control
4. Power

2-33. The “cone and crater” effect that is associated with relay contacts is caused by what condition?

1. Current flowing in two directions through the relay
2. Dust collecting on the contacts
3. Current flowing in one direction through the relay
4. Rounding of flat contacts

2-34. When one of the contacts of a shunt relay is badly pitted, what action should you take?

1. Replace the relay
2. Replace the pitted contact
3. Replace the contacts
4. Dress the contacts

2-35. What should you use to clean relay contacts?

1. A burnishing tool
2. An emery cloth
3. Sandpaper
4. A file

2-36. When the relay contact springs are bent during cleaning, what action should you take?

1. Straighten the contact springs with long-nosed pliers
2. Straighten the contact with a point bender
3. Replace the contacts
4. Replace the relay

2-37. The magnetomotive force of a solenoid depends on which of the following factors?

1. The magnitude of current flowing through the coil
2. The number of turns of wire in the coil
3. The flux density of the core
4. Each of the above

2-38. Solenoids are used for which of the following reasons?

1. To convert electrical energy into mechanical motion
2. To convert mechanical motion into electrical energy
3. To replace relays
4. To replace switches

2-39. What is the second step in checking an improperly operating solenoid?

1. Check for opens
2. Check for grounds
3. Check the energizing voltage
4. Make a good visual inspection

2-40. What is the maximum rating of a fuse that may be used on one associated group of an A-call circuit whose rated load is 9.1 amperes?

1. 5 amp
2. 10 amp
3. 15 amp
4. 20 amp

2-41. What type of fuse holder will hold two fuses?

1. EL-1
2. FHL10G
3. FHl11G
4. FHL12G

2-42. In replacing a blown fuse, which of the following procedures should you follow?

1. Short circuit the fuse
2. Open the switch to the circuit
3. Wear rubber gloves
4. Replace with a fuse of larger current capacity

IN ANSWERING QUESTION 2-43, REFER TO FIGURE 2-31 IN YOUR TEXTBOOK.

2-43. What is the purpose of fuses F1, F2, and F3?

1. To protect branch No. 1
2. To isolate branches No. 2 and No. 3
3. To protect the load
4. To protect the main feeder supply

2-44. Chemicals and solvents come in what type of form of gas, vapor, mist, dust, or fumes?

1. Gas, vapor, mist dust and fumes
2. Gas, vapor and fumes
3. Vapor, mist and dust
4. Mist dust and fumes

2-45. When cleaning electrical equipment with a cleaning solvent, equipment should be warm or hot to increase the cleaning power of the solvent.

1. True
2. False

2-46. When should you review the MSDS (Material Safety Data Sheet)

1. After using a cleaning solvent
2. Before starting any equipment that has been cleaned with a cleaning solvent
3. Before using any cleaning solvent
4. Only when is require for a PMS

2-47. When should you repaint electrical equipment or enclosure?

1. Before any Commanding Officer inspection
2. To improve appearances of the equipment
3. Every two years
4. When necessary to ward off corrosion

2-48. Who should you obtain permission before working aloft inport?

1. OOD
2. OOD and CDO
3. OOD and LPO
4. None of the above

2-49. When operating a portable CO2 extinguishers you should grasp the horn handle by the insulated (thermal) grip.

1. To maintain control of the extinguisher
2. To activate the CO2 before extinguish the fire
3. The grip is insulated against possible frostbite of the hand.
4. None of the above

2-50.Soda-Acid extinguisher is best used for what type of fire?

1. Alpha
2. Bravo
3. Charlie
4. Delta

2-51. When you consider the manner in which the skin or tissue is broken, what are the general kinds of wounds?

1. Abrasions and incisions
2. Incisions and lacerations
3. Lacerations and punctures
4. All of the above

2-52. Areas and equipment that produce continuous and intermittent sound levels greater than 64 dB (A) or impact or impulse levels of 120 dB peak are considered hazardous.

1. True
2. False

2-53. Heat stress can cause poor mental and physical performance.

1. True
2. False

Textbook Assignment: Chapter 3, “Power Distribution, IC Switchboards, and Controllers.

ASSIGNMENT 3

3-1. IC systems that are essential to the safety of the ship and ship personnel are assigned what readiness classification?

1. Class 1
2. Class 2
3. Class 3
4. Class 4

3-2. What is the importance classification of an IC system that, if disabled, would seriously impair the fighting effectiveness and maneuverability of the ship?

1. Un-vital
2. Nonvital
3. Semivital
4. Vital

3-3. What are the three permanently installed power distribution systems aboard ship?

1. Ship’s service, casualty, and lighting
2. Lighting, ship’s service, and emergency
3. Casualty, emergency, and lighting
4. Emergency, casualty, and ship’s service

3-4. Bus ties on ship’s service distribution switchboards serve what function?

1. They allow power distribution direct from generator to load
2. They feed power to the dc generators
3. They allow generators to operate in series
4. They permit any switchboard to feed power to any other switchboard

3-5. The majority of ac power distribution systems in naval ships have which of the following characteristics?

1. 220 volts, single phase, 60 HZ
2. 220 volts, single phase, 400 Hz
3. 450 volts, 3 phase, 60 Hz
4. 450 volts, 3 phase, 400 Hz

3-6. When all electrical power is lost, the emergency generator is designed to start within what time period?

1. 1 sec
2. 10 sec
3. 1 min
4. 10 min

3-7. The emergency switchboard system is normally energized from what source?

1. The after emergency diesel
2. The forward emergency diesel
3. The alternate source of ship’s service power
4. The preferred source of ship’s service power

3-8. Casualty power bulkhead terminals are permanently installed on opposite sides of the bulkheads for what reason?

1. To permit selected equipment to receive casualty power
2. To permit transmission of power through compartments without the loss of watertight integrity
3. To permit transmission of power through decks
4. To permit phase checking for proper polarity

3-9. What is the main purpose of the casualty power system?

1. To make temporary connections to vital circuits
2. To make permanent connections to vital equipment
3. To make permanent connections to vital circuits
4. To make temporary connections to furnish power to ac generators

3-10. What is the proper procedure for rigging casualty power cables?

1. From source to load
2. From source to source
3. From load to source
4. From load to load

3-11. Most IC switchboards are normally energized by which of the following power supplies?

1. Normal and casualty power
2. Alternate and casualty power
3. Normal and emergency power only
4. Normal, alternate, and emergency power

3-12. Which of the following statements best describes a front-service main IC switchboard?

1. Terminal board inspection is accomplished through the rear access panel
2. Operation and maintenance are accomplished from the front of the switchboard
3. Maintenance is accomplished through the rear and side access panels
4. Operation and maintenance are accomplished from three sides of the switchboard

3-13. What panel in the power distribution section of the main IC switchboard supplies dc power to various IC circuits?

1. Panel 1
2. Panel 2
3. Panel 3
4. Panel 4

3-14. What are the functions of the ACO section of the main IC switchboard?

1. Isolation and transfer control of certain IC systems
2. Isolation and control of IC systems
3. Integration and operation of all IC systems
4. Integration and operation of special IC systems

3-15. When are ABTs used to transfer power supplies?

1. Upon loss of preferred power
2. Upon loss of emergency power
3. Upon loss or restoration of preferred power
4. Upon loss of alternate power

3-16. To test the automatic transfer capability of an ABT, the control disconnect switch must be in what position?

1. NORMAL
2. AUTO
3. MANUAL
4. EMERGENCY

3-17. Which of the following types of switches are usually found on IC switchboards?

1. Toggle and rotary
2. JL
3. JR
4. Each of the above

3-18. What is the power source for the type IC/E1D1 electronic signal unit?

1. A nickel-cadmium battery
2. 115 volts dc
3. 115 volts ac, 60 Hz
4. 115 volts ac, 400 Hz

3-19. When you operate an ACO transfer switch, what causes the overload indicator light to flash?

1. An open rotor circuit
2. A momentary displacement between the transmitter and receiver
3. A shorted rotor circuit
4. An open or shorted stator circuit

3-20. The engine-room local IC switchboard receives its emergency power supply from what source?

1. The nearest main IC switchboard
2. The nearest emergency switchboard
3. The nearest ship's service switchboard
4. The local emergency lighting circuit

3-21. Inspection of de-energized equipment should be limited to visual examination only and should not include touching and shaking of electrical connections.

1. True
2. False

3-22. What should you use to clean the panels of live front switchboards?

1. A cloth dampened in soapy water
2. A cloth dampened in clear water
3. A dry cloth
4. A cloth dampened in a cleaning solution

3-23. When inspecting an IC switchboard, which of the following components should you inspect?

1. Rheostats
2. Meters
3. Fuses
4. All of the above

3-24. Bus transfer equipment should be tested a minimum of how often?

1. Daily
2. Weekly
3. Monthly
4. Yearly

3-25. Circuit breakers should be carefully inspected a minimum of how often?

1. Daily
2. Weekly
3. Monthly
4. Yearly

3-26. Silver-alloy contacts must be replaced if slight burning, pitting, or erosion is found.

1. True
2. False

3-27. Ship’s force personnel may not make repairs on which of the following components?

1. Bolt-on parts
2. Attachments
3. Subassemblies
4. Meters

3-28. Under normal conditions, the motor generator set and control equipment should be inspected and cleaned according to what guidelines?

1. At least yearly
2. At least monthly
3. IAW the MRCs
4. IAW the technical manual

3-29. Suction cleaning of motors and generators is preferred to other methods because it lessens the possibility of damage to which of the following components?

1. Brushes
2. Insulation
3. Commutators
4. Soldered parts

3-30. You should use air pressure up to 30 psi to clean out motors and generators of what maximum rated (a) horsepower or (b) kilowatts?

1. (a) 50 (b) 50
2. (a) 25 (b) 30
3. (a) 60 (b) 70
4. (a) 90 (b) 100

3-31. Which of the following factors determines the grade of brush used in a motor or generator?

1. The time in service
2. The size of the motor or generator
3. The load and speed of the motor or generator
4. Each of the above

3-32. When should you install new brushes in a generator or motor?

1. When the brushes have enclosed shunts
2. When the brushes have a polished surface
3. When the brushes are worn to within 1/8 inch of the metallic parts
4. When the polarity of the brushes is reversed

3-33. To calculate brush pressure, you should use which of the following methods?

1. Subtract the spring pressure from the brush contact area
2. Subtract the brush contact area from the spring pressure
3. Divide the brush contact area by the spring pressure
4. Divide the spring pressure by the brush contact area

3-34. When seating a brush, you should use sandpaper and what other equipment?

1. An oil stone
2. A brush seater
3. Emery paper
4. A file

3-35. When seating a brush you should place the sandpaper between the brush and the commutator with the rough side toward (a) what component and (b) pull in what direction?

1. (a) The brush
   (b) direction of rotation
2. (a) The commutators
   (b) opposite the direction of rotation
3. (a) The commutator
   (b) direction of rotation
4. (a) The brush
   (b) opposite the direction of rotation

A. Use No. 0 sandpaper

B. Use the brush seater at the heel of the brush

C. Use No. 1 sandpaper

D. Vacuum the carbon dust from the commutator

E. Vacuum the white powder from the brush holders and windings

Figure 3A

IN ANSWERING OUESTION 3-36, REFER TO THE PROCEDURAL STEPS FOR SEATING BRUSHES SHOWN IN FIGURE 3A.

3-36. Which of the following is the proper sequence for seating brushes?

1. A, C, D, B, E
2. C, B, A, D, E
3. A, C, B, D, E
4. C, A, D, B, E

3-37. To complete the job of seating the motor brushes, you should perform which of the following steps?

1. Pull a finer strip of sandpaper between the brush and the commutator once or twice, vacuum the dust that results, and clean the heel of the commutator
2. Turn the sandpaper over, sandpaper again, and touch the seater to the heel of the brush for a second or two
3. Touch the seater to the commutator for one or two seconds, vacuum the dust that results, and clean the commutator
4. Lift the brush, insert the seater between the brush and commutator for a second or two, and clean the commutator

Textbook Assignment: Chapter 4, “Gyrocompass Systems.

ASSIGNMENT 4

4-1. The supporting rings of a gyroscope are known as:

1. gimbals
2. axles
3. bearings
4. rotors

4-2. How are the X, Y, and Z axes related to each other?

1. They are vertical to each other
2. They are parallel to each other
3. They are horizontal to each other
4. They are perpendicular to each other

4-3. A gyroscope rotor has how many degrees of freedom?

1. One
2. Two
3. Three
4. Four

4-4. What two properties make it possible to convert a free gyroscope into a gyrocompass?

1. Precession and rigidity of plane
2. Spin and tilt
3. Tilt and turn
4. Rigidity of plane and spin

4-5. If the case of a spinning gyroscope is tilted to the left, what, if anything, will happen to the rotor axle?

1. It will tilt to the left
2. It will tilt to the right
3. It will point in the same direction as the case
4. Nothing, it will not change direction

4-6. How can a gyroscope be made more rigid?

1. By concentrating most of the rotor weight away from the circumference
2. By making the rotor spin slower
3. By making the rotor lighter
4. By concentrating most of the rotor weight near the circumference

4-7. How does a gyro react to the application of torque?

1. It will move at left angles to the direction of torque
2. It will move at right angles to the direction of torque
3. It will spin faster
4. It will spin slower

4-8. If force is applied to the wheel of a spinning gyroscope, where will this force be felt?

1. At the point it is applied
2. At a point 45° away in the opposite direction of rotation
3. At a point 90° away in the direction of rotation
4. At a point 90° away in the opposite direction of rotation

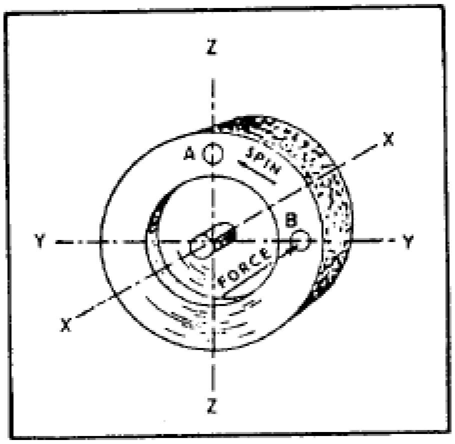

Figure 4A

IN ANSWERING QUESTION 4-9, REFER TO FIGURE 4A.

4-9. In the figure, in what direction will point A move?

1. About the Y axis in the direction of the applied force
2. About the Y axis opposite to the direction of the applied force
3. About the Z axis in the direction of the applied force
4. About the Z axis opposite to the direction of the applied force

4-10. Force of translation is best described by which of the following phrases?

1. Any force operating through the vertical axis
2. Any force caused by precession around the horizontal axis
3. Any force operating through the tilt axis
4. Any force operating through the center of gravity

4-11. A free-spinning gyroscope is located at a point on the equator during a 24-hour period. What will be the apparent effect of the earth's rotation on the gyroscope, as seen from the South Pole?

1. The gyroscope will make a complete clockwise revolution about its vertical axis
2. The gyroscope will make a complete clockwise revolution about a horizontal axis
3. The gyroscope will make a complete counterclockwise revolution about its vertical axis
4. The gyroscope will make a complete counterclockwise revolution about a horizontal axis

4-12. An observer is located in space above a free-spinning gyroscope located at the North Pole. What will be the apparent effect of the earth's rotation on the gyroscope during a 24-hour period of time?

1. The gyroscope will make a complete clockwise revolution about a horizontal axis
2. The gyroscope will make a complete counterclockwise revolution about a horizontal axis
3. The gyroscope will remain stable while the earth will appear to rotate under it
4. The gyroscope will make a complete counterclockwise revolution about its vertical axis

4-13. You are observing a free-spinning gyroscope with the spinning axis not parallel to the earth's axis. What is the effect of the earth's rotation during the part of the day that the north end of the gyroscope axle points to the east of the meridian?

1. The north end moves up
2. The south end moves up
3. The east end moves up
4. The west end moves up

4-14. To make a free gyroscope into a gyrocompass, what must you do?

1. Make the gyro axle point to the North Pole
2. Keep the gyro axle nearly horizontal
3. Both 1 and 2 above
4. Point the gyro axle to the east or west

4-15. How is the gyroscope made north seeking?

1. By adding a nonpendulous weight to the bottom of the vertical ring
2. By adding a nonpendulous weight to the phantom ring
3. By adding a pendulous weight to the phantom ring
4. By adding a pendulous weight to the bottom of the vertical ring

4-16. How is the gyroscope made north indicating?

1. By adding a smaller weight on the east side of the rotor
2. By adding a larger weight on the east side of the rotor
3. By adding a smaller weight on the west side of the rotor
4. By adding a larger weight on the west side of the rotor

4-17. How is the basic gyrocompass made to function properly over a wide range of latitudes?

1. By stabilizing it with respect to the earth’s surface
2. By damping out the effects of ship’s acceleration
3. By damping out the effects of ship’s deceleration
4. All of the above

4-18. What does the mark (Mk) indicate in the designation of a gyrocompass?

1. A major development of a compass
2. A minor development of a compass
3. Change to a major development of a compass
4. Change to a minor development of a compass

4-19. The Mk 23 Mod 0 gyrocompass system uses a gravity reference which generates what kind of signal?

1. One that is inversely proportional to the speed of the gyro rotor
2. One that is inversely proportional to the tilt of the gyro axle
3. One that is directly proportional to the speed of the gyro rotor
4. One that is directly proportional to the tilt of the gyro axle

4-20. The Mk 23 Mod 0 gyrocompass element has how many degrees of freedom about the pitch and roll axes?

1. ± 45°
2. ± 70°
3. ± 85°
4. ± 90°

4-21. Which of the following components is NOT found in the control cabinet?

1. The follow-up amplifier
2. The alarm control unit
3. The power supply
4. The control amplifier

4-22. What is the speed range of the speed unit?

1. 0 to 10 knots
2. 0 to 20 knots
3. 0 to 40 knots
4. 0 to 100 knots

4-23. Under normal conditions, what is the status of the lamp on the visual indicator?

1. It lights continuously
2. It flashes continuously
3. It is out
4. It flashes momentarily

4-24. In what location will you find the instruction plate that has a summary of the procedure for starting and securing the gyrocompass under normal conditions?

1. Top of the master unit
2. Front of the master unit
3. Top of the control cabinet
4. Front of the control cabinet

4-25. How many modes of gyrocompass operation are there?

1. One
2. Two
3. Three
4. Four

4-26. Before a compass is needed for service, as a minimum, how far ahead of time should you start it?

1. 30 min
2. 60 min
3. 75 min
4. 120 min

4-27. Before you start the compass, what should be the respective settings of the power and operation switches?

1. GYRO and UNCAGE
2. GYRO and LEVEL
3. OFF and SETTLE
4. OFF and CAGE

4-28. During the preliminary procedure for operating the gyrocompass, in what order do you set the latitude switch, latitude dial, and speed unit?

1. Latitude dial, latitude switch, and speed unit
2. Latitude dial, speed unit, and latitude switch
3. Latitude switch, latitude dial, and speed unit
4. Latitude switch, speed unit, and latitude dial

4-29. After you complete the preliminary procedure for operating the gyrocompass, what should be your first step in the starting procedure?

1. Position the power switch to AMPL’S
2. Position the power switch to FIL’S
3. Position the power switch to GYRO
4. Set the ship’s heading on the compass card

4-30. Before you place the operation switch in the NORMAL position, it should be left in the SETTLE position for what length of time?

1. 10 to 20 min
2. 20 to 30 min
3. 30 to 40 min
4. 40 to 60 min

4-31. If the power to the compass fails, in what position should you place the (a) power switch and (b) operation switch?

1. (a) ON (b) CAGE
2. (a) OFF (b) UNCAGE
3. (a) FIL’S (b) UNCAGE
4. (a) FIL’S (b) CAGE

4-32. What is the normal procedure for shutting down the compass?

1. Set the power switch to OFF, wait 30 minutes, then place the operation switch to CAGE
2. Set the operation switch to CAGE, wait 10 seconds, then turn the power switch to OFF
3. Set the operation switch to UNSETTLE, wait 30 to 40 minutes, then turn the power switch to OFF
4. Set the power switch to OFF, then without waiting, turn the operation switch to UNCAGE

4-33. How much of a change in ship's latitude requires you to manually correct the setting on the latitude dial?

1. 1°
2. 2°
3. 1 1/2°
4. 1/2°

4-34. Which of the following is NOT a normal operating condition for the compass?

1. The master unit being lukewarm
2. The tilt indicator pointer oscillating evenly about the zero position
3. The corrector failure and follow-up failure lamps lighted
4. The speed dial indicating zero knots during directional gyro operation

4-35. What information is contained in the gyrocompass log?

1. Compass conditions and available power sources
2. Name and rate of the gyrocompass technician
3. Date the gyrocompass was installed on the ship
4. Recommendations for future reference

4-36. How are many additional units, if any, used with the Mk 23 Mod C-3 gyrocompass system that are NOT used with the Mk 23 Mod 0?

1. One
2. Two
3. Three
4. None

4-37. Prior to starting the Mk 23 Mod C-3 gyrocompass, the switch on the power supply control unit must be in what position?

1. START
2. STOP
3. ON
4. OFF

4-38. The Mk 27 gyrocompass is designed to operate on which of the following voltages?

1. 115 volts, 60 hertz, single phase
2. 115 volts, 400 hertz, single phase
3. 24 volts dc
4. Each of the above

4-39. What is used to make the compass north-seeking?

1. A liquid ballistic filled with mercury
2. A liquid ballistic filled with refined silicone oil
3. A liquid ballistic filled with lukewarm water
4. A liquid ballistic filled with special gases

4-40. Where is the instruction plate for starting and securing the compass located?

1. Near the electronic control cabinet
2. On the front of the electronic control cabinet
3. On the front of the power supply
4. On the top of the master unit

4-41. Which, if any, of the following devices is used in the master unit to allow for temperature variation?

1. A centrifugal fan
2. A small air conditioner
3. A bellows assembly
4. None of the above

4-42. The meridian gyro control system includes the gravity reference system, the azimuth control system, and the leveling control system. These systems control the meridian gyro in the same manner as the Mk 23 compass control system.

1. True
2. False

4-43. Which of the following factors causes azimuth or leveling errors?

1. Ship effect
2. Earth effect
3. Constant torque effect
4. Each of the above

4-44. Changes in the ship’s speed will cause compass errors if not compensated. How are errors caused by acceleration of the ship compensated?

1. By the manual corrector
2. By mercury ballistics
3. By the electrolytic bubble level
4. By the E-core transformer

4-45. If the ship has been maneuvering, how long, if at all, should you wait before changing from the high latitude mode to the directional gyro mode of operation?

1. 11 min
2. 2 hr
3. 30 min
4. No waiting time is required

4-46. When the compass heading is within 10° of true north, what should you do to change from the directional gyro mode to the high latitude mode of operation?

1. Stop the compass and restart it
2. Turn the mode selector switch to HIGH LATITUDE
3. Turn the master switch to the OFF position
4. Turn the mode selector switch to the FIL’S position

4-47. The AN/WSN-2 stabilized gyrocompass set is comprised of what total number of major assemblies?

1. One
2. Two
3. Five
4. Six

4-48. During normal power failure, the battery set will provide power for approximately what maximum length of time?

1. 15 min
2. 30 min
3. 45 min
4. 60 min

4-49. To ensure accuracy of outputs of the set, as a minimum, how often should the AUTO CAL mode of operation be used during continuous operation?

1. Every 30 days
2. Every 60 days
3. Every 90 days
4. Every 120 days

4-50. During an emergency condition, what is the first step you should take in securing the compass?

1. Place the MODE control in the POWER OFF position
2. Place the PWR switch in the OFF position
3. Place the SYN REF switch in the OFF position
4. Place the MODE control and the SYN REF in the POWER OFF and OFF respectively

4-51. The 2.5-volt antistickoff voltage is obtained from what component(s)?

1. A transformer in the amplifier unit
2. The power supply transformer
3. S1 and S2 synchro terminals
4. R1 and R2 synchro terminals

4-52. The AN/WSN-7B(V) is a self-contained system whose Inertial Measuring Unit (IMU) employs?

1. One RLGs and One accelerometers, in strapdown configuration
2. Two RLGs and two accelerometers, in strapdown configuration
3. Three RLGs and three accelerometers, in strapdown configuration
4. Four RLGs and Four accelerometers, in strapdown configuration

4-53. A Built-In Test (BIT) function, incorporate both hardware and software tests.

1. True
2. False

4-54. What is the temperature range for the AN/WSN-7B(V) full accuracy?

1. 0 to 50 C
2. 10 to 60 C
3. 15 to 65 C
4. 20 to 70 C

4-55. The AN/WSN-7B(V) is designed for ease of maintenance through a modular design. Lowest Replaceable Units (LRUs)

1. True
2. False

4-56. The keypad on the AN/WSN-7B(V) is used in conjunction with the displayed menus to perform all control and data entry functions. The keys are grouped into how many categories?

1. One
2. Two
3. Three
4. Four

4-57. On a normal configuration the AN/WSN-7B(V) is set to receive inputs from what two sources

1. Ship’s Speed log and Wind Speed log
2. Wind Speed log and GPS
3. Ship’s Speed log and GPS
4. All of the above

4-58. The AN/WSN-7B(V) will use the last Lat and Lon from NVRAM when the system is turned on again if the system has run (with no faults which prevent NVRAM update) for at least one hour at last power-up.

1. True
2. False

4-59. Leaving the navigation system in Dockside Align while getting underway will result in the display of what Fault Code and prevent the navigation system from transition to the NAV mode.

1. 50
2. 51
3. 52
4. 53

4-60. After power is turned on, the AN/WSN-7B(V) self-aligns system to roll, pitch, and heading using the reference velocity and internal sensors?

1. Roll and Pitch
2. Pitch and Heading
3. Roll, Pitch, Wind Heading and Ships Heading
4. Roll Pitch and Ships Heading

4-61. The self-align process, takes place automatically following power-up self-test and consists of what stage/s:

1. Leveling and Coarse Align
2. Latitude Coarse Align
3. Fine Align
4. All of the above

4-62. What modes of selection are available for selecting operation using Transverse coordinates reference.

1. AUTO and MNORM
2. MNORM AND MANUAL
3. MTXVS AND MANUAL
4. AUTO MNORM AND MTXVS

4-63. A position fix is used to correct the system estimate of position and to update the navigation filter (self-calibrate)?

1. True
2. False

4-64. Fault Codes classified as "**non-critical**" indicate that a fault condition exists which may be bypassed by which of the following actions?

1. Changing operation modes
2. Selecting other sensors
3. Manual entry of data
4. All of the above

4-65. Fault Codes classified as "**critical**" indicate that a fault condition exists but still can use the system as a reference source?

1. True
2. False

4-66. The following is/are examples of Position Reference Error Faults.

1. 209
2. 213
3. 217
4. All of the above

4-67. What is the primary component man-machine interface to/from the RLGN?

1. AN/WSN-7(V) Master
2. AN/WSN-7(V) Slave
3. Control Display Unit
4. None of the above

4-68. Once the RLGN has settled to Fine Align state in the At-Sea Align mode, the RLGN switches automatically from Fine Align to manual mode when error estimate criteria are met.

1. True
2. False

4-69. The INS alternate (Transverse) Earth coordinate's reference system is used when the INS is operating at latitudes greater than approximately what degrees.

1. 75 Degrees
2. 80 Degrees
3. 85 Degrees
4. 90 Degrees

4-70. The AN/SSN-6 Navigation Sensor System Interface (NAVSSI) System is an integrated shipboard system that automatically accepts, processes, and disseminates navigation and time information from various shipboard navigation sources?

1. True
2. False

4-71. The AN/SSN-6 utilizes inputs from what component/s.

1. INS only
2. EM Log and GPS
3. AN/UQN-4 Sonar Sounding Set
4. All of the above

4-72. AN/SSN-6 NAVSSI provide extremely accurate position (latitude and longitude)

1. True
2. False

4-73. The AN/SSN-6 is composed of which major units?

1. DCS
2. RTS, DCS
3. INS, RTS and DCS
4. DCS, RTS and BWS

4-74. The DCS is normally located in what room?

1. The Bridge
2. The Chart room
3. Forward IC room
4. Aft IC room

4-75. The NAVSSI AN/SSN-6 Block 3 system software uses how many Computer Software Configuration Item/s (CSCls)?

1. One
2. Two
3. Three
4. Four

4-76. The primary source of navigation data used by NAVSSI AN/SSN-6.

1. GPS satellite system
2. INS
3. VMS
4. None of the above

4-77. The integrated Digital Indicator Panel have how many simultaneous interfaces and decoding data independently for each indicator?

1. One
2. Two
3. Three
4. Four

Textbook Assignment: Chapter 5, "Sound-Powered Telephone System"; and Chapter 6, Automatic Dial Telephone System".

ASSIGNMENT 5

5-1. What is the purpose of the line cutout portion of a switchjack on a sound-powered telephone switchboard?

1. Only to connect a telephone station jackbox to a circuit
2. Only to disconnect a telephone station jackbox from its circuit
3. To connect or disconnect a telephone station jackbox from its circuit
4. To parallel a telephone station jackbox to another telephone station jackbox

5-2. String-type circuits usually fall under what classification?

1. Primary
2. Supplementary
3. Auxiliary
4. Emergency

5-3. What is the circuit designation of the flag officer's circuit?

1. JA
2. JC
3. JF
4. 1JG

5-4. What shipboard circuit is designated 3JZ?

1. Aircraft service
2. Mirror deck landing sight
3. Surface search radar
4. Main deck repair circuit

5-5. How do you parallel a primary circuit with an auxiliary circuit?

1. By use of a tie switch or a tie plus switch
2. By use of a patch cord or a jackbox
3. By use of a tie plus switch or a patch cord
4. By use of a tie switch or a patch cord

5-6. Which of the following is a disadvantage of paralleling sound powered telephone circuits?

1. Several different stations can be controlled by one station
2. It requires the use of additional telephone talkers
3. Overloaded transmitters
4. Lost communications can be reestablished easily

5-7. Which of the following spaces does NOT have a permanently installed X40J jackbox?

1. Central control stations
2. Bridge
3. Engine rooms
4. Emergency generator rooms

5-8. Phone/distance and station-to-station lines are used under which of the following conditions?

1. During replenishment at sea
2. During general quarters
3. When all other sound-powered communications are lost
4. When primary circuit communications are lost

5-9. When you conduct insulation tests on sound-powered circuits, which of the following is a proper procedure to follow?

1. Disconnect all sound-powered telephone headsets from the circuit
2. Disconnect all sound-powered telephone handsets from the circuit
3. Close all tie switches connected to the circuit
4. Open all line cutout switches on associated switchboards or switchboxes

5-10. What is the source of power for sound-powered telephones?

1. A 24-volt battery
2. A 117-volt source
3. A 120-volt source
4. Sound waves produced by the talker’s voice

5-11. When using the sound-powered telephone handset, you must depress switch S1 to perform which of the following functions?

1. For transmitting only
2. For receiving only
3. For transmitting and receiving
4. For tone compensation

5-12. The transmitter and receiver units in a sound-powered telephone handset are NOT interchangeable.

1. True
2. False

5-13. When sound waves strike the diaphragm of a sound-powered transmitter unit, what happens first?

1. A switch turns on the unit
2. The free end of the armature moves to a position exactly midway between the pole pieces
3. The diaphragm vibrates
4. The number of magnetic lines of force passing lengthwise through the armature is sharply reduced

5-14. What is the maximum number of sound-powered handsets you can connect in parallel and still maintain efficiency?

1. One
2. Two
3. Three
4. Four

5-15. What is the purpose of capacitor C1 in a sound-powered head set chest set?

1. It is used for power-factor correction
2. It prevents the flow of dc through the receiver units when the set is used with a sound powered telephone amplifier
3. It improves the acoustical quality of the set
4. It is used for tone compensation

5-16. Which of the following types of sound-powered headset-chestsets uses the press-to-talk switch in a junction box clipped to the talker's belt?

1. H-200/U
2. H-201/U
3. H-202/U
4. H-203/U

5-17. What maximum number of sound powered telephone headset-chestsets can be connected in parallel before line level response is considered critical?

1. 10
2. 15
3. 20
4. 25

5-18. What part of a sound-powered telephone headset-chestset might be damaged if it were stowed with soap powder?

1. The cord
2. The switch
3. The diaphragm
4. The stowage box

5-19. When repairing sound-powered telephones, what main hazard exists, if you work on a dirty workbench?

1. Dust may get into the PRESS-TO-TALK switch and short-circuit it
2. Iron filings may come into contact with the magnets and be difficult to remove
3. Moisture may reach the coils and ruin the insulation
4. Dust may come into contact with the armature and drive rod and cause distortion of the signal

5-20. If an entire sound-powered telephone circuit is inoperative, what is the most probable cause?

1. A short circuit
2. An open circuit
3. A loss of sensitivity
4. A broken switch

5-21. What is the proper procedure for testing a sound-powered handset for loss of sensitivity?

1. Depress the PRESS-TO-TALK switch and blow into the transmitter
2. Depress the PRESS-TO-TALK switch and blow into the receiver
3. Plug the set into the test receptacle on the sound-powered telephone test set
4. Only blow into the transmitter

5-22. What material is used for whipping tinsel conductors that are being made from bulk supply for use with headsets?

1. Cotton thread
2. DCOP cord
3. 32-gauge steel wire
4. 32-gauge tinned copper wire

5-23. When replacing a tinsel cord on a sound-powered telephone head set chest set, what must you do before disconnecting the cord?

1. Unscrew the entrance bushing
2. Make a diagram of the color coding
3. Secure the tie cord
4. Seal the port

5-24. When replacing the cord on a sound powered handset, what must you do before disconnecting the cord?

1. Unscrew the entrance bushing
2. Make a diagram of the color coding
3. Secure the tie cord
4. Seal the port

5-25. Sound-powered telephone amplifiers are capable of transmitting the amplified signal to what total number of (a) headset-chestsets and (b) loudspeakers?

1. (a) Two (b) six
2. (a) Two (b) two
3. (a) Six (b) two
4. (a) Six (b) six

5-26. Sound-powered amplifiers operate on power supplied from which of the following sources?

1. A 115-volt, 60-Hz power supply
2. Sound waves from the sound powered handset or head se chest sets in the circuit
3. A 115-volt, 400-Hz power supply
4. Batteries in a central switchboard

5-27. When is relay K1 maintained in an operated condition?

1. When Q6 is in an unsaturated state
2. When Q6 is in a saturated state
3. When R32 and R33 emitter bias voltage is less than Q6 to ground
4. When C1, CR1, and Q6 sense a signal from an incoming voice

5-28. If power is lost to the amplifier, what will happen to sound-powered communications?

1. All sound-powered communications on the circuit will be lost
2. Remote stations will still be able to transmit but will not be able to receive
3. Local stations will still be able to transmit but will not be able to receive
4. Local and remote stations will still be able to communicate at the normal sound-powered level

5-29. What is the purpose of an amplifier control switch?

1. It allows for the connection of more than one amplifier to a sound-powered circuit
2. It allows any one of several circuits to be amplified while retaining normal sound-powered communications for other circuits
3. It allows for the connection of a sound-powered amplifier to a sound-powered switchboard
4. It allows an operator to control all sound-powered amplifiers from one central location

5-30. What total number of (a) sections and (b) stationary contacts can be found on a type A-26A sound-powered telephone selector switch?

1. (a) 2 (b) 16
2. (a) 16 (b) 2
3. (a) 32 (b) 2
4. (a) 2 (b) 32

5-31. Soundproof booths for sound-powered telephones are used in spaces where the ambient noise level is at what decibel level?

1. 20 dB or less
2. 45 dB to 60 dB
3. 65 dB to 80 dB
4. 90 dB or more

5-32. In which of the following spaces would you likely find a plotters transfer switchboard?

1. Combat information center
2. Damage control central
3. Quarterdeck
4. Bridge

5-33. What sound-powered telephone call circuit is used for engineering?

1. 1E
2. 3E
3. 5E
4. 7E

5-34. Using a type IC/D call signal station, what total number of individual stations can be called?

1. 6
2. 12
3. 16
4. 32

5-35. Which of the following components are mounted on the cover of an IC/D call signal station?

1. Howler unit, SELECTOR switch, and attenuator
2. Howler unit, terminal board, and SELECTOR switch
3. Terminal board, sound-powered telephone jack outlet, and attenuator
4. Sound-powered telephone jack outlet, SELECTOR switch, and attenuator

5-36. When a station is being called, the howler at the selected station will howl for what maximum length of time?

1. 10 sec
2. 30 sec
3. Until the called station answers
4. Until the calling station stops cranking the generator

5-37. What total number of separate conversations are possible at one time on circuit MJ?

1. 1
2. 6
3. 8
4. 16

5-38. The AN/WTC-2(V) sound-powered telephone system may contain what maximum number of terminal stations?

1. 8
2. 16
3. 144
4. 288

5-39. The AN/WTC-2(V) sound-powered telephone system uses what total number of separate major units?

1. 6
2. 8
3. 16
4. 144

5-40. What is the difference between terminal stations unit 1 and unit 2?

1. Unit 1 has one station selection switch; unit 2 has two station selection switches
2. Unit 1 has a side-crank hand-ringing generator; unit 2 has a front-crank hand-ringing generator
3. Unit 1 has one attenuator; unit 2 has two attenuators
4. Unit 1 is bulkhead-mounted; unit 2 is console-mounted

5-41. What component is contained in unit 3 but NOT in units 1 and 2?

1. An audible alarm
2. A hand-ringing generator
3. A handset
4. An attenuator

5-42. Unit 4 of the AN/WTC-2(V) sound powered telephone system is what type of jackbox?

1. Single-gang
2. Double-gang
3. Triple-gang
4. Four-gang

5-43. What type of sound-powered telephone headset-chestset is used with unit 4?

1. H-200/U
2. H-201/U
3. H-202/U
4. H-203/U

5-44. What maximum number of extension visual signal devices can be connected to unit 6?

1. One
2. Two
3. Three
4. As many as is required to cover a space

5-45. An extension visual signal device uses what size of incandescent lamp?

1. 15 watts
2. 30 watts
3. 50 watts
4. 100 watts

5-46. Unit 7 is used to test which of the following components?

1. Sound-powered telephone jackboxes
2. Sound-powered telephone headset-chestsets
3. Sound-powered telephone handsets
4. Terminal station selector switches and associated wiring

5-47. When additional audible signaling is required due to high noise levels, what device mounted within unit 8 provides this audible signal?

1. A siren
2. An electrical horn
3. A bell
4. A loudspeaker

5-48. The AN/WTC-2(V) system contains several nets so certain stations may operate as a string circuit during particular conditions.

1. True
2. False

Textbook Assignment: Chapter 6, “Automatic Dial Telephone System (continued)”.

ASSIGNMENT 6

6-1. To check for a noisy handset cord, you should listen for a clicking or cracking noise in the receiver while performing which of the following actions?

1. Holding the cord with both hands and stretching it out completely
2. Rolling the cord back and forth between your hands
3. Twisting the cord in a back and forth motion
4. Holding the cord with one hand and pulling on it with the other

6-2. The dial should return to its normal position in approximately how much time after dialing 0?

1. 1 sec
2. 7 sec
3. 3 sec
4. 5 sec

6-3. How many adjustments are there on the telephone set?

1. One
2. Two
3. Three
4. Four

6-4. When adjusting the ringer, which leads of the telephone set do you connect to the ringing voltage supply?

1. The red and black leads
2. The black and grey leads
3. The grey and red leads
4. The red and green leads

6-5. How many tabs are there on the dial frame for dial speed adjustment?

1. 6
2. 9
3. 3
4. 12

6-6. High-voltage safety procedures should be followed whenever working on the inside of a telephone set.

1. True
2. False

6-7. Before replacing a defective telephone set transmitter and receiver units, you should attempt to repair them.

1. True
2. False

6-8. When replacing the cord on a handset, one end of the red jumper wire is connected to the receiver. Where is the other end connected?

1. On the same terminal of the transmitter mounting cup as the short red wire
2. On the same terminal of the mounting cup as the short yellow wire
3. On the same terminal of the transmitter as the long red wire
4. On the same terminal of the receiver as the green wire

6-9. When replacing the dial of a telephone set, after removing the telephone set chassis from the cover, what is the first step you should take?

1. Remove the dial dust cover
2. Remove the screws that hold the dial to the chassis
3. Disconnect the dial leads
4. Lift the dial out of the chassis

6-10. When replacing the ringer on a telephone set, which, if any, of the following leads should you unsolder?

1. The red lead only
2. The green lead only
3. The green and red leads
4. None of the above

6-11. What is the proper procedure for removing the dial illumination lamp from its holder?

1. Press down gently and rotate the lamp one-quarter turn counterclockwise
2. Press down hard and rotate the lamp one-quarter turn clockwise
3. Rotate the lamp one full turn counterclockwise
4. Gently pull the lamp straight out

6-12. When replacing the transmission network, what total number of lead terminals must you disconnect?

1. 5
2. 11
3. 17
4. 21

6-13. In checking a telephone set for no dial tone, you use the hand test telephone to isolate the problem and find that a dial tone is present. Where is the problem located?

1. In the telephone set
2. In the line coming from the automatic dial telephone switchboard
3. In the automatic dial telephone switchboard
4. In the main IC switchboard

6-14. What is the most common cause of dial pulses heard in the receiver while dialing?

1. The dial is out of adjustment
2. The receiver is defective
3. The telephone set cord is defective
4. The hookswitch shunt spring contacts are out of adjustment

6-15. To loosen the carbon granules that are clinging together in a handset transmitter unit, what should you do?

1. Strike the transmitter unit sharply with a hammer
2. Hold the handset in a horizontal position and shake it in a circular motion
3. Take the transmitter apart and use a nonmagnetic screwdriver to separate the granules
4. Hold the handset in a vertical position and shake it vigorously in a circular motion

6-16. If a telephone set has poor or weak reception, which of the following factors may be the cause?

1. Loose connections inside the handset
2. A worn receiver cord
3. A problem in the transmission network
4. Each of the above

6-17. All EXCEPT which of the following factors can cause a telephone to transmit but not receive?

1. A shorted transmitter unit
2. A shorted contact of the dial shunt springs
3. A defective receiver
4. An open transmitter unit

6-18. If the ringer on a telephone does not sound, what is the first component you should check?

1. The coil
2. The capacitor
3. The connections
4. The gong

6-19. Which of the following actions could result in a wrong number being dialed?

1. Keeping your finger on the dial while it is returning to its normal position
2. Jiggling the hookswitch before dialing
3. Incorrect dial speed
4. Each of the above

6-20. Where is the latch release button located on the type G (version 2) telephone set?

1. On the side of the handset
2. On the cover of the telephone set
3. On the front of the handset handle
4. On the back of the telephone set

6-21. What is capacitor C2 used for in the network assembly?

1. To protect the receiver from dc voltages
2. For gain control
3. To compensate for line capacitance
4. For mutual inductance

6-22. In the telephone set, what component is used to suppress clicks in the receiver?

1. Varistor RV1
2. Varistor RV2
3. Varistor RV3
4. Varistor RV4

6-23. When a caller dials your number, the automatic dial telephone switchboard applies how much voltage to the ringer of the telephone set?

1. 25 to 50 volts
2. 50 to 75 volts
3. 60 to 90 volts
4. 75 to 100 volts

6-24. What total number of adjustments are there on the type G (version 2) telephone set?

1. Six
2. Two
3. Eight
4. Four

6-25. If the dial speed on the type G (version 2) telephone set is too slow, which of the following actions should you take?

1. Replace the dial
2. Loosen the dial speed tension spring
3. Turn the dial speed adjust screw in a clockwise direction
4. Turn the dial speed adjust screw in a counterclockwise direction

6-26. When you adjust the hookswitch contact springs of the type G (version 2) telephone set, what is the correct contact separation for the Z combination?

1. 0.000 in. to 0.010 in.
2. 0.020 in. to 0.025 in.
3. 0.025 in. to 0.035 in.
4. 0.045 in. to 0.055 in.

6-27. When making an adjustment, what, if anything, will happen to the magnetic field of the ringer if you remove the three screws located on the bottom of the ringer?

1. It will decrease
2. It will increase
3. It will be broken and the ringer will need remagnetization
4. Nothing

6-28. When you replace the ringer on the type G (version 2) telephone set, what lead is connected to terminal 2 of the network assembly?

1. Red
2. Black
3. White
4. Green

6-29. What voltage is utilized to initiate an “off-hook” signal?

1. -48VDC
2. 48VDC
3. 240VAC
4. 120VAC

6-30. The IVN system uses what power for the Power Cabinet?

1. -48VDC
2. 115VAC 400HZ
3. 48VDC

4. 115VAC 60HZ

6-31. What is the total number of shore lines for the IVN system?

1. 64
2. 50
3. 75
4. 96

6-32. What is the purpose of the Emergency Transfer Unit?

1. Routes emergency calls to specified shipboard digital voice terminals
2. Routes emergency calls to specified shipboard analog voice terminals
3. Routes all calls to specific shipboard voice terminals
4. Routes emergency calls to the DCSS

6-33. Where are the Shore Connection Boxes located?

1. Port and starboard mooring stations
2. Forward IC
3. Forward and Aft IC
4. Aft IC

6-34. There are four batteries for the back-up battery set. What is the voltage output of the batteries?

1. All 12VDC
2. All 10VDC
3. Three 12VDC and one 10VDC
4. Three 10VDC and one 12VDC

6-35. What is the actual voltage output from the back-up battery set?

1. -10VDC to -12VDC
2. -12VDC to -24VDC
3. -24VDC to -36VDC
4. -46VDC to -52VDC

6-36. What is the expanded cabinet set called which interfaces with the IVN system PPN cabinet that provides access to analog sound-power and net circuits?

1. Digital Data Multiplexer (DDM)
2. Digital Conferencing Switch Set (DCSS)
3. Processor Port Network (PPN)
4. Main Cross Connect Field (MCCF)

6-37. What type of signals does the DCSSA expanded interface convert?

1. Analog to digital
2. Digital to analog
3. Digital only
4. Both 1 and 2

6-38. What is the location of DCSS circuit C-CS3183?

1. Prpln Rpr Smn
2. AMID Rpr No. 4
3. Conflag Sta No. 5
4. Passage (Unit Patrol Lkr)

6-39. What is the unit number reference designator for the A/C Power Distribution Frame?

1. Unit 26
2. Unit 1
3. Unit 4
4. Unit 14

6-40. The STC-2 consists of how many switching centers?

1. 4
2. 1
3. 3
4. 2

6-41. What is the total number of shore lines for the STC-2 system?

1. 20
2. 40
3. 30
4. 10

6-42. What is the input voltage to the ICSC's AC/DC power supplies?

1. 115 VAC
2. 440 VAC
3. -18 VDC
4. +5 VDC

6-43. What is the maximum number of sound powered circuits for the ICSC?

1. 8
2. 16
3. 32
4. 4

6-44. What voltage is used to power the High Speed Printer?

1. 440 VDC
2. 24 VDC
3. 115 VAC
4. -48 VDC

6-45. How many different types of dial terminals are available for use with the STC-2?

1. 2
2. 4
3. 5
4. 3

6-46. How many separate lines are accessible on a TA-998/STC-2(V) multiline?

1. 2
2. 5
3. 7
4. 3

6-47. What unit is used to load the Main Traffic Program?

1. Unit 6
2. Unit 7
3. Unit 21
4. Unit 8

6-48. How many processors are contained in one ICSC?

1. 4
2. 3
3. 2
4. 1

6-49. The primary function of MarCom Integrated Voice Communication System is to;

1. Address communication issues during normal ship operation
2. Provide a reliable voice-to-voice communication
3. Integrate the terminals to form a system
4. Support the users for conference calling

6-50. The MarCom Integrated Voice Communication System consists of four primary elements;

1. Switch Assemblies, NT Assemblies, Set of user terminals, and the SAT
2. System Administration Terminal, SAT Docking Station, SAT Printer, SPS
3. Main Cross Connect Field, SAT, Terminal Equipment, MDF
4. System Power Supply, Switch Assembly, SAT

6-51. The input power requirements for MarCom Integrated Voice Communication System are;

1. 440 VAC, 3-Phase, Delta Configuration Connection
2. 110 VAC, 3-Phase, Wye Configuration Connection
3. 440 VAC, 1-Phase, Delta Configuration Connection
4. 115 VAC, 3-Phase, XYZ Configuration Connection

6-52. The Common Controller Circuit Card Assembly (CCA's) of the MarCom Integrated Voice Communication System performs;

1. ISDN Signal processing for up to 24 BRI S/T digital ports using power and with no power.
2. Connecting 24 ISDN port for audio and control signal switching between devices.
3. System administrative functions and call processing in the IVCS Switch.
4. Emergency system shutdown during abnormal operation.

6-53. Which of the following Printed Wiring Assembly (PWA) or CCA's provides the interface between an Analog NT CCA in the IVCS and external analog devices?

1. IADS Interface
2. Analog NT CCA
3. Analog NT Interface
4. Common NT I/O CCA

6-54. The SAT (System Administration Terminal) function as the:

1. Message processing center for the MarCom IVCS for software reporting.
2. Human Machine Interface for system configuration data entry, status reports and alerts.
3. Model for monitoring system troubleshooting terminal equipment.
4. Interface for all of the Printed Wiring Assemblies (PWA) inside the switch assemblies.

6-55. The acronym ISDN stands for:

1. International System Data Networking
2. Interior Switching Data Numbering
3. Integrated Service Digital Network
4. Integrated Switching Data Network

6-56. A communications channel that can send signals in both directions at the same time is referred to as;

1. Full-duplex channel
2. Dual homed channel
3. Half-duplex channel
4. Bi-duplex channel

6-57. Which of the following terminals features a liquid crystal display, 32 programmable call appearance/function buttons and standard handset?

1. POTS Telephone, Model 6221
2. Automatic Dial Terminal, Model MT-9971
3. ISDN Telephone, Model i2021
4. Enhanced ISDN Telephone, Model i2022

6-58. A phone line that always dials a single pre-determined number when the phone is taken off-hook.

1. Hot-miked
2. Hands-free operation
3. Hot-line
4. Executive Break-in

Textbook Assignment: Chapter 7, “Amplified Voice Systems”.

ASSIGNMENT 7

7-1. What is the circuit designation for the general announcing system used aboard ship?

1. 1MC
2. 5MC
3. 40MC
4. 51MC

7-2. The circuit designation 21MC is used for which of the following shipboard announcing systems?

1. Flag administrative
2. Captain’s command
3. Bridge
4. Flag command

7-3. What is the importance classification of the 4MC?

1. Nonvital
2. Semivital
3. Vital
4. Not vital

7-4. What is the readiness classification of the 32MC?

1. One
2. Two
3. Three
4. Four

7-5. What do all microphones have in common?

1. They all convert electrical energy into sound energy
2. They all require an external voltage source
3. They are all rated the same
4. They all have a metal diaphragm

7-6. When a compression wave strikes the diaphragm of a magnetic microphone, in what direction does the (a) armature and (b) flux path move?

1. (a) Left (b) south
2. (a) Right (b) north
3. (a) Left (b) north
4. (a) Right (b) south

7-7. The magnetic microphone is preferred to the other types of microphones for use in shipboard announcing systems because of which of the following reasons?

1. Its resistance to shock
2. Its wide-frequency range
3. Its high-voltage output
4. Its high impedance

7-8. Rochelle salt is most commonly used in crystal microphones for which of the following reasons?

1. Its low-voltage output
2. Its low-current output
3. Its high-current output
4. Its high-voltage output

7-9. In the carbon microphone, the voltage developed across the secondary depends on which of the following factors?

1. Ratio of primary and secondary turns
2. Change in primary current
3. Both 1 and 2 above
4. The number of carbon granules

7-10. Why do shipboard announcing systems distort the frequency response of the system by attenuating the lower frequencies and boosting the higher frequencies?

1. To increase the gain of the system
2. To impart a pleasant quality to the sound
3. To improve the radiation efficiency of the loudspeaker
4. To make announcements easier to understand in noisy locations

7-11. Why is it important to have the sensitivity of a microphone as high as possible?

1. Because less gain is required in the amplifier
2. Because it eliminates all background noise
3. Because it provides for a low electrical power output level
4. Because it allows the speaker to hold the microphone at a greater distance from his or her mouth

7-12. What device in an announcing system converts electrical energy into sound energy?

1. A microphone
2. A loudspeaker
3. An amplifier
4. A transmission line

7-13. What is the basic type of driving mechanism used in Navy loudspeakers?

1. Moving-armature
2. Moving-coil
3. Magnetic
4. Carbon

7-14. Which of the following components must be used in a direct-radiator loudspeaker to reproduce low frequencies?

1. A baffle
2. A large diaphragm
3. A small diaphragm
4. Electrodynamics speaker coils

7-15. What factor(s) determine(s) if the use of a folded-horn loudspeaker would be practical?

1. The size and the amplitude of the sound to be reproduced
2. The amplitude of the sound to be produced and the distance from the loudspeaker to the listener
3. The distance from the loudspeaker to the listener only
4. The shape and the size

7-16. Which of the following factors does NOT principally influence the low-frequency response in a horn loudspeaker?

1. Mouth dimensions
2. Flare
3. Diameter of the cone
4. Basic horn formula employed

7-17. What relationship exists between the directional patterns of a small loudspeaker transmitting a high-frequency signal and a large loudspeaker transmitting a low-frequency signal?

1. They are inversely proportional
2. They are opposite
3. They are directly proportional
4. They are the same

7-18. A loudspeaker that is buzzing may normally have this fault corrected by which of the following actions?

1. By reducing the power applied
2. By lengthening the cone
3. By replacing the driver
4. By decreasing the flare of the cone

7-19. What is the usual range of voice coil impedance?

1. 20 to 60 ohms
2. 15 to 30 ohms
3. 3 to 15 ohms
4. 40 to 75 ohms

7-20. What is the purpose of the transformer used in shipboard loudspeakers?

1. To provide a means of varying the speaker volume
2. To match the voice coil to the line
3. To improve speaker frequency response
4. To reduce reverberation

7-21. In addition to the power rack, what is the other major component of the AN/SIA-114B amplifier-oscillator group?

1. Oscillator rack
2. Amplifier rack
3. Control rack
4. Speaker rack

7-22. To increase the low-level microphone and alarm signals, what total number of transistor amplifier stages is contained in each preamplifier?

1. One
2. Six
3. Eight
4. Four

7-23. The power supply modules supply what operating voltages to the alarm modules and preamplifier modules?

1. -1 Vdc and -10 Vdc
2. -10 Vdc and -30 Vdc
3. -20 Vdc and -40 Vdc
4. -40 Vdc and -50 Vdc

7-24. What total number of alarm modules is in each oscillator group?

1. 5
2. 10
3. 15
4. 20

7-25. Which of the following alarm modules takes priority over the other?

1. Flight crash over general
2. Chemical attack over collision
3. General over collision
4. Chemical attack over general

7-26. What component in the collision alarm module is used to adjust the number of pulses in a group?

1. Resistor R107
2. Relay K101
3. Resistor R117
4. Resistor R127

7-27. After the alarm contact maker is released, the general alarm will sound for approximately what maximum length of time?

1. 5 sec
2. 15 sec
3. 30 sec
4. 1 min

7-28. What generates the alarm signal in the chemical alarm module?

1. Striking multivibrator
2. Phase shift oscillator
3. Relaxation oscillator
4. Square wave multivibrator

7-29. Transistor Q503 in the flight crash alarm module is normally set to produce what varying frequency?

1. 550 to 700 cycles per second
2. 700 to 1750 cycles per second
3. 750 to 1750 cycles per second
4. 1700 to 2750 cycles per second

7-30. What alarm module produces a jump tone?

1. Unassigned A
2. Flight crash
3. Chemical
4. General

7-31. Which amplifier channel is normally used for (a) 1MC operation and (b) 6MC operation?

1. (a) A (b) B
2. (a) B (b) A
3. (a) A (b) A
4. (a) B (b) B

7-32. What is the normal position for the oscillator group selector switch?

1. 1
2. 2
3. A
4. B

7-33. The amplifier oscillator power switches supply power to which of the following components?

1. The power amplifiers located in the control rack
2. The relay power supply located in the control rack
3. The power supplies located in the power rack
4. The blowers located in the control rack

7-34. What total number of (a) microphone control station disconnect switches and (b) loudspeaker group disconnect switches are located on the front of the control rack?

1. (a) Three (b) five
2. (a) Five (b) five
3. (a) Five (b) six
4. (a) Six (b) six

7-35. What total number of (a) selector switches and (b) meters are mounted on the front of the power rack?

1. (a) Two (b) two
2. (a) Eight (b) two
3. (a) Two (b) eight
4. (a) Eight (b) eight

7-36. Which of the following microphone control stations is the only one capable of transmitting over both circuit 1MC and circuit 6MC?

1. Main control
2. Quarterdeck
3. Forward IC
4. Bridge

7-37. Which of the following loudspeaker groups is associated with circuit 1MC?

1. Topside
2. Fantail
3. Flight deck
4. Each of the above

7-38. To transmit over the 1MC when the busy 2 indicator light is lighted, what should you do?

1. Wait until the light goes off before attempting to use the 1MC system
2. Switch to channel B and make your transmission
3. Make your transmission over the 1MC at any time
4. Disregard the light and use the 6MC system for your transmission

7-39. In the one-way central announcing system, when both busy indicator lights are lighted, which of the following conditions exists?

1. An alarm signal is being transmitted
2. Both the 1MC and 6MC are in use
3. Both the 1MC and 6MC are using the same amplifier channel
4. Each of the above

7-40. In the one-way central announcing system, under normal conditions, a transmission will result in a meter reading of how many decibels?

1. 0 dB
2. 5 dB
3. 10 dB
4. 20 dB

7-41. Which of the following types of loudspeakers is used with circuit 6MC?

1. Multiunit direct-radiator
2. Multiunit straight-horn
3. Multiunit folded-horn
4. Each of the above

7-42. What is the color of the general alarm contact maker?

1. Green
2. Yellow
3. Red
4. Gray

7-43. In which of the following spaces is a visual alarm indicator installed?

1. On the bridge
2. In the engine room
3. On the quarterdeck
4. In the galley

7-44. When conducting a remote alarm contact maker test, which of the following alarm contact makers should you operate first?

1. Chemical attack
2. Collision
3. General
4. Engineering

7-45. If microphone station No. 1 was the only station operative, which of the following relays would probably be defective?

1. K973
2. K948
3. K933
4. K953

7-46. If there is no output when the general alarm contact maker is operated, which of the following relays is probably defective?

1. K101
2. K201
3. K302
4. K402

7-47. If there is no output when any 1MC mike circuit is energized, which of the following relays is probably defective?

1. K941
2. K942
3. K943
4. Each of the above

7-48. When testing a crystal can-type relay using the relay test facility, which, if any, of the following conditions indicates that the relay is defective?

1. Lamps light in test position 1 only
2. Lamps light in test position 2 only
3. Lamps light in both test positions
4. None of the above

7-49. Which of the following conditions indicates that a tube filament is open?

1. Filament not glowing
2. Low volume output
3. A lower than normal meter reading
4. A higher than normal meter reading

7-50. Which of the following is an indication that a resistor in a circuit is overloaded?

1. A burnt odor
2. Discoloration
3. Both 1 and 2 above
4. A loud crackling noise

7-51. Which of the following components will cause an amplifier to lose its output?

1. Open cathode bypass capacitor
2. Shorted coupling capacitor
3. Leaking coupling capacitor
4. Open coupling capacitor

7-52. Which of the following conditions could cause an excessive output voltage of a power-supply choke?

1. An internal short within the choke
2. A winding shorted to the case
3. A winding shorted to the core
4. An open winding

7-53. To check a suspected defective transistor, which of the following steps should you take?

1. Substitute with a known good transistor
2. Test with an out-of-circuit transistor test set
3. Test with an in-circuit transistor test set
4. Each of the above

7-54. What is the maximum number of calls that can be originated from the LS-433A/SIC intercommunicating unit?

1. 5
2. 10
3. 20
4. 25

7-55. The reproducer in an intercommunicating unit serves what function?

1. It performs as an amplifier
2. It performs as a microphone
3. It performs as a speaker
4. Both 2 and 3 above

7-56. How many banks of selector switches are provided with the 20-station LS-434A/SIC?

1. One
2. Two
3. Three
4. Four

7-57. When using a handset with an intercommunicating unit, where will the incoming calls be heard?

1. The handset
2. The reproducer
3. Both 1 and 2 above
4. A local loudspeaker

7-58. When the dimmer control knob is in the OFF position, what lights, if any, are lighted?

1. Release
2. Call
3. Station designation
4. None

7-59. In an intercommunicating unit, what type of coupling is used for (a) input and (b) output of the amplifier?

1. (a) RC
   (b) transformer
2. (a) Direct
   (b) transformer
3. (a) Transformer
   (b) transformer
4. (a) Direct
   (b) RC

7-60. To answer a call from another station, you should take which of the following actions?

1. Listen, then depress the talk switch to talk
2. Depress the calling station selector button, then talk
3. Check for a busy signal, then talk
4. Depress the calling station selector button and listen, then depress the talk switch to talk

7-61. When using the test fixture, which of the following characteristics is NOT tested by the amplifier and reproducer test?

1. Signaling circuits
2. General performance of the entire unit
3. Amplifier gain
4. Power output

7-62. To interrupt microphonics howls, test switch S201 on the test fixture provides a short circuit across what terminal?

1. 1 and 2
2. 1 and 1C
3. 2 and 3
4. 2 and 2C

7-63. When you are performing a signal circuit test with the test fixture, in what position should you initially place the 11 test switches?

1. OFF
2. RELEASE
3. ON
4. STANDBY

7-64. What is/are the main difference(s) between the new LS-518/SIC and LS-519/SIS intercommunicating units and the older LS-433A/SIC and LS-434A/SIC intercommunicating units?

1. The new units have the capability of using a remote loudspeaker
2. The new units have the capability of hands-free operation
3. Both 1 and 2 above
4. The new units are 20 and 40 station units

7-65. What mode of operation of the integrated intercommunication system has its own auxiliary storage battery supply?

1. Alarm signals
2. Portable loudspeaker
3. Sonar control room
4. Escape trunk

7-66. In the AN/PIC-2, what types of transistors are (a) Q1 and (b) Q3 and Q4?

1. (a) Input
   (b) push-pull power
2. (a) Push-pull power
   (b) input
3. (a) Input
   (b) output
4. (a) Output
   (b) input

7-67. When operating the AN/PIC-2, when is there maximum current drain?

1. Whenever switch S1 is depressed
2. When amplifying the loudest signal
3. When operating on external batteries
4. When operating on internal batteries

7-68. What should you use to clean salt crystals off the opening to the microphone housing?

1. Petrolatum
2. Fresh water
3. Sandpaper
4. Oil

7-69. What are the power requirements for the lectern-type public address system?

1. 115-volt ac or 220-volt ac
2. A self-contained dry battery or 115-volt ac
3. A self-contained dry battery or 220-volt ac
4. 115-volt dc or 115-volt ac

Textbook Assignment: Chapter 8, “Data Multiplexing Systems”.

ASSIGNMENT 8

8-1. DMS improves integration of the interfacing ship's electrical subsystems without compromising:

1. Circuits
2. Total System Capability
3. Cables and Multi-pin Connectors
4. Junction Boxes

8-2. DMS continuously monitors and displays its operating status from a centralized control station called a:

1. Maintenance Group (MG)
2. Maintenance Console (MC)
3. Control Group (CG)
4. Maintenance Station (MS)

8-3. Software for the DMS is resident on the:

1. AN/UYK-43
2. OL-267
3. AN/UYK-44
4. OE-82

8-4. Where is the first stage of multiplexing accomplished?

1. RM
2. AM
3. PM
4. DM

8-5. Where is the second stage of multiplexing accomplished?

1. RM
2. AM
3. PM
4. DM

8-6. User input signals are received by the input/output unit (IOU) through user cabling and are converted to nonreturn-to-zero (NRZ) are:

1. 17-bit digital format
2. 17-hex digital format
3. 128-bit encryption
4. Secure layered digital format

8-7. What is the IOU-to-RTM transmit bit rate?

1. 4.8 megahertz
2. 3.0 megahertz
3. 2.4 megahertz
4. 1.6 megahertz

8-8. What is the correct Source/Sink Combination?

1. Single sink, single source
2. Single sink, multiple source
3. Multiple sink, single source
4. All of the above

8-9. A Dual-Stage DMS is suitable for:

1. Complex installations
2. WAN installations
3. Large to medium installations
4. Small installations

8-10. For Module Keying, how many possible codes are available?

1. 24
2. 48
3. 64
4. 124

8-11. The IOU16 provides power, cooling, and environmental protection for the modules.

1. True
2. False

8-12. In a specific application, each IOM performs can perform what system function? one of four general system functions: input, output, input plus output, and message processing.

1. Input and Output
2. Input Plus Output
3. Output and message processing
4. All of the above

8-13. Message processor modules are a special type of IOM that provide only internal switching control or messages for other IOMs and do not have direct interfaces with any user device.

1. True
2. False

8-14. Remote Multiplexer (RM) interface with what unit/s

1. IOU's and AM's
2. AM's only
3. IOU's only
4. None of the above

8-15.What is the maximum number of IOM's that can interface with a RMH

1. 10
2. 16
3. 64
4. 96

8-16. The source RMH transmits the transmit request header as a transmit request message in the same way that a receive request message is transmitted except the RMH will wait for a one-word acknowledge message from a sink RMH instead of a data message

1. True
2. False

8-17. The AMHs of an AM are functionally and electrically independent of each other except for what.

1. Output data
2. Message linking data
3. Cross-reporting of BITE data
4. None of the above

8-18. The purpose of a TC is to provide orderly control of primary bus access to what units?
1. AM's only
2. ARM's only
3. AM's and ARM's
4. AM's ARM's and ME's

8-19. The transmitter of the RF transceiver (Figure 8-25 of Text) transmits the CO messages on the control channel; the two receivers operate together as a pair, alternately tuning to;

1. One of the four data channels at a time to scan for and detect vacant channels.
2. Two of the four data channels at a time to scan for and detect vacant channels.
3. Three of the four data channels at a time to scan for and detect vacant channels.
4. Four of the four data channels at a time to scan for and detect vacant channels.

8-20. On the CM Data (Message PROM Contents) Display/Printout the operator may initiate display/printout of?

1. The message PROM contents for a particular message PROM in an RMH/ARM (LHD only),
2. The contents of all message PROMs in an RMH/AMH
3. The contents of all message PROMs in all RMHs/ARMs.
4. All of the above.

8-21. The primary bus interface and the basic message format and protocol for the ME are the same as those for the ARM (LHD only) and the AM.

1. True
2. False

8-22. The teletypewriter set (Figure 8-35 of Text book) provides permanent hard-copy records of what?

1. DMS status
2. DMS status and fault localization
3. Fault localization and configuration monitoring
4. All of the above

8-23. The Fiber Optic Data Multiplex System (FODMS) AN/USQ-82(V) is a modular, general purpose, information transfer system designed to integrate interior ship system equipment.

1. True
2. False

8-24. How many independent SAFENET does FODMS has?

1. One
2. Two
3. Three
4. Four

8-25. What are the major components of FODMS?

1. SAFENET networks and Trunk Coupling Boxes (TCBs),
2. SAFENET networks and Input Output Units (IOUs),
3. Input Output Units (IOUs), and Maintenance Group (MG).
4. SAFENET networks, Trunk Coupling Boxes (TCBs), and Input Output Units (IOUs), and Maintenance Group (MG).

8-26. What is/are the function/s of the IOU (Input/Output Unit)?

1. Converts user signals at the IOM input to fiber optic signals for transmission to other IOUs
2. Converts incoming fiber optic signals from the other IOUs for transmission to users connected to IOM outputs
3. Both 1 and 2
4. None of the above

8-27. An IOM converts data from a user to standard analog format.

1. True
2. False

8-28. Cooling on the FODMS system is accomplished by which of the following?

1. External AC fan.
2. Internal DC fan
3. External DC fan
4. Internal AC fan

8-29. The IOU operates from what AC source/s?

1. Single source 115 volts, single phase 60 Hz, Type I power.
2. Dual Source 115 volts, three phase 60 Hz Type I power
3. Single Source 440 volts three phase, 60 Hz
4. Dual Source 115 volts single phase 60Hz, Type I power.

8-30. The IOU will remain fully operational through which of the fallowing momentary power interruptions? of 650 milliseconds or less on either of the two inputs

1. 450 milliseconds or less on either of the two inputs.
2. 550 milliseconds or less on either of the two inputs.
3. 650 milliseconds or less on either of the two inputs.
4. 750 milliseconds or less on either of the two inputs.

Textbook Assignment: Chapter 9, “Alarm, Safety, and Warning System”.

ASSIGNMENT 9

9-1. What is the circuit designation for the flooding alarm system?

1. F
2. FD
3. FH
4. FR

9-2. What is the readiness classification of the wrong direction alarm system?

1. 1
2. 2
3. Vital
4. Semivital

9-3. What is the importance classification of the boiler water alarm system?

1. 1
2. 2
3. Vital
4. Nonvital

9-4. The contacts in a flow switch will open and initiate an alarm whenever the fluid flow rate increases.

1. True
2. False

9-5. The contacts in a relay will open and initiate an alarm whenever there is a loss of power.

1. True
2. False

9-6. What total number of contacts are sealed into the glass tube of a mercury thermostat?

1. Six
2. Two
3. Three
4. Five

9-7. What maximum number of mercury thermostats may be connected in parallel on any one line?

1. Six
2. Two
3. Three
4. As many as needed

9-8. The thermostat that is normally installed in a ship's magazines will activate the alarm system at what minimum temperature?

1. 105°F
2. 115°F
3. 125°F
4. 150°F

9-9. Where are combustion gas and smoke detector heads located?

1. On the overhead in the compartment to be protected
2. On the bulkhead of the compartment at shoulder level
3. On the baseboard of the compartment bulkhead
4. On the front of the upper section of an alarm switchboard

9-10. To initiate an alarm in the combustible gas and smoke detector system, combustion gases or smoke has to be present in which of the following locations?

1. In the cold cathode tube
2. In the inner chamber of the detector head
3. In the compartment where the detector is located
4. In the outer chamber of the detector head

9-11. In a combustion gas and smoke detector head, the saturation point is reached when which of the following conditions occur?

1. When all ionized particles are of sufficient potential to reach the plates
2. When the gas molecules being ionized contain heavy particles of combustion products
3. When the ionized radium is working at full strength
4. When the battery is fully charged

9-12. Why will the presence of combustible gas or smoke in the detector head initiate an alarm?

1. Because the gas molecules are large and carry a greater electric charge
2. Because the saturation point of the galvanometers is reached quicker because of the more slowly moving ions
3. Because the large size of the gas and smoke particles causes the current flow in the detector head to decrease
4. Because the potential across the detector plates is reduced due to the absorption of gamma rays

9-13. What are dual-purpose detectors?

1. A combination mercury thermostat and an ionization detector connected in parallel in the same circuit
2. Two ionization detector heads connected together
3. A combination ionization detector and mercury thermostat connected in series in the same circuit
4. Two mercury thermostats connected in series in the same circuit

9-14. What type of bell has a circular 8-inch diameter watertight gong?

1. IC/B5S5
2. IC/B1S4
3. IC/B8S4
4. IC/B1S8

9-15. How is the type IC/B3D4 bell operated?

1. Battery operated
2. Ac operated
3. Dc operated
4. Both 2 and 3 above

9-16. The IC/Z1D4 de-operated buzzer has which of the following features?

1. A resonated bar
2. A resonated transducer
3. Make-and-break contacts
4. No contacts

9-17. Which of the following types of horns uses a diaphragm and produces a sound with a distinctive frequency characteristic?

1. IC/H2D4
2. IC/H8S3
3. IC/H4D3
4. IC/H8D4

9-18. Which of the following factors determines the frequency of the sound produced by a siren?

1. The number of holes in the siren housing
2. The motor speed
3. The number of rotor blades
4. Each of the above

9-19. The IC/E3D2 electronic signal unit is capable of generating what total number of distinct tones?

1. One
2. Two
3. Three
4. Four

9-20. Why are two 115-volt lamps connected in parallel and mounted behind each dial of a standard watertight lamp indicator?

1. To obtain greater brilliancy
2. To provide two separate signals
3. To provide an even heat inside the indicator
4. To prevent loss of illumination if one lamp burns out

9-21. A four-dial, variable-brilliancy standard watertight lamp indicator uses what total number of 6-volt lamps?

1. 16
2. 2
3. 8
4. 4

9-22. The prism-shaped jewels used in the special lamp indicator panels are what colors?

1. Green and red
2. Red and blue
3. Blue and green
4. Yellow and brass

9-23. The supervisory feature for systems using alarm panels and alarm switchboards consists of what size resistor?

1. 5,000-ohm, 7-watt
2. 7,000-ohm, 7-watt
3. 5,000-ohm, 5-watt
4. 7,000-ohm, 5-watt

9-24. A system is in what condition when there is no current flowing in the circuit?

1. Alarm
2. Supervisory
3. Trouble
4. Normal

9-25. What total number of supervisory resistors is needed for a circuit containing four sensing devices?

1. One
2. Two
3. Three
4. Four

9-26. When is the test light of the IC/S alarm panel energized?

1. When the test switch is in the normal position
2. When the test switch is in the silent alarm test position
3. When the test switch is in the silent trouble test position
4. Both 2 and 3 above

9-27. What total number of 2-line alarm units (B-51 alarm panels) are used for each 10-line panel?

1. 5
2. 10
3. 15
4. 20

9-28. Which of the following statements correctly describes the components of a B-51 alarm panel?

1. Two relays and a two-position rotary test switch
2. Three relays and a four-position rotary test switch
3. Three relays and two three-position rotary test switches
4. Four relays and two three-position rotary test switches

9-29. What is the resistance of the magnetic coil of the (a) alarm relay and (b) supervisory relay?

1. (a) 1,325 ohms (b) 1,325 ohms
2. (a) 1,325 ohms (b) 1,350 ohms
3. (a) 1,350 ohms (b) 1,325 ohms
4. (a) 1,350 ohms (b) 1,350 ohms

9-30. On the B-51 alarm panel, when the alarm-target relay is operated, what color does the alarm drum show?

1. Yellow
2. White
3. Black
4. Red

9-31. In the two-line alarm unit, what is the resistance value of the supervisory resistor?

1. 5,000 ohms
2. 7,000 ohms
3. 9,000 ohms
4. 11,000 ohms

9-32. What audible device is normally used with the visual signal of the B-51 alarm switchboard to alert personnel of a trouble condition in a circuit?

1. A bell
2. A buzzer
3. A siren
4. A horn

9-33. What is the least amount of current needed to operate the alarm relay?

1. 0.012 amp
2. 0.024 amp
3. 0.043 amp
4. 0.049 amp

9-34. With the test switch in the silent alarm test position and the line unit switch in the test position, what will be the color of the alarm relay drum if the system is operating correctly?

1. Gray
2. Yellow
3. White
4. Red

9-35. The line display section of the type IC/SM alarm panel contains which of the following components?

1. Subassemblies common to any size alarm panel
2. Ground detector lamps
3. Individual display modules
4. Battery back-up power supply

9-36. What component(s) is/are used to recognize the state of the remote sensors?

1. The alarm modules
2. The control panel
3. The alarm panel
4. The common alarm

9-37. The IC/SM-50 alarm switchboard is capable of monitoring what total number of individual lines?

1. 5
2. 10
3. 50
4. 100

9-38. Which of the following components is NOT mounted on the front of the common alarm section of the IC/SM-50 alarm switchboard?

1. An audible volume control
2. A ground detection indicator
3. A dimmer control
4. A visual-audible switch

9-39. The dimmer control dims the alarm module display lamps on the IC/SM-50 alarm switchboard in all EXCEPT which of the following conditions?

1. Steady
2. Normal
3. Alarm
4. Flashing

9-40. Which audible signal is generated by the IC/SM-50 alarm switchboard during an alarm condition?

1. Wailing
2. Pulsating
3. Steady
4. Siren

9-41. The battery in the IC/SM-50 alarm switchboard is used for which of the following reasons?

1. It supplies power to the alarm silence indicator when the visual-audible switch is in the visual position
2. It supplies power to the tone generator during a loss of primary power
3. Both 1 and 2 above
4. It supplies emergency power to operate the switchboard during a loss of primary power

9-42. During normal switchboard operation, the battery voltage should be between what range?

1. 6.3 volts and 12.0 volts
2. 6.3 volts and 13.8 volts
3. 12.0 volts and 13.8 volts
4. 0 volts and 6.3 volts

9-43. The line display alarm modules in the IC/SM-50 alarm switchboard have how many power supplies?

1. 1
2. 5
3. 10
4. 50

9-44. What section of the IC/SM-50 alarm switchboard is the line display section?

1. Lower
2. Middle
3. Upper
4. Top

9-45. On the IC/SM-50 alarm switchboard, which half of a line display alarm module shows the location of the circuit sensor?

1. Left
2. Right
3. Lower
4. Upper

9-46. During an alarm condition, what will be the status of the (a) upper display lamp and (b) lower display lamp on the line display alarm module of the IC/SM-50 alarm switchboard?

1. (a) On steady (b) flashing
2. (a) Flashing (b) off
3. (a) Off (b) flashing
4. (a) Flashing (b) on steady

9-47. There is no audible signal when the mode selector switch is placed in which position?

1. Normal
2. Standby
3. Cutout
4. Test

9-48. An alarm cannot be detected in a circuit during which, if any, of the following conditions?

1. Supervisory
2. Trouble
3. Normal
4. None of the above

9-49. When the mode switch is in the CUTOUT position, what is the state of the (a) upper and (b) lower lamps of the alarm module?

1. (a) Steady (b) flashing
2. (a) Dark (b) steady
3. (a) Steady (b) steady
4. (a) Flashing (b) flashing

9-50. What is the circuit designation of the high-temperature alarm system?

1. F
2. FH
3. E
4. EC

9-51. Where are pressure transducers of the pressure-to-current type located?

1. In the lubricating oil supply lines
2. In the lubricating oil scavenge lines
3. In the lubricating oil discharge lines
4. All of the above

9-52. What is the circuit designation of the auxiliary machinery lubricating oil low-pressure alarm system?

1. 1EC
2. 3EC
3. 2EC
4. 4EC

9-53. What is the circuit designation of the generator bearing and stator temperature indicating and alarm system?

1. 1ED
2. 2EW
3. EF
4. F

9-54. What circuit provides a means of indicating when carbon dioxide and Halon gas are released in compartments?

1. F
2. FH
3. FD
4. FR

9-55. What circuit provides a means of indicating the pressure in the compressed air system?

1. FH
2. F
3. EL
4. EK

9-56. When testing and maintaining the security alarm system, what minimum number of authorized personnel must be present?

1. One
2. Two
3. Three
4. Four

9-57. Which of the following conditions could cause an alarm panel or alarm switchboard alarm to sound a false alarm?

1. Shorted relay contacts
2. Weak alarm relay spring
3. Grounds
4. Each of the above

9-58. If a complete loss of power occurs in an IC/SM-50 alarm switchboard, what components should you check first?

1. The power transformers located inside the switchboard
2. The fuses that supply primary power to the switchboard
3. The fuses located on the front of the common alarm section
4. The fuses located on the front of the line display section

Textbook Assignment: Chapter 10, “Ship’s Order Indicating and Metering Systems”.

ASSIGNMENT 10

10-1. Which of the following circuits are associated with the ship’s control console?

1. M and MB
2. M and LB
3. MB and LB
4. LB and N

10-2. In the propeller revolution order system, the throttleman who acknowledges orders transmitted from the pilothouse is located in which engine room?

1. No. 1
2. No. 2
3. No. 3
4. Whichever engine room receives the order

10-3. The propeller order indicator transmitter contains what total number of synchro transmitters?

1. Six
2. Two
3. Three
4. Four

10-4. What is the circuit designation for the engine order system?

1. M
2. MB
3. L
4. N

10-5. What is the function of the engine order system?

1. It transmits and acknowledges required shaft speed changes
2. It transmits and acknowledges required shaft direction changes
3. Both 1 and 2 above
4. It transmits required propeller revolution changes

10-6. What person operates the engine order indicator-transmitters in the ship control console?

1. The OOD
2. The lee helmsman
3. The throttleman
4. The duty IC man

10-7. Where is the transmitter for the rudder angle indicator system located?

1. At the ship control console
2. In the steering control console
3. At the rudder head
4. In the No. 1 engine room

10-8. The rudder order system should be used in which of the following situations?

1. Whenever the steering gear room watch is steering the ship
2. Whenever the ship is underway
3. Whenever the ship is entering port
4. Whenever the OOD orders a change in rudder angle

10-9. The circuit designation LB is used for what system?

1. Propeller revolution order system
2. Steering emergency alarm system
3. Rudder angle indicator system
4. Rudder order system

10-10. What device is used in the steering gear room to alert the watch stander that a steering emergency has occurred?

1. A bell
2. A trick wheel
3. A combination rudder angle order indicator
4. A siren

10-11. Which of the following is NOT a purpose of gears?

1. To increase or decrease the speed of the applied motion
2. To change the direction of mot ion
3. To increase or decrease the applied force
4. To eliminate frictional losses

10-12. When gears are used to reduce speed, what, if anything, will happen to the force at the output of the gear?

1. It will be increased
2. It will be decreased
3. It will double
4. Nothing

10-13. Which condition must hold true if two spur gears are to mesh properly?

1. The teeth of both gears must be the same size
2. Both gears must have the same diameter
3. The teeth of both gears must be the same distance apart
4. The gears must turn on parallel shafts

10-14. Which type of spur gear uses teeth with a leading end and a trailing end?

1. Straight
2. Thrust
3. Helical
4. Herringbone

10-15. Which type of spur gear is used mostly on heavy machinery?

1. Pinion
2. Straight
3. Rack
4. Herringbone

10-16. Which of the following is the most commonly used type of spur gear?

1. Spiral
2. Helical
3. Straight
4. Sector

10-17. What type of gear is used in a rack and pinion arrangement to save space and material?

1. Pinion
2. Herringbone
3. Driver
4. Sector

10-18. If you should find it necessary to transmit circular motion from one shaft to a second shaft which is at right angles to the first shaft, which of the following gear arrangements should you use?

1. Rack and pinion gears
2. Miter gears
3. Helical gears and a thrust bearing
4. Internal and external pinion gears

10-19. The whole width of each tooth does not come in contact with the mating tooth at the same time. Which type of bevel gear is described in this statement?

1. Straight
2. Miter
3. Angle
4. Spiral

10-20. In a worm gear-worm wheel combination, the worm gear is double threaded and the worm wheel has 50 teeth. To turn the worm wheel one complete revolution, the worm gear must be given what total number of complete turns?

1. 25
2. 2
3. 50
4. 100

10-21. To back up an automobile, it is necessary to reverse the direction of the crankshaft.

1. True
2. False

10-22. You have a pinion gear with 14 teeth driving a spur gear with 42 teeth. If the pinion gear turns at 420 rpm, what will be the speed of the spur gear?

1. 42 rpm
2. 140 rpm
3. 160 rpm
4. 278 rpm

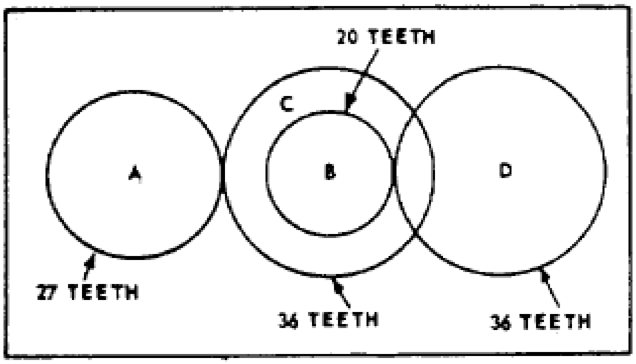

Figure 10A

IN ANSWERING QUESTION 10-23, REFER TO FIGURE 10A.

10-23. Gears B and C in the gear arrangement are rigidly fixed together. If gear A is turned counterclockwise at a rate of 120 rpm, (a) in what direction and (b) at what speed will gear D turn?

1. (a) Clockwise
   (b) 20 rpm
2. (a) Clockwise
   (b) 50 rpm
3. (a) Counterclockwise
   (b) 50 rpm
4. (a) Counterclockwise
   (b) 100 rpm

10-24. The product of all the driving teeth of a turbine reduction gearing is 400 and the product of all the driven teeth is 4,000. When the propeller shaft turns at 200 rpm, at what speed is the turbine turning?

1. 200 rpm
2. 400 rpm
3. 2,000 rpm
4. 4,000 rpm

10-25. What is the purpose of an idler gear?

1. To increase speed ratio
2. To decrease speed ratio
3. To take up lost motion
4. To allow the driven gear to turn in the same direction as the driver gear

10-26. What is the theoretical mechanical advantage if the number of teeth on a driven gear is 32 and the T. is 4?

1. 128
2. 64
3. 8
4. 4

10-27. What is the total theoretical mechanical advantage of a compound machine made up of two simple machines if the M.A. of one machine is 10 and the M.A. of the other machine is 5?

1. 50
2. 25
3. 15
4. 5

IN ANSWERING QUESTIONS 10-28 THROUGH 10-30, REFER TO FIGURE 10-25 IN YOUR TEXTBOOK.

10-28. The two bevel gears located above and below the center of the mechanism are called what type of gears?

1. End gears
2. Input gears
3. Output gears
4. Spider gears

10-29. What gears are used to connect the end gears and spider shaft to another mechanism?

1. Two output gears and one input gear
2. Two input gears and one output gear
3. One output gear and one input gear
4. Two output gears and two input gears

10-30. Which type of gear is NOT bearing mounted?

1. Spider gear
2. End gear
3. Output gear
4. Input gear

10-31. Which of the following statements is true of a gear differential regardless of the type of hookup used?

1. The spider will follow the end gears for half the sum or difference of their revolutions
2. The two side gears are the inputs and the gear on the spider shaft is the output
3. The spider shaft is one input, one of the sides is the other input, and the other side is the output
4. If the two inputs are equal and opposite, the spider shaft will move in either direction

10-32. The outputs of computing mechanisms are used to do which of the following tasks?

1. Drive heavy loads
2. Control servomotors
3. Position the output mechanism
4. Each of the above

10-33. What is the propeller revolution indicator system used to indicate?

1. Total revolutions of each propeller shaft
2. Direction of rotation of each propeller shaft
3. RPMs of each propeller shaft
4. Each of the above

10-34. The synchro transmitters for the propeller revolution indicator system transmitters are driven (a) at what speed and (b) in what direction?

1. (a) Same speed as their respective shaft
   (b) clockwise
2. (a) Same speed as their respective shaft
   (b) counterclockwise
3. (a) Twice their respective shaft speed
   (b) clockwise
4. (a) One-half their respective shaft speed
   (b) counterclockwise

10-35. Where are the transmitters for the propeller revolution indicator system located?

1. In the pilothouse
2. On their respective propeller shaft
3. On the reduction gear for their respective propeller shaft
4. In the throttle station for their respective propeller shaft

10-36. At what speed is the revolution counter in the transmitter driven?

1. One-half the speed of the shaft
2. Twice the speed of the shaft
3. The same speed as the shaft
4. One-tenth the speed of the shaft

10-37. The remote indicator signal lights are energized by what component(s) in the transmitter?

1. The center contact and two of the movable contacts
2. The center contact and one of the stationary contacts
3. The swinging links
4. The small insulating block

10-38. The synchro transmitter is prevented from driving the counter backward during brief periods of rapid speed reduction by what component(s) in the transmitter?

1. The brake shoes
2. The contact assembly
3. The helical gears
4. The idler gear

10-39. How are the transmitters connected to their respective indicator transmitters?

1. Through gears
2. Electrically
3. By a stub shaft
4. Directly coupled

10-40. Which of the following components is NOT a part of an indicator transmitter?

1. A dial
2. A speed-measuring mechanism
3. A running synchro transmitter
4. A positioning synchro transmitter

10-41. The speed-measuring mechanism in the indicator-transmitter operates by what principle?

1. Vector gear
2. Differential gear
3. Accelerometer assembly
4. Friction disk and roller assembly

10-42. How is the outer dial of the indicator-transmitter numbered?

1. For each 5 rpm
2. For each 25 rpm
3. For each 50 rpm
4. For each 100 rpm

10-43. What total number of complete revolutions does the short pointer on the indicator-transmitter make for full-scale indication?

1. 1
2. 10
3. 100
4. 1000

10-44. As the roller is moved toward the center of the friction disk in the indicator-transmitter, what will happen to its speed?

1. It will increase inversely with the distance traveled
2. It will increase in direct proportion with the distance traveled
3. It will decrease inversely with the distance traveled
4. It will decrease in direct proportion to the distance traveled

10-45. What is the friction disk speed for an indicator-transmitter with a range of 400?

1. 16 2/3 rpm
2. 33 1/3 rpm
3. 45 rpm
4. 78 rpm

10-46. What component determines the direction of rotation of the follow-up motor in an indicator transmitter?

1. A synchronous motor
2. A friction roller and helical gear
3. A slip ring and contact assembly
4. A running synchro transmitter

10-47. When the roller is at the exact center of the friction disk, what will be the position of the long pointer?

1. 1 rpm
2. 0 rpm
3. 100 rpm
4. Full scale indication

10-48. On an indicator-transmitter with a speed signal switch, what is the range of the signal setting?

1. 0 rpm to 1/4 full speed
2. 1/4 full speed to 5 rpm
3. 1/4 full speed to 0 rpm
4. 5 rpm to 1/4 full speed

10-49. When, if at all, is the dummy log in the underwater log system used in place of the rodmeter?

1. When the ship is operating in shallow water
2. When the ship is operating in deep water
3. When the propeller shafts are not turning
4. Never

10-50. The output of the rodmeter is fed directly to which of the following components of the indicator transmitter?

1. The integrator
2. The speed dial
3. The speed servo
4. The synchro output transmitter

10-51. What is the purpose of the valve position indicator system?

1. To enable personnel to open certain valves remotely
2. To enable personnel to close certain valves remotely
3. Both 1 and 2 above
4. To enable personnel at remote stations to see if certain valves are opened or closed

10-52. The sensitive switches used in the valve position indicator system normally have what type of contact arrangement?

1. Make
2. Break
3. Make before break
4. Break before make

10-53. The salinity indicator system measures which of the following conditions?

1. Electrolytic impurities of dirty water
2. Electrolytic impurities of seawater
3. Electrolytic impurities of fresh water
4. Electrolytic impurities of salt water

10-54. To prevent damage to the ship’s boilers, boiler feedwater should be kept below what maximum emp?

1. 0.656
2. 0.650
3. 0.560
4. 0.065

10-55. What, if anything, will happen to current flow in a salinity cell if the impurities in the water decrease?

1. Current flow will increase
2. Current flow will decrease
3. Current flow will stop
4. Nothing, current flow will remain the same

10-56. The automatic temperature compensator in a salinity cell is made from a material having what kind of temperature coefficient?

1. Negative
2. Positive
3. Resistive
4. Capacitive

10-57. What type of electrodes are used in a salinity cell to detect impurities?

1. Gold
2. Silver
3. Copper
4. Platinum

10-58. The meter unit in a salinity panel is calibrated in which of the following measurements?

1. Gallons
2. Volts
3. Ohms
4. Epm

10-59. What valve is used in the salinity indicator system to stop contaminated water from reaching the potable water tanks?

1. Dump
2. Ball
3. Gate
4. Redirect

10-60. What category of level detectors is used to detect fluid levels in systems with a need for greater accuracy?

1. Transmitter
2. Level link
3. Magnetic
4. Reed

Textbook Assignment: Chapter 11, “Auxiliary Electrical Equipment”.

ASSIGNMENT 11

A. Manual controller
B. Magnetic controller
C. Across-the-line controller
D. Dc resistor controller
E. Ac primary resistor controller
F. Ac secondary resistor controller
G. Static variable-speed controller
H. Autotransformer controller
J. Reactor controller

Figure 1A

IN ANSWERING QUESTIONS 11-1 THROUGH 11-8, REFER TO FIGURE 1A.

11-1. In what controller are resistors inserted in the secondary circuit of a wound-rotor ac motor for starting or speed control?

1. B
2. C
3. E
4. F

11-2. What controller throws the connected load directly across the main supply line?

1. A
2. B
3. C
4. D

11-3. What controller consists of solid state and other devices that regulate motor speeds in indefinite increments through a predetermined range?

1. H
2. G
3. F
4. E

11-4. What controller has a resistor in series with the armature circuit of the motor?

1. D
2. C
3. B
4. A

11-5. What controller is operated by hand directly through a mechanical system?

1. A
2. C
3. G
4. J

11-6. What controller has its contacts closed or opened by electromechanical devices operated by local or remote master switches?

1. H
2. F
3. D
4. B

11-7. In what controller are resistors inserted in the primary circuit of the motor to control both starting current and speed?

1. E
2. F
3. G
4. H

11-8. What controller starts the motor at a reduced voltage and then connects the motor to the supply line?

1. C
2. D
3. F
4. H

11-9. Manual bus transfer switches are most commonly used for what class of equipment or circuit?

1. Emergency
2. Nonvital
3. Vital
4. Casualty

11-10. Motor controllers are used aboard ship to start large motors because the starting current is lower than the running current.

1. True
2. False

11-11. Which of the following is NOT a manually operated master switch?

1. Drum
2. Selector
3. Toggle
4. Pressure

11-12. The contactors of a magnetic controller are operated by which of the following means?

1. Electromechanical devices
2. A remote control master switch
3. A locally controlled master switch
4. Each of the above

11-13. What type of controller is used to start a 1/4-hp dc motor?

1. A dc resistor motor controller
2. A static variable-speed controller
3. An across-the-line controller
4. An autotransformer controller

11-14. In the secondary circuit of a wound-rotor motor, what type of controller is used to insert resistance?

1. An ac secondary resistor
2. A dc secondary resistor
3. An ac primary resistor
4. An autotransformer

11-15. Which of the following is a disadvantage of an open-transition compensator?

1. The motor may slip into phase during transition
2. The resistor dissipates too much heat
3. The wound rotor has a tendency to overspeed
4. The motor may slip out of phase during transition, causing an overload

11-16. A master switch that is mounted in the controller is classified as what type of switch?

1. Local
2. Remote
3. Momentary
4. Maintaining

11-17. In a magnetic controller, what circuit is opened by an overload relay?

1. The circuit through the main contacts
2. The circuit through the master switch
3. The circuit through the control fuse element
4. The circuit through the main operating coil

11-18. Which of the following is a coarse adjustment to the thermal overload relay?

1. Changing the heater element
2. Changing the magnetic air gap
3. Increasing the distance between the heater and the sensitive unit
4. Decreasing the distance a bimetallic strip has to move to open the circuit

A. Dashpot
B. Bimetal
C. Induction
D. Solder pot
E. Single metal

Figure 1B

IN ANSWERING QUESTIONS 11-19 THROUGH 11-21, REFER TO THE TYPES OF OVERLOAD RELAYS LISTED IN FIGURE 1B.

11-19. Which relay is NOT a type of thermal overload relay?

1. A
2. B
3. C
4. D

11-20. A heat-sensitive element that lengthens when heated to open the contacts is used in which type of relay?

1. B
2. C
3. D
4. E

11-21. Which type of relay is manufactured for exclusive use in ac circuits?

1. A
2. C
3. D
4. E

11-22. In the instantaneous and time-delay magnetic overload relays, how should you adjust the current settings?

1. By replacing the heating unit
2. By changing the distance of the air gap between the armature and the coil
3. By changing the distance between the induction coil and the tube
4. By changing the distance between the heater and the heat-sensitive unit

11-23. Which of the following types of overload relays requires a time delay before it is reset?

1. Dashpot
2. Magnetic
3. Solder pot
4. Each of the above

11-24. A controller protecting a motor is able to disconnect it from the power supply, keep it disconnected, and then restart it automatically when conditions return to normal. What form of protection is the controller providing?

1. Low-voltage
2. Low-voltage release
3. Overload
4. Each of the above

11-25. One type of ac motor speed controller regulates the speed of an ac motor by performing which of the following actions?

1. Increasing and decreasing stator current
2. Switching from one set of stator windings to another
3. Increasing and decreasing the voltage of the power source
4. Shunting different values of resistance across the stator windings

11-26. A 3-phase autotransformer is used in starting 3-phase induction motors and synchronous motors because of its ability to perform what function?

1. Furnish variable voltage
2. Reverse the direction of rotation of the motor rotor
3. Switch motor stator connections from wye to delta
4. Switch motor stator connections from delta to wye

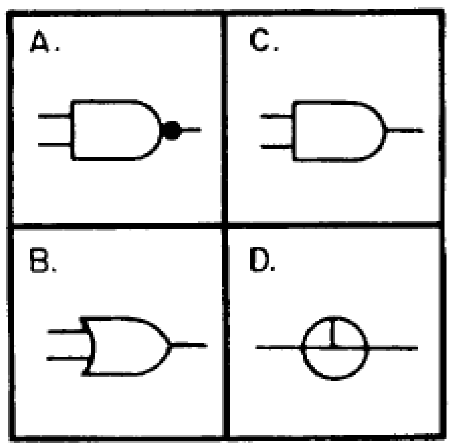

Figure 1C

IN ANSWERING REFER TO THE QUESTIONS 11-27 AND 1-28, SYMBOLS SHOWN IN FIGURE 1C.

11-27. Which logic symbol represents an AND symbol?

1. A
2. B
3. C
4. D

11-28. Which symbol represents an OR logic symbol?

1. A
2. B
3. C
4. D

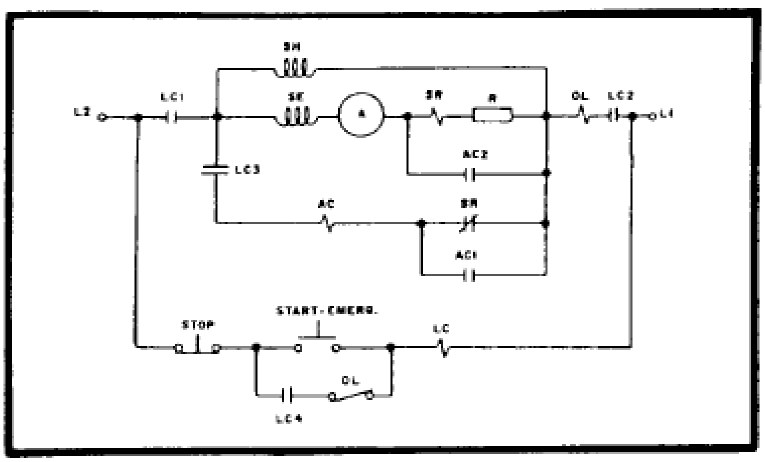

Figure 1D

IN ANSWERING QUESTIONS 1-29 THROUGH 11-32, REFER TO THE DC CONTROLLER WITH ONE STAGE OF ACCELERATION SHOWN IN FIGURE 1D.

11-29. If the start button is pressed, what action will cause line contacts LC1 and LC2 to close?

1. Closing of line contacts LC4
2. Operation of contactor coil LC
3. Operation of overload relay coil OL
4. Current flowing through armature A and contacts LC3

11-30. After closing contacts LC1, LC2, and LC3, the controller accelerates the motor. The controller connects the motor across the line in what manner?

1. By the SR contact completing the circuit to coil AC
2. By contact AC2 shorting out the starting resistor
3. By allowing coil SR to restore, closing the SR contact
4. Each of the above

11-31. After the motor is connected directly across the line, what should you do to interrupt the circuit?

1. Press the stop button
2. Press the start-emergency button
3. Short out the series relay coil
4. Short out the starting resistor

11-32. To vary the speed of the motor, how should you change the controller circuitry?

1. Disconnect the SR relay
2. Disconnect the shunt field winding
3. Connect a rheostat in series with the SH winding
4. Connect a rheostat in parallel with the AC coil

11-33. Magnetic blowout coils quench the arc across contacts by which of the following actions?

1. They increase the contact separation
2. They provide a magnetic flux that blows out the arc
3. They oppose the current flow
4. They pull the arc toward the contacts

11-34. Why are shaded coils used in an ac solenoid brake?

1. To overcome eddy currents
2. To reduce eddy currents
3. To make magnetic pull constant
4. To reduce vibration

11-35. In the operation of the torque motor brake, what action applies the brake shoes to the brake wheel?

1. The torque motor advances the jack screw upward
2. The torque motor acts to increase the pressure in the torque spring
3. The torque motor stalls, permitting the brake to act
4. The torque motor circuit opens, releasing the spring

11-36. In a series dc motor, how is dynamic breaking usually accomplished?

1. The motor is disconnected from the line
2. The armature and field are connected in series with a resistor to form a loop
3. Both 1 and 2 above
4. The field is disconnected from the line

11-37. A dc motor is slowed by dynamic braking when its turning armature generates a countervoltage that forces current through a connected braking resistor. This resistor is connected in what manner for (a) dc series-wound motors and (b) dc shunt-wound motors?

1. (a) Across the armature;
   (b) in series with the field
2. (a) In series with the field;
   (b) across the armature
3. (a) Across the armature;
   (b) across the armature
4. (a) In series with the field;
   (b) in series with the field

11-38. When dynamic braking is used with a dc shunt-wound motor, when, if ever, does the generated countervoltage equal zero?

1. When the motor armature stops turning
2. When the motor armature is turning and lifting a heavy load
3. When the brake is energized
4. Never

IN ANSWERING QUESTION 11-39, REFER TO TABLE 11-4 IN YOUR TEXTBOOK.

11-39. If controller contact tips overheat, what action(s) should maintenance personnel take?

1. Replace the blowout coil
2. Clean and adjust the contacts
3. Instruct the operator in the correct operation
4. Replace the shading coil

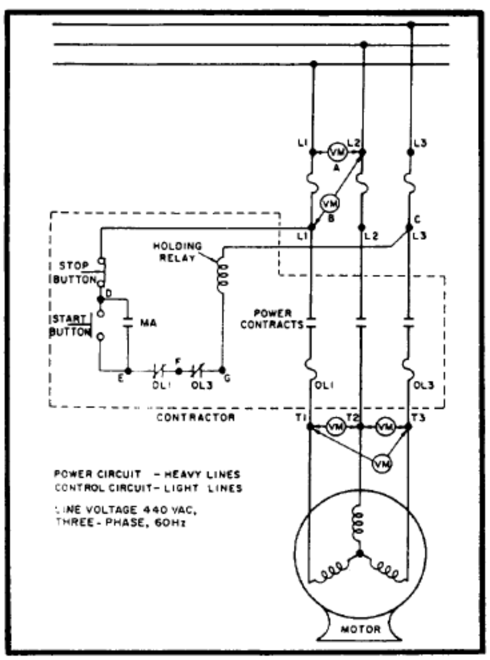

Figure 1E

IN ANSWERING QUESTIONS 11-40 AND 11-41, REFER TO THE 3-PHASE MAGNETIC LINE STARTER SHOWN IN FIGURE 1E.

11-40. If a voltage is read at position A, and no voltage is present at position B, which of the following statements is true?

1. The voltmeter is defective
2. All fuses are good
3. L1 fuse is defective
4. L2 fuse is defective

11-41. With the start button depressed, what voltage will be present between points B and D?

1. 440 V
2. 220 V
3. 110 V
4. 0 V

10-42. To ensure a wide variety of whistle characteristics, the fundamental frequency of a whistle must be between which of the following defined limits?

1. 200 to 500 Hz, for a ship less than 75 meters (240 feet) long
2. 100 to 300 Hz, for a ship 75 to 200 meters (240 to 650 feet) long
3. 130 to 600 Hz, for a ship more than 200 meters (650 feet) long
4. 130 to 350 Hz, for a ship 75 to 200 meters (240 feet to 650 feet) long