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# ELECTRONICS WARFARE TECHNICIAN 3 & 2

NAVAL EDUCATION AND TRAINING COMMAND  
RATE TRAINING MANUAL AND NONRESIDENT CAREER COURSE  
NAVEDTRA 10127-A

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The Nonresident Career Course pages have been perforated for removal to permit easier use in course completion. When the course is removed, the classified pages must be properly safeguarded in accordance with the classification requirements of OPNAVINST 5510.1 series.

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## PREFACE

This Rate Training Manual and Nonresident Career Course (RTM/NRCC) form a self-study package that will enable ambitious Electronics Warfare Technicians to help themselves fulfill the requirements of their rating. Among these requirements are the abilities to maintain, repair and operate Electronics Warfare equipment and to maintain records and prepare requisitions and reports.

Designed for individual study and not formal classroom instruction, the RTM provides subject matter that relates directly to the occupational qualifications of the Electronic Warfare rating. The NRCC provides the usual way of satisfying the requirements for completing the RTM. The set of assignments in the NRCC includes learning objectives and supporting items designed to lead students through the RTM.

This training manual and nonresident career course was prepared by the Naval Education and Training Program Development Center, Pensacola, Florida, for the Chief of Naval Education and Training. Technical assistance was provided by Commander, Naval Electronics Systems Command, Washington, D.C.

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# **THE UNITED STATES NAVY**

## **GUARDIAN OF OUR COUNTRY**

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

## **WE SERVE WITH HONOR**

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

## **THE FUTURE OF THE NAVY**

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.



## CONTENTS

CHAPTER	Page
1. The Electronics Warfare Technician . . . . .	1
2. Missions and Functions of CIC . . . . .	11
3. Basic Concepts of EW . . . . .	23
4. ESM Systems . . . . .	49
5. ESM Antennas and Control Unit . . . . .	109
6. Blankers and Preamplifiers . . . . .	119
7. EW Recording Devices . . . . .	135
8. ECM Systems . . . . .	147
9. EW Publications and Instructions . . . . .	179
10. Signal Analysis and Identification . . . . .	185
11. Communications . . . . .	201
12. EW Status Boards, Logs and Plots . . . . .	225
13. EMCON . . . . .	237
14. ELINT Collection and Reporting Procedures . . . . .	250
15. Maintenance and Test Equipment . . . . .	265
 APPENDIX	
I. Glossary . . . . .	271
INDEX . . . . .	293
 Nonresident Career Course follows Index	

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## CHAPTER 1

## THE ELECTRONICS WARFARE TECHNICIAN

This training manual has been prepared for men of the regular Navy and the Naval Reserve, not only to assist you in attaining advancement but also to increase your knowledge in the various aspects of the Electronics Warfare rating. The maintenance and operational standards used in the preparation of this manual are contained in the *Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards*, NAVPERS 18068 (series), and will not be repeated in this manual. It is recommended that you study the first section of NAVPERS 18068 to gain an understanding of the skills and knowledge required of an Electronics Warfare Technician.

This manual has been organized to give you a systematic understanding of your job. For information about the material covered in the manual, refer to the table of contents. Study the subject matter of this manual carefully. It will not only help you toward advancement but will expand your knowledge of combat information center (CIC) operations. This knowledge will enable you to become a more proficient operator and the Navy will profit from the skills of a proficient craftsman.

Your contribution to the Navy depends upon your willingness and ability to accept increasing responsibilities as you advance in rate. When you assume the duties of an EW, you begin to accept certain responsibilities for the work of others. As you advance in your career, you accept responsibilities in military matters as well as the occupational requirements of the EW rating.

Your responsibilities for military leadership are about the same as those of petty officers in other ratings since every petty officer is a military man as well as a technical specialist.

Your responsibilities for technical leadership are special to your rating and directly related to your work as an EW. The operation and maintenance of a ship's CIC requires teamwork. It requires a special kind of leadership ability that can be developed only by personnel who have a high degree of technical competence and a deep sense of personal responsibility. Strive to improve your leadership ability and technical knowledge through study, observation, and practical application.

ENLISTED RATING  
STRUCTURE

The two main types of ratings in the present enlisted rating structure are general ratings and service ratings.

GENERAL RATINGS identify broad occupational fields of related duties and functions. Some general ratings include service ratings; others do not. Both Regular Navy and Naval Reserve personnel may hold general ratings. An example of a general rating is EW.

SERVICE RATINGS identify subdivisions or specialties within a general rating. Although service ratings can exist at any petty officer level, they are most common at the PO3 and PO2 levels. Both Regular Navy and Naval Reserve personnel may hold service ratings. Examples of service ratings are STG, STS, GMG, and GMM.

ELECTRONICS WARFARE  
TECHNICIAN RATING

Navy ratings are divided into a total of 9 occupational areas known as Defense Grouping

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(DG) NECs, with ratings in each particular group related occupationally. The Electronics Warfare Technician rating is a general rating in DG-9720, commonly called the communication and intelligence specialist group.

An Electronics Warfare Technician is an important man in the combat readiness of his ship. An enemy can be engaged only after he is detected, and your ship's ability to detect an airborne, subsurface, or surface enemy depends upon your alertness and skill as an Electronics Warfare Technician.

Yours is an ever-changing and challenging rating. The Navy is constantly developing new equipment and procedures in Electronic Support Measures (ESM) and Electronic Countermeasures (ECM), as well as radar and communications. All of these new developments are worthless without skilled personnel to maintain and operate them properly.

You will be required to stand watches in the EW module on sound-powered phones, radio circuits, ESM and ECM equipment, as well as the various status boards and plots.

As you study this text, you are preparing yourself for Electronics Warfare Technician third or second. When you are promoted to Electronics Warfare Technician third class, you become a petty officer of the United States Navy. Your responsibility as a petty officer breaks down into two types of duties: professional and military.

You learned—or will learn—your military duties from *Military Requirements for Petty Officer 3 & 2*, NAVPERS 10056 (series). Your professional duties as an Electronics Warfare Technician 3 & 2 vary, depending upon the type of ship and number of men in your division. As an Electronics Warfare Technician you will be required to operate and perform organizational and intermediate maintenance on Electronic Warfare equipment (in the near future you will have to operate and maintain a variety of equipments such as infrared, lasers, and computers). You will extract, interpret, and apply data from intelligence publications, reports, and other documentation; evaluate, interpret, and determine equipment capabilities and limitations; intercept, evaluate, and identify intercepted signal information; evaluate, interpret, process, and apply intercepted signal

data for ELINT reports; train and supervise personnel in EW assignments; supervise the preparation of electronic warfare reports; inform the Electronics Warfare Officer (EWO) and CIC Officer concerning the nature of threat signals, and recommend appropriate countermeasures; and possibly serve as assistant EWO. Additionally, you may be assigned as an instructor in one of the schools that provides training in subjects dealing with electronic warfare.

Keep in mind that the EW duties listed here vary from ship to ship. The personnel problems of any ship determine the amount of work required of an Electronics Warfare Technician 3 or 2. The condition of the equipment, training status of the men, and keeping accurate, up-to-date records, logs and reports—all of these functions are a direct reflection on the ability of a petty officer 3 or 2.

Responsibility of a petty officer doesn't stop with putting on the "crow". He must learn what has to be done, how to do it, then do it to the best of his ability. Performing on the job in this manner, the petty officer's confidence blossoms and flourishes and so does the confidence others have in him. Doubt has no place in EW. Ships, missiles, and aircraft move at such great speed that there is no room for mistakes. Occasionally the evaluator, EW officer, and even the Captain will ask advice from the EW 3 or 2 and they must have confidence in his recommendations. Never try to "bull" your way through a situation; if you don't know the answer say so, otherwise you are just destroying the trust placed upon you.

The burden of defense rests squarely on the shoulder of the personnel responsible for the maintenance and operation on the early warning equipment such as ESM, ECM, radar and other electromagnetic detection devices. It is vital that the Electronics Warfare Technician understands this problem and accepts the responsibility. All newly acquired missiles and weapons are of no value unless the enemy is first detected.

When you become a third or second class petty officer, your status will be that of a leader of men. Effective leadership is based on personal example, good management practices, and moral responsibility. Your timely and adequate preparation in the organization and training of

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your men, and the maintenance of your equipment is the key to an effectively functioning Electronics Warfare team.

### THE NAVY ENLISTED ADVANCEMENT SYSTEM

Many of the rewards of Navy life are earned through the advancement system. The basic ideas behind the system have remained stable for many years, but specific portions may change rather rapidly. It is important that you know the system and follow changes carefully. BUPERS Notices 1418 will normally keep you up to date.

The normal system of advancement may be easier to understand if it is broken into two parts:

1. Those requirements that must be met before you may be considered for advancement.
2. Those factors that actually determine whether or not you will be advanced.

### QUALIFYING FOR ADVANCEMENT

In general, to QUALIFY (be considered) for advancement, you must first:

1. Have a certain amount of time in pay grade.
2. Demonstrate knowledge of material in your mandatory Rate Training Manuals by achieving a suitable score on your command's test, by successfully completing the appropriate NRCCs or, in some cases, by successfully completing an appropriate Navy school.
3. Demonstrate the ability to perform the Personnel Advancement Requirement (PAR) Program, NAVPERS 1414/4.
4. Be recommended by your commanding officer.
5. For petty officer third and second candidates ONLY, demonstrate knowledge of military subjects by passing a locally administered MILITARY/LEADERSHIP examination based on the naval standards for advancement (from NAVPERS 18068 (series)).

6. Demonstrate knowledge of the technical aspects of your rate by passing a Navywide advancement examination based on the occupational standards applicable to the rate for which you are competing and those at and below your rate level.

Figure 1-1 gives a detailed view of the requirements for advancement of active duty personnel; figure 1-2 gives this information for inactive duty personnel. Remember that the occupational standards can change. Check with your division officer or training officer to be sure that you know the most recent standards.

If you meet all of the above requirements satisfactorily, you become a member of the group from which advancements will be made.

### WHO WILL BE ADVANCED?

Advancement is not automatic. Meeting all of the requirements makes you eligible but does not guarantee your advancement. Some of the factors that determine which persons, out of all of those QUALIFIED, will actually be advanced in rate are the score made on the advancement examination, the length of time in service, the performance marks earned, and the number of vacancies being filled in a given rate.

If the number of vacancies in a given rate exceed the number of qualified personnel, then ALL of those qualified will be advanced. More often, the number of qualified people exceeds the vacancies. When this happens, the Navy has devised a procedure for advancing those who are BEST qualified. This procedure is based on combining three personnel evaluation systems:

- Merit rating system (Annual evaluation and C.O. recommendation),
- Personnel testing system (Advancement examination score—with some credit for passing previous advancement exams)
- Longevity (seniority) system (Time in Rate and Time in Service)

Simply, credit is given for how much the individual has achieved in the three areas of performance, knowledge, and seniority. A composite, known as the final multiple score, is



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REQUIREMENTS*	E1 to E2	E2 to E3	#E3 to E4	#E4 to E5	E5 to E6	##+E6 to E7	##+E7 to E8	##+E8 to E9
SERVICE	6 mos. service.	6 mos. as E-2.	6 mos. as E-3. 2 years time in service.	12 mos. as E-4. 3 years time in service.	24 mos. as E-5. 7 years time in service.	36 mos. as E-6. 10 years time in service.	36 mos. as E-7. 8 of 13 years time in service must be enlisted.	36 mos. as E-8. 10 of 16 years time in service must be enlisted.
SCHOOL	Recruit Training. (C.O. may advance up to 10% of graduating class.)		Class A for PR3, DT3, IS3, AME3, HM3, FTB3, MT3, MU3, EW3	Naval Justice School LN2		Navy School for AGC, MUC.++		
PERSONNEL ADVANCEMENT REQUIREMENT (PAR) NAVPERS 1414/4			Personnel Advancement Requirement (PAR) must be completed for advancement to E-4 through E-7.					
PERFORMANCE TEST			Specified ratings must complete applicable performance tests before taking examinations.					
ENLISTED PERFORMANCE EVALUATION	As used by CO when approving advancement.		Counts toward performance factor credit in advancement multiple.					
EXAMINATIONS**	Locally prepared tests.	See below.	Navywide examinations required for all PO advancements.			Navywide selection board.		
RATE TRAINING MANUAL (INCLUDING MILITARY REQUIREMENTS)		Required for E-3 and all PO advancements unless waived because of school completion, but need not be repeated if identical course has already been completed. See NAVEDTRA 10052 (current edition).				Nonresident career courses and recommended reading. See NAVEDTRA 10052 (current edition).		
AUTHORIZATION	Commanding Officer		NAVEDTRAPRODEVGEN					

\*All advancements require commanding officer's recommendation.

+2 years obligated service required for E-7, E-8, and E-9.

#Military leadership exam required for E-4 and E-5.

\*\*For E-2 to E-3, NAVEDTRAPRODEVGEN exams or locally prepared tests may be used.

++Waived for qualified EOD personnel.

##Advancement to E-7 will be 10 years TIS effective 1 January 1979; to E-8, 13 years TIS effective 1 November 1978; to E-9, 16 years TIS effective 1 November 1978.

Figure 1-1.—Active duty advancement requirements.

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REQUIREMENTS*	E1 to E2	E2 to E3	E3 to E4	E4 to E5	E5 to E6	E6 to E7	E8	E9
TOTAL TIME IN GRADE	6 mos.	6 mos.	6 mos.	12 mos.	24 mos.	36 mos. with total 9 yrs service.	36 mos. with total 12 yrs service.	24 mos. with total 15 yrs service.
TOTAL TRAINING DUTY IN GRADE†	14 days	14 days	14 days	14 days	28 days	42 days	42 days	28 days
PERFORMANCE TESTS	Specified ratings must complete applicable performance tests before taking examination.							
DRILL PARTICIPATION	Satisfactory participation as a member of a drill unit in accordance with BUPERSINST 5400.42 series.							
PERSONNEL ADVANCEMENT REQUIREMENT (PAR) NAVPERS 1414/4	Personnel Advancement Requirements (PAR) NAVPERS 1414/4 must be completed for advancement to E4 through E7.							
RATE TRAINING MANUAL (INCLUDING MILITARY REQUIREMENTS)	Completion of applicable course or courses must be entered in service record.							
EXAMINATION	Standard Exam		Standard Exam required for all PO advancements. Also pass Military Leadership Exam for E4 and E5.				Standard Exam Selection Board.	
AUTHORIZATION	Commanding Officer		NAVEDTRAPRODEVCCEN					

\*Recommendation by commanding officer required for all advancements.

†Active duty periods may be substituted for training duty.

Figure 1-2.—Inactive duty advancement requirements.

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generated from these three factors. All of the candidates who have PASSED the examination from a given advancement population are then placed on one list. Based on the final multiple score, the person with the highest multiple score is ranked first, and so on, down to the person with the lowest multiple score. For candidates for E-4, E-5, and E-6, advancement authorizations are then issued, beginning at the top of the list, for the number of persons needed to fill the existing vacancies. Candidates for E-7 whose final multiple scores are high enough will be designated PASS SELBD ELIG (Pass Selection Board Eligible). This means that their names will be placed before the Chief Petty Officer Selection Board, a BUPERS board charged with considering all so-designated eligible candidates for advancement to CPO. Advancement authorizations for those being advanced to CPO are issued by this board.

Who, then, are the individuals who are advanced? Basically, they are the ones who achieved the most in preparing for advancement. They were not content to just qualify; they went the extra mile in their training, and through that training and their work experience they developed greater skills, learned more, and accepted more responsibility.

While it cannot guarantee that any one person will be advanced, the advancement system does guarantee that all persons within a particular rate will compete equally for the vacancies that exist.

**HOW TO PREPARE FOR ADVANCEMENT**

What must you do to prepare for advancement? You must study the occupational standards, work on the PARS, study the required rate training manuals, and study other material that is required for advancement in your rate. To prepare for advancement, you will need to be familiar with (1) the *Occupational Standards Manual*, (2) the Personnel Advancement Requirement (PAR) Program, (3) a publication called *Bibliography for Advancement Study*, NAVEDTRA 10052, and (4) applicable rate training manuals. The

following sections describe them and give you some practical suggestions on how to use them in preparing for advancement.

**Occupational Standards**

Section I of the *Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards*, NAVPERS 18068 (series) contains the occupational standards and naval standards for advancement to each paygrade. Contained in section II are the Navy Enlisted Classification Codes. This manual replaces the "quals manual" and the NEC manual.

NAVAL STANDARDS are requirements that apply to all ratings rather than to any one particular rating. Naval requirements for advancement to third class and second class petty officer rates deal with military conduct, naval organization, military justice, security, watch standing, and other subjects which are required of petty officers in all ratings.

OCCUPATIONAL STANDARDS are requirements that are directly related to the work of each rating.

Both the naval requirements and the occupational standards are divided into subject matter groups.

You are required to pass a Navywide military/leadership examination for E-4 or E-5, as appropriate, before you take the occupational examinations. The military/leadership examinations are administered on a schedule determined by your commanding officer. Candidates are required to pass the applicable military/leadership examination only once. Each of these examinations consists of 100 questions based on information contained in *Military Requirements for Petty Officer 3 & 2*, NAVEDTRA 10056 (series) and in other publications listed in *Bibliography for Advancement Study*, NAVEDTRA 10052 (series).

The Navywide occupational examinations for paygrades E-4 and E-5 contain 150 questions related to occupational areas of your rating.

If you are working for advancement to second class, remember that you may be examined on third class standards as well as on second class standards.

NAVPERS 18068 is kept current by means of changes. The occupational standards for your rating which are covered in this training manual were current at the time the manual was printed. By the time you are studying this manual, however, the standards for your rating may have been changed. Never trust any set of standards until you have checked it against an UP-TO-DATE copy in the NAVPERS 18068.

**Personnel Advancement  
Requirement (PAR)  
Program, NAVPERS 1414/4**

The Personnel Advancement Requirement (PAR) Program is a new program initiated to replace the Record of Practical Factors (NAVEDTRA 1414/1).

The former "quals" were stated in terms of practical factors and knowledge factors. The new occupational standards are presented only as task statements. This new format of the occupational standards does not lend itself to the practical factor checkoff list concept of the Record of Practical Factors. As a result, a new form and new concept of determining eligibility for advancement has been developed. The Personnel Advancement Requirement (PAR) (NAVPERS 1414/4) will replace the Record of Practical Factors. This new system allows a command to evaluate the overall abilities of an individual in a day-to-day work situation and eliminates the need to complete a mandatory, lengthy, and detailed checkoff list.

The E-8 and E-9 are exempted from the program as there are other means of selection for advancement to these paygrades. The E-3 apprenticeships are so broad as to make the development of a single PAR impractical.

Each rating PAR lists the requirements for advancement to paygrades E-4 through E-7 in one pamphlet. It contains descriptive information, instructions for administration, special rating requirements, and advancement requirements in the following sections:

- Section I—Administrative Requirements
- Section II—Formal School and Training Requirements
- Section III—Occupational and Military Ability Requirements

Section I contains the individual's length of service, time in rate, and a checkoff for the individual having passed the E-4/E-5 Military Leadership Examination.

Section II contains a checkoff entry for the individual having completed the Military Requirements Navy Training Course and the applicable Navy Training Course for the rating.

Section III is a checkoff list of task statements. Items in this section are to be interpreted broadly and do not demand actual demonstration of the item, or completion of alternate local examination, although demonstration is a command prerogative. Individuals are evaluated on their ability to perform the task whether it be by observation of ability in related areas, training received or, if desired, by demonstration.

There is currently a pilot program which includes the PQS watch station qualifications and preventive maintenance actions as a separate section of the PAR form. Section III under this program lists task statements required of the rating which are not reflected in the PQS qualifications. As PQS qualifications are developed, PAR forms will be revised.

PAR forms are stocked in the Navy Supply System.

**NAVEDTRA 10052**

*Bibliography for Advancement Study*, NAVEDTRA 10052 is a very important publication for any enlisted person preparing for advancement. This Bibliography lists required and recommended rate training manuals and other reference material to be used by personnel working for advancement.

NAVEDTRA 10052 is revised and issued once each year by the Naval Education and Training Command. Each revised edition is identified by a letter following the NAVEDTRA number. When using this publication, be SURE that you have the most recent edition.

If extensive changes in standards occur in any rating between the annual revisions of NAVEDTRA 10052, a supplementary list of study material may be issued in the form of a BUPERS Notice. When you are preparing for advancement, check to see whether changes have been made in the standards for your rating. If

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changes have been made, see if a BUPERS Notice has been issued to supplement NAVEDTRA 10052 for your rating.

The required and recommended references are listed by paygrade in NAVEDTRA 10052. If you are working for advancement to third class, study the material that is listed for third class. If you are working for advancement to second class, study the material that is listed for second class; but remember that you are also responsible for the references listed in the third class level.

In using NAVEDTRA 10052, you will notice that some rate training manuals are marked with an asterisk (\*). Any manual marked in this way is MANDATORY—that is, it must be completed at the indicated rate level before you can be eligible to take the Navywide examination for advancement. Each mandatory manual may be completed by (1) passing the appropriate nonresident career course that is based on the mandatory training manual; (2) passing locally prepared tests based on the information given in the training manual; or (3) in some cases successfully completing an appropriate naval school.

Do not overlook the section of NAVEDTRA 10052 which lists the required and recommended references relating to the naval standards for advancement. Personnel of ALL ratings must complete the mandatory military requirements training manual for the appropriate rate level before they can be eligible to advance.

The references in NAVEDTRA 10052 which are recommended but not mandatory should also be studied carefully. ALL references listed in NAVEDTRA 10052 may be used as source material for the written examinations, at the appropriate rate levels.

**Rate Training Manuals**

There are two general types of rate training manuals. RATING manuals (such as this one) are prepared for most enlisted ratings. A rating

manual gives information that is directly related to the occupational standards of ONE rating. SUBJECT MATTER manuals or BASIC manuals give information that applies to more than one rating.

Rate training manuals are revised from time to time to keep them up to date technically. The revision of a rate training manual is identified by a letter following the NAVEDTRA number. You can tell whether any particular copy of a training manual is the latest edition by checking the NAVEDTRA number and the letter following this number in the most recent edition of *List of Training Manuals and Correspondence Courses*, NAVEDTRA 10061. (NAVEDTRA 10061 is actually a catalog that lists all current training manuals and courses; you will find this catalog useful in planning your study program.)

Each time a rate training manual is revised, it is brought into conformance with the official publications and directives on which it is based; but during the life of any edition, discrepancies between the manual and the official sources are almost certain to arise because of changes to the latter which are issued in the interim. In the performance of your duties, you should always refer to the appropriate official publication or directive. If the official source is listed in NAVEDTRA 10052, the Naval Education and Training Program Development Center uses it as a source of questions in preparing the fleetwide examinations for advancement. In case of discrepancy between any publications listed in NAVEDTRA 10052 for a given rate, the examination writers will use the most recent material.

Rate training manuals are designed to help you prepare for advancement. The following suggestions may help you to make the best use of this manual and other Navy training publications when you are preparing for advancement.

1. Study the naval standards and the occupational standards for your rating before you study the training manual, and refer to the standards frequently as you study. Remember, you are studying the manual primarily in order to meet these standards.

2. Set up a regular study plan. It will probably be easier for you to stick to a schedule



if you can plan to study at the same time each day. If possible, schedule your studying for a time of day when you will not have too many interruptions or distractions.

3. Before you begin to study any part of the manual intensively, become familiar with the entire book. Read the preface and the table of contents. Check through the index. Thumb through the book without any particular plan, looking at the illustrations and reading bits here and there as you see things that interest you.

4. Look at the training manual in more detail, to see how it is organized. Look at the table of contents again. Then, chapter by chapter, read the introduction, the headings, and the subheadings. This will give you a pretty clear picture of the scope and content of the book. As you look through the book in this way, ask yourself some questions:

- What do I need to learn about this?
- What do I already know about this?
- How is this information related to information given in other chapters?
- How is this information related to the occupational standards?

5. When you have a general idea of what is in the training manual and how it is organized, fill in the details by intensive study. In each study period, try to cover a complete unit—it may be a chapter, a section of a chapter, or a subsection. The amount of material that you can cover at one time will vary. If you know the subject well, or if the material is easy, you can cover quite a lot at one time. Difficult or unfamiliar material will require more study time.

6. In studying any one unit—chapter, section, or subsection—write down the questions that occur to you. Many people find it helpful to make a written outline of the unit as they study, or at least to write down the most important ideas.

7. As you study, relate the information in the training manual to the knowledge you

already have. When you read about a process, a skill, or a situation, try to see how this information ties in with your own past experience.

8. When you have finished studying a unit, take time out to see what you have learned. Look back over your notes and questions. Maybe some of your questions have been answered, but perhaps you still have some that are not answered. Without looking at the training manual, write down the main ideas that you have gotten from studying this unit. Don't just quote the book. If you can't give these ideas in your own words, the chances are that you have not really mastered the information.

9. Use nonresident career courses whenever you can. The courses are based on rate training manuals or on other appropriate texts. As mentioned before, completion of a mandatory rate training manual can be accomplished by passing a nonresident career course based on the rate training manual. You will probably find it helpful to take other courses, as well as those based on mandatory manuals. Taking a course helps you to master the information given in the training manual, and also helps you see how much you have learned.

10. Think of your future as you study rate training manuals. You are working for advancement to third class or second class right now, but some day you will be working toward higher rates. Anything extra that you can learn now will help you both now and later.

### SOURCES OF INFORMATION

Besides training manuals, NAVEDTRA 10052 lists official publications on which you may be examined. You should not only study the sections required, but should become as familiar as possible with all publications you use.

One of the most useful things you can learn about a subject is how to find out more about it. No single publication can give you all the information you need to perform the duties of

**UNCLASSIFIED**

your rating. You should learn where to look for accurate, authoritative, up-to-date information on all subjects related to the naval requirements for advancement and the occupational standards of your rating.

**PUBLICATIONS  
YOU SHOULD KNOW**

Chapter 9 of this training manual discusses most of the publications you will use. The detailed information you need for advancement and for everyday work is contained in them. Some are subject to change or revision from time to time, some at regular intervals, others as the need arises. When using any publication that is subject to change or revision, be sure that you have the latest edition. When using any publication that is kept current by means of changes, be sure you have a copy in which all official changes have been made. Studying canceled or obsolete information will not help you to do your work or to advance; it is likely

to be a waste of time, and may even be seriously misleading.

**TRAINING FILMS**

Training films available to naval personnel are a valuable source of supplementary information on many technical subjects. Training films are listed in the *United States Navy Film Catalog*, NAVAIR 10-1-777 (formerly NAVWEPS 10-1-777), published in 1969. Copies may be ordered in accordance with the *Navy Stock List of Forms and Publications*, NAVSUP 2002. Monthly supplements to the Film Catalog are distributed to catalog holders.

When selecting a film, note its date of issue listed in the Film Catalog. As you know, procedures sometimes change rapidly. Thus some films become obsolete rapidly. If a film is obsolete only in part, it may sometimes be shown effectively if before or during its showing you carefully point out to trainees the procedures that have changed.

**METRIC SYSTEM**

The Metric System Single-Subject Training Manual and its associated OCC-ECC form a self-study package (NAVEDTRA 475-01-00-75) to train Navy personnel in conversion from the U.S. Customary System to the International System (SI). Your Educational Services Officer can order the course and text on NAVEDTRA Form 1550/1, using the course number 475-01-00-75-1 from NAVEDTRAPRODEVEN, Pensacola, Florida, 32559. To order ONLY the text, order by stock number 0507-LP-475-0000 from NPFC, Philadelphia, Pennsylvania, 19120.

## **CHAPTER 2**

# **MISSIONS AND FUNCTIONS OF CIC**

### **MISSIONS OF CIC**

(U) The primary mission of CIC is to provide for the collection, display, evaluation, and dissemination of pertinent tactical information and intelligence to command and control stations. CIC is responsible for keeping conn advised, at all times, of the current tactical situation. Conn may be in the person of the commanding officer or whomever he has delegated as his representative (ordinarily the OOD).

(U) A secondary and equally important mission of CIC is to control and/or assist in specific operations as delegated by proper authority.

### **FUNCTIONS OF CIC**

(U) Information handling comprises five major functions: gathering, processing, displaying, evaluating, and disseminating information and orders. All information handling must be considered a continuous and growing process that ultimately furnishes a composite picture of a situation, enabling the commanding officer to make a final evaluation and give his orders for action. Following is a brief discussion of each of the functions of CIC.

#### **GATHERING INFORMATION**

(U) Gathering is the collection of information from various sources. Combat information from the following sources is either gathered in or made available to CIC. All must be used to attain maximum effectiveness.

1. Radars
2. Voice radio

3. Radio messages
4. Radio direction finders
5. Electronic warfare equipment
6. IFF
7. Sonar
8. Depth sounder
9. Naval tactical data systems (NTDS)
10. Visual sources, such as optical rangefinders, lookouts, signal bridge, and conn
11. Internal sources, such as sound-powered telephones, MC units, ship's service telephones, and messengers
12. Intelligence reports
13. Publications, such as the NWP, ATP, ACP series
14. OPLANS and OPORDERS
15. Charts and navigational data
16. Aerological observations, reports, and forecasts
17. Current instructions, notices, and directives

#### **PROCESSING INFORMATION**

(U) When information from the preceding sources is received, it is processed so that all nonessential information can be eliminated. This processing step consists of sorting, inspecting, appraising, and correlating all information so that the resulting filtered information may be displayed and disseminated as necessary.

#### **DISPLAYING INFORMATION**

(U) The function of displaying information is accomplished by CIC through the use of various tactical and strategic plots, status boards, and other means. These include the following devices, some of which are explained in greater

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detail later in this chapter and in subsequent chapters.

1. Summary plots
2. Status boards
3. Surface plots
4. Strategic plots
5. Geographic plots
6. NTDS consoles (on NTDS ships)
7. Maps and charts
8. Television
9. Logs and records

4. Control of small craft
5. Control of own ship's maneuvers during antisubmarine operations
6. Control of other vessels as may be assigned
7. Control of weapons and electronic countermeasures to defend the ship against antiship missiles

(U) CIC may also be charged with the responsibility of providing assistance to, and coordinating with other internal or external agencies. Such assistance may be provided during the following evolutions:

**EVALUATING INFORMATION**

(U) Evaluation is the process of considering and weighing all available factors and pieces of information in order to arrive at a sound operational decision which may be passed on as a recommendation to command and such other stations as may be appropriate, or, when authorized, acted upon in CIC. In addition, information is evaluated in order to isolate items of tactical value from other information in order to provide a comprehensive tactical picture to the command.

1. Navigation and plotting
2. Antisubmarine operations
3. Antiaircraft operations
4. Antisurface operations
5. Missile defense
6. Target indication, designation, and acquisition
7. Shore bombardment
8. Search and rescue operations
9. Tactical deception
10. Tactical maneuvers

**DISSEMINATING INFORMATION**

(U) Dissemination is the process of distributing information which has been collected, processed, displayed, and evaluated to the various control stations and others throughout the ship who need to know. The dissemination of evaluated information will be accomplished in a clear, concise manner via the various communication means available.

**Target Designation and Acquisition**

(U) CIC is tasked with the responsibility of coaxing the fire control radars onto any potential threat target. Reaction time is critical, particularly if the target is an incoming missile or high-speed aircraft.

(U) CIC must alert the fire control directors when a threat is approaching and report frequent positions when the target enters the fire control radar range. Rapid acquisition of the target permits the destruction of the threat by guns or missiles, at the greatest possible distance from the ship.

**CONTROL AND ASSIST FUNCTIONS**

(U) CIC may be called upon to exercise direct control of various operations, which may include any of the following:

**Search and Rescue (SAR) Operations**

1. Control of electromagnetic radiations
2. Control of offensive and defensive operations of manned aircraft
3. Control of helicopters for vertical envelopment

(U) The initial action of the station first made aware of a distress situation is of the utmost importance and may mean the difference between a fruitless search and a successful one. As an ESM operator, you may well be the first person to become aware of a distress situation,

and you must be prepared to react accordingly. Emergency IFF responses and/or transmissions on one of the voice radio distress circuits may last only a few seconds. Therefore, you must quickly obtain a bearing to the IFF or to the station transmitting the distress on the radio circuit and pass this information on to your supervisor.

(C) Two distress voice radio signals denote the type of emergency of an aircraft in distress.

1. (C) PAN: The word "pan" spoken three times and followed by the aircraft's call means the pilot has a very urgent message to transmit concerning the safety of a ship, aircraft, or other vehicle or of some person on board or in sight.

2. (C) MAYDAY: The word "mayday" spoken three times and followed by the aircraft's call means the pilot is threatened with danger and needs help immediately.

(U) A lost aircraft may be discovered by a radar operator because of the pattern he is flying. For example, a lost aircraft that has only a receiver will switch to one of the distress frequencies and fly a right-hand triangular pattern. When the lost aircraft has no receiver, he will fly a left-hand triangle.

(U) Anytime you observe an aircraft flying a triangular pattern, the position must be reported immediately to your watch supervisor.

(U) Obtaining an accurate position of a unit in distress is vital because all SAR operations are based upon the last known position.

(U) CIC is the coordinating station for all air, surface, or subsurface SAR operations. CIC is responsible for the following:

1. Recommending course and speed to the scene, search plans, and procedures to be followed throughout the operations

2. Establishing and maintaining communications on all of the SAR voice radio circuits

3. Providing conn and other interested stations with all available information pertaining to the SAR incident, including the description, capabilities and limitations, and characteristics of the platform in distress

(U) An SAR incident can rarely be anticipated. Therefore, every CIC watchstander must have a thorough knowledge of the SAR procedures as outlined in the CIC doctrine for his particular ship. You must be prepared to act quickly and correctly because in every SAR operation human lives are at stake.

### **CIC DOCTRINE**

(U) A chief source of information, helpful in indoctrinating new personnel in CIC operation, is the CIC doctrine. The objective of the CIC doctrine is to put in writing the correct procedures and organizational structure of the particular CIC. Figure 2-1 shows an example of the organization of the CIC group within the operations department.

(U) The CIC doctrine normally contains all of the operational, training, emergency, and destruction bills to which CIC personnel are assigned. It also contains the duties and responsibilities of all the officer and enlisted personnel assigned to CIC. You must become familiar with the contents of your CIC doctrine.

### **OPERATIONS DEPARTMENT ORGANIZATION**

(U) In addition to familiarizing yourself with CIC organization, you must also acquaint yourself with the makeup of the operations department. The operations officer heads the department. He normally has several assistants. The EW officer and the assigned division officers are the ones you will be working for. From time to time they will assign you tasks requiring a thorough knowledge of the entire ship's administrative command structure as well as the departmental organization. For a better understanding of the operations department and how it fits into the shipboard administrative organization, refer to figures 2-2, 2-3, and 2-4.

(U) Figure 2-2 typifies a "universal" type of administrative organization and therefore is not representative of a particular ship. All departments of a typical ship are included, and the relationship of each department in the



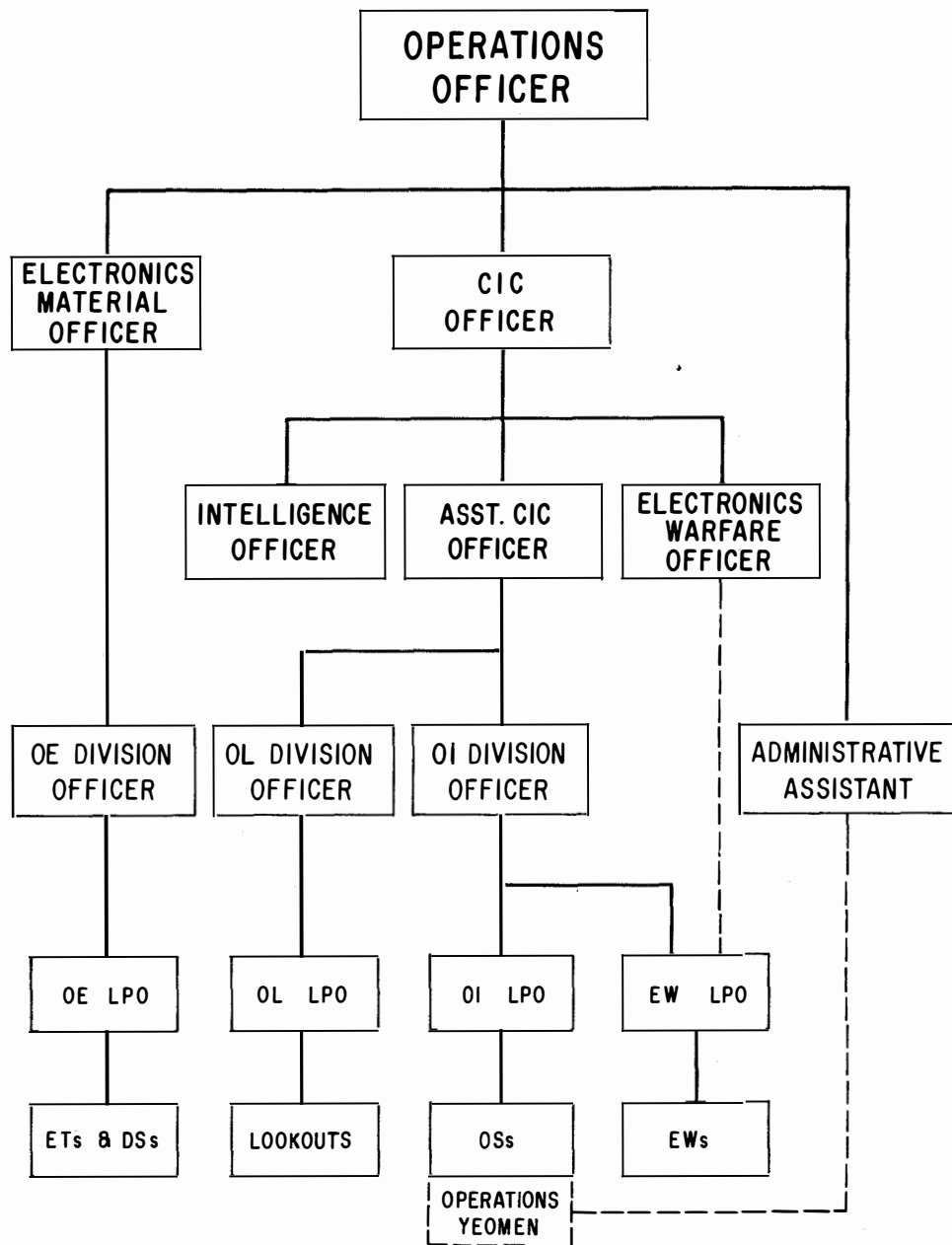
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Figure 2-1.—(U) CIC organization within the operations department (U).

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overall administrative organization is shown. Notice especially that the operations department is responsible for these functions: preparation of operation plans, preparation of operational training schedules, visual and electronic search

intelligence, operational evaluation, combat information, operational control of airborne aircraft, electronic countermeasures, radio and visual communications, issuance control of Tactical Warfare Publications,

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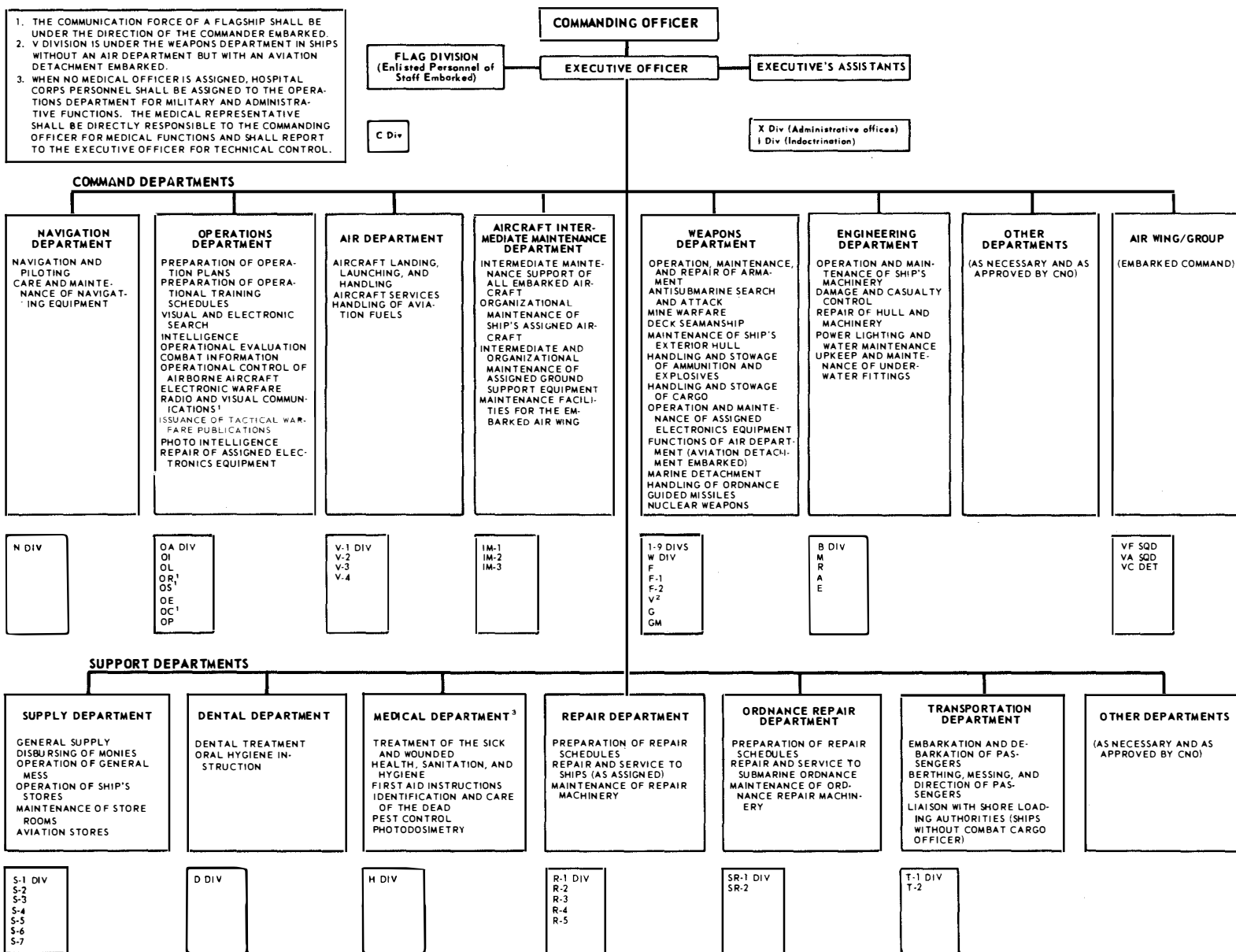
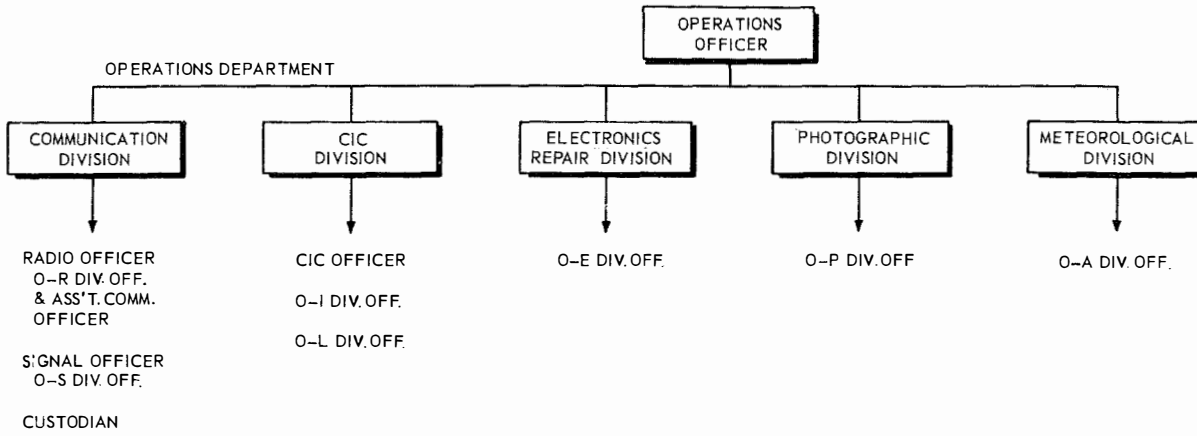


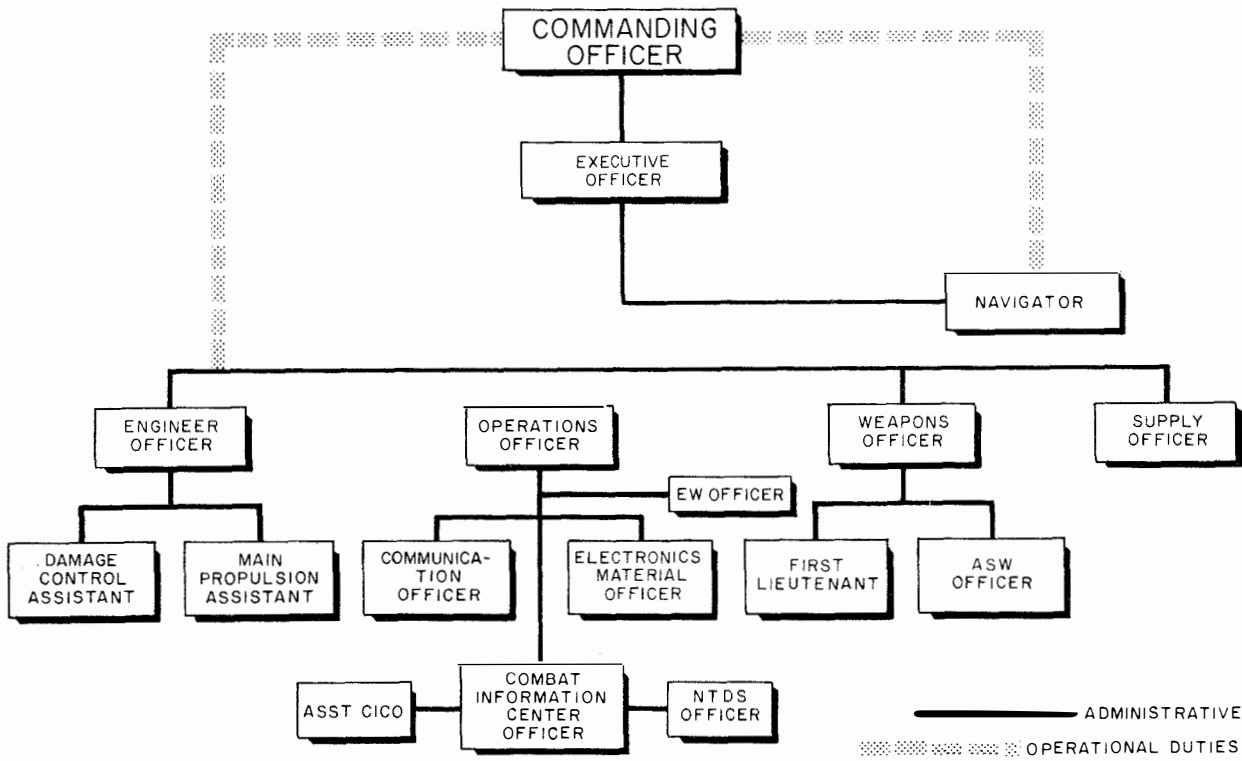
Figure 2-2.—(U) Administrative organization (U).

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36.1

Figure 2-3.—(U) Operations department organization for cruisers (U).



36.2

Figure 2-4.—(U) Departmental organization for destroyers/frigates (U).

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photo-intelligence, and repair of assigned electronic equipment.

(U) Figure 2-3 shows how an operations department for a cruiser may be set up.

(U) A typical departmental organization for destroyers/frigates is shown in figure 2-4. Because of the limited number of officers available, there is much doubling of duties aboard most destroyers. The executive officer, for example, may also be navigator; the engineer officer may perform the duties of main propulsion assistant; and the CIC officer may double as evaluator. Aboard a large ship the CIC officer has several assistants: The preventive maintenance officer, CIC communication officer, air controllers, and so on. Depending on the size of the ship, the CIC officer may also be the OI division officer.

(U) Briefly, the OI division officer is responsible to the operations officer for the organization, administration, implementation, training, and functioning of the OI division and

the division's assigned personnel and material in support of the overall mission of the operations department.

(U) Figure 2-5 is representative of a standard organization of personnel comprising a CIC decision and evaluation team. Depending on the type of ship and the number of officers available, it may be necessary in some instances to fill some of the decision and evaluation team billets with qualified petty officers.

### CIC ORGANIZATION IN NTDS

(U) CIC organization aboard an NTDS unit differs only slightly from that of a conventional unit. Although functions are performed in a different manner, the overall mission of CIC remains the same. For the purpose of this discussion, we will relate NTDS personnel positions to their non-NTDS counterparts. Figure 2-6 illustrates personnel organization in NTDS.

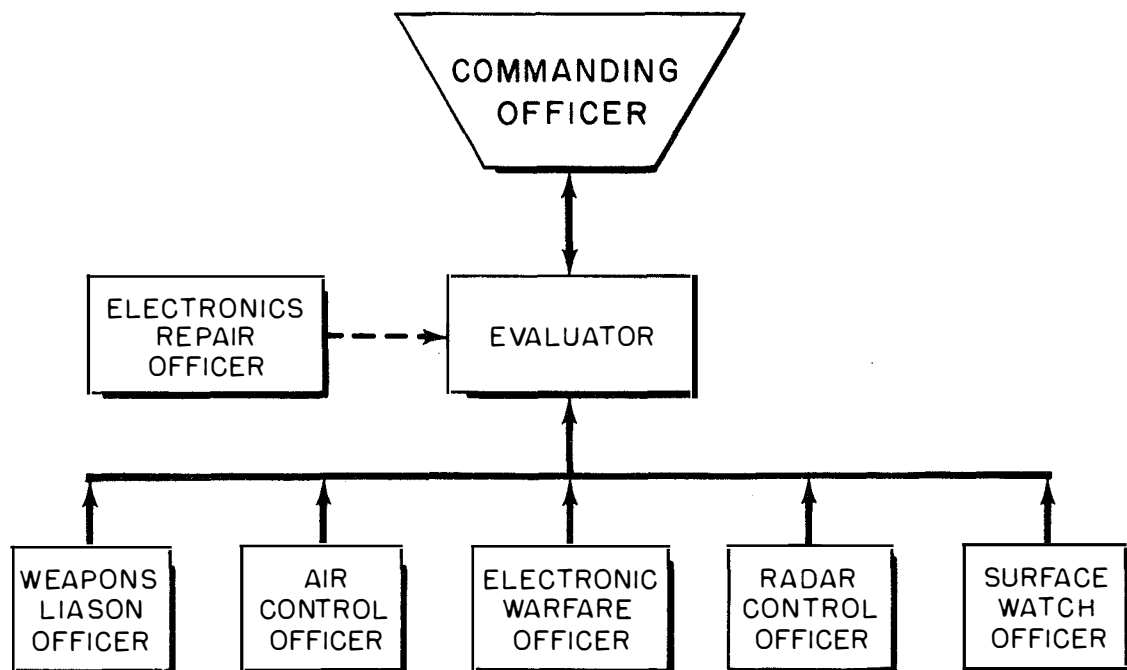


Figure 2-5.—(U) CIC decision and evaluation team (U).

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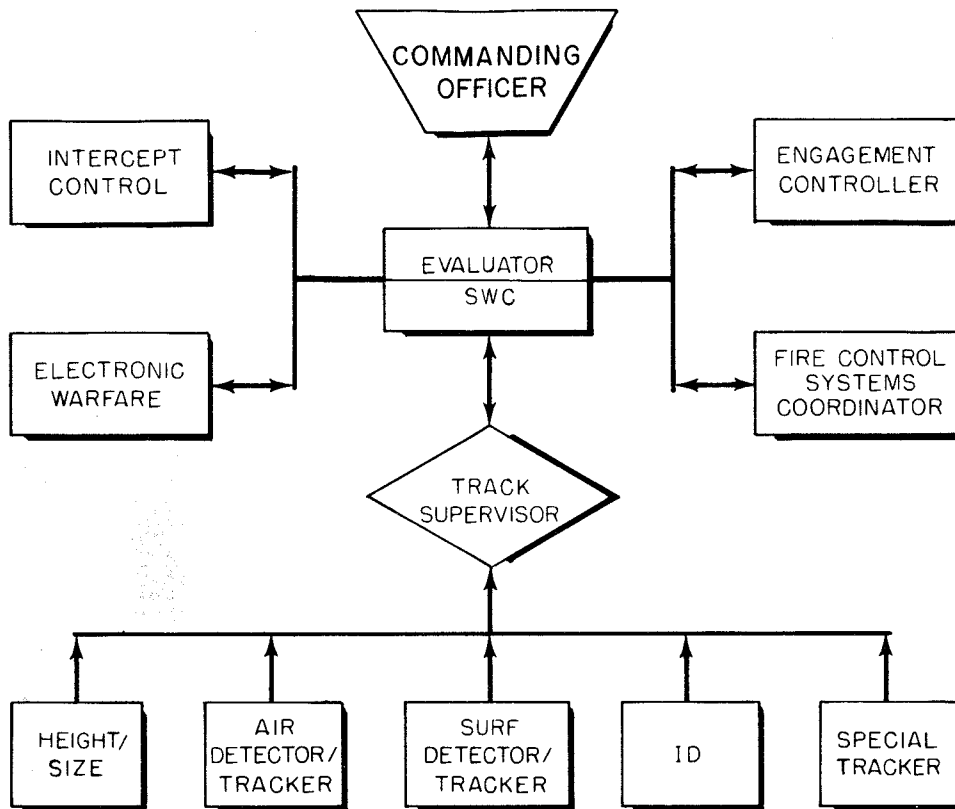
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Figure 2-6.--(U) NTDS CID data flow (U).

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### EVALUATOR/SHIP'S WEAPONS COORDINATOR (SWC)

(U) The responsibilities of the evaluator remain the same as that of a conventional unit. Some commands combine the evaluator and SWC duties, while others utilize separate positions. In the latter case, SWC will follow the orders of the evaluator in assigning weapons to targets.

(C) The tracks of incoming raids and friendly aircraft displayed on the NTDS console in the form of symbols are similar to those used on vertical plots. This enables the evaluator/SWC to view the "real time" AAW, ASW, EW and surface warfare situation without the time delay inherent in conventional CICs. Weapons assignment is accomplished via the NTDS rather than by voice.

(U) The evaluator/SWC is responsible to the commanding officer. As in conventional CICs, the evaluator position is filled by the operations officer or executive officer during condition of readiness I. During condition III, the position is generally manned by the operations officer, engineer officer and weapons officers. When the evaluator/SWC positions are separated, the SWC is usually a junior officer or an OSC.

### TRACK SUPERVISOR (TRK SUP)

(U) The duties of the TRK SUP parallels that of the radar control officer (RCO). Supervising the air trackers, surface tracker, height/size operator, identification operators, and special tracker is his primary responsibility. In addition to controlling the operation of the radars, the TRK SUP must also maintain link 11 and link

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14 operations. The TRK SUP is responsible to the evaluator/SWC. (See figure 2-6.)

### **DETECTION AND TRACKING (D&T) SUPERVISOR**

(U) On larger units such as cruisers and carriers, and where personnel requirements permit, a D&T supervisor is assigned to assist the TRK SUP. He primarily supervises the personnel of the detection and tracking team and status boards, allowing the TRK SUP to concentrate on maintaining data links, an up-to-date air picture, and AAW(R) net functions. The D&T supervisor also reports to the evaluator/SWC.

### **DETECTION AND TRACKING TEAM**

(C) The D&T team is made up of the air trackers, identification operators, height/size operators, and a special tracker. They operate in the same fashion as a conventional D&T team with one primary difference. Where conventional detectors and trackers report their contacts to the vertical plot, the NTDS operator inserts the contacts into the system. The console then becomes the "summary plot," and the tracks can be viewed from any console in CIC. ID information (friendly, hostile, SIF number, etc.) can be inserted as well as height and size.

(C) The special tracker replaces the conventional weapons plot. Targets assigned to missiles or CAP are tracked with precision by the special tracker until acquisition or intercept occurs.

### **WEAPONS CONTROL**

(C) The engagement controller (EC) and fire control systems coordinator (FCSC) make up the weapons control personnel. Indication, designation and acquisition of a target as well as missile selection, launcher assignment, and missile firing are conducted through weapons control in CIC.

(U) Weapons control receives target orders from the evaluator/SWC and makes all reports to the evaluator/SWC. Weapons control duties are similar to those of the conventional weapons liaison officer.

### **ELECTRONIC WARFARE (EW) AND INTERCEPT CONTROL (IC)**

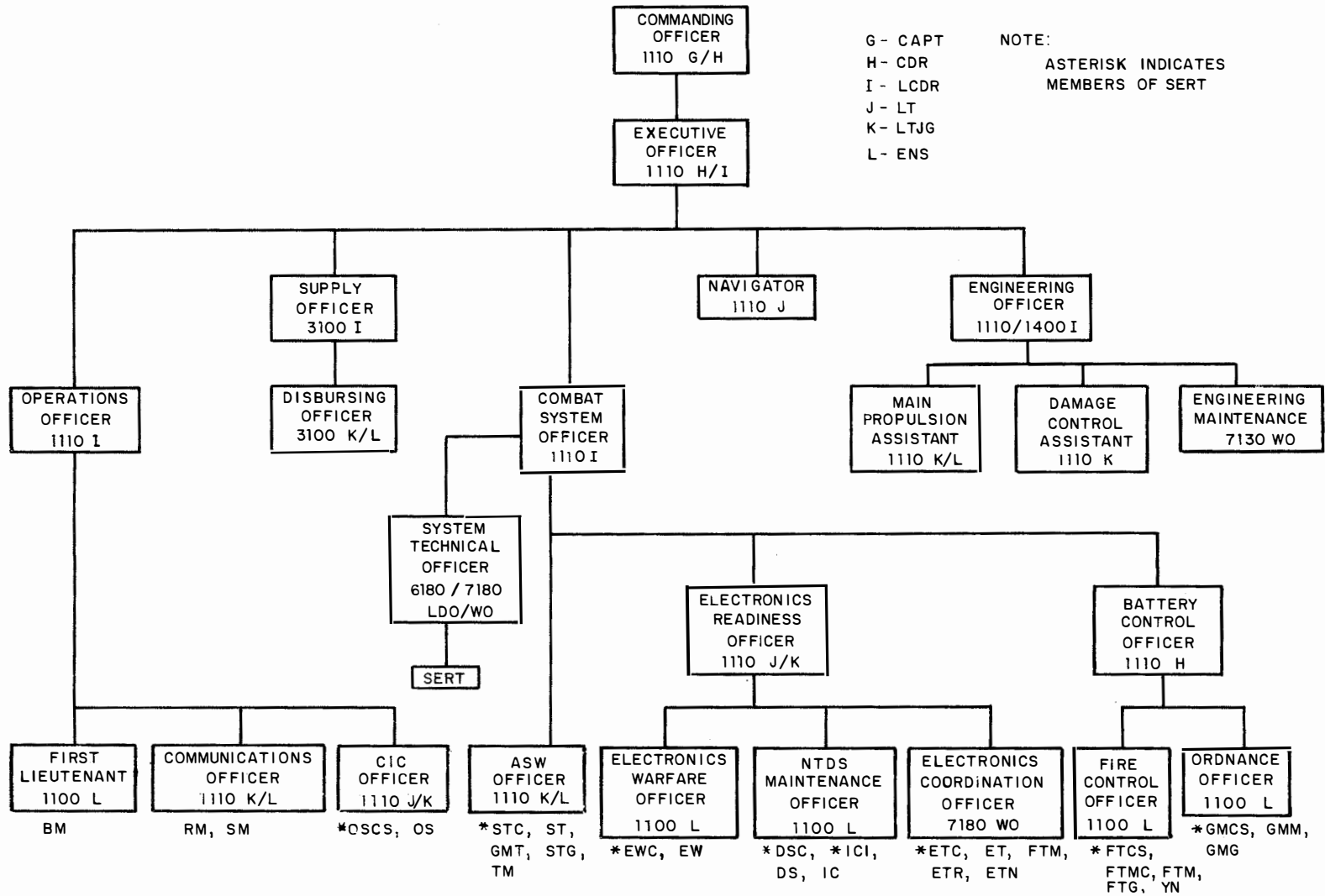
(C) The rules that apply to electronic warfare and intercept control in a conventional unit apply in NTDS. Additionally, some NTDS units are equipped to have EW information appear on the console, while others continue to utilize the 81JS and vertical plot.

### **COMBAT SYSTEMS CONCEPT IN NTDS**

(U) For the first time since World War II, shipboard organization is undergoing a significant change to correct a division of responsibility that arose when a new crewman—the computer—reported aboard. Although the NTDS functioned well for the operations department as a command and control system and for the weapons department with the missile weapons system, tests conducted aboard ship pointed out the need for the administrative structure to be integrated in the same way the combat systems were integrated.

(U) As a result, a combat system personnel training and management plan published by the Chief of Naval Personnel in November 1971 pictures the new ships' organization and identifies the training requirement to support the organization. As shown in the example in figure 2-7, under the commanding officer and executive officer, there is an operations officer, a combat systems officer, engineer officer, navigator, and supply officer. The new setup eliminates the weapons officer and places responsibility upon the combat systems officer for maintenance and test of the ship's total electronics package, command and control, sensors, weapons and communications. The operations officer is responsible for tactical employment of the combat system and also has the first lieutenant in his department. This latter job was formerly under the weapons officer.

(U) Under the combat systems officer, enlisted men with a variety of ratings work on the various electronic and weapons subsystems. (See figure 2-8.) In the communications and navigation maintenance groups, there are electronics technicians, radiomen, data systems



20

G - CAPT  
H - CDR  
I - LCDR  
J - LT  
K - LTJG  
L - ENS

NOTE:  
ASTERISK INDICATES  
MEMBERS OF SERT

Figure 2-7.--(U) DDG-37 (AAW Mod) and CG/N-16/28 (AAW Mod) combat system organization (U).

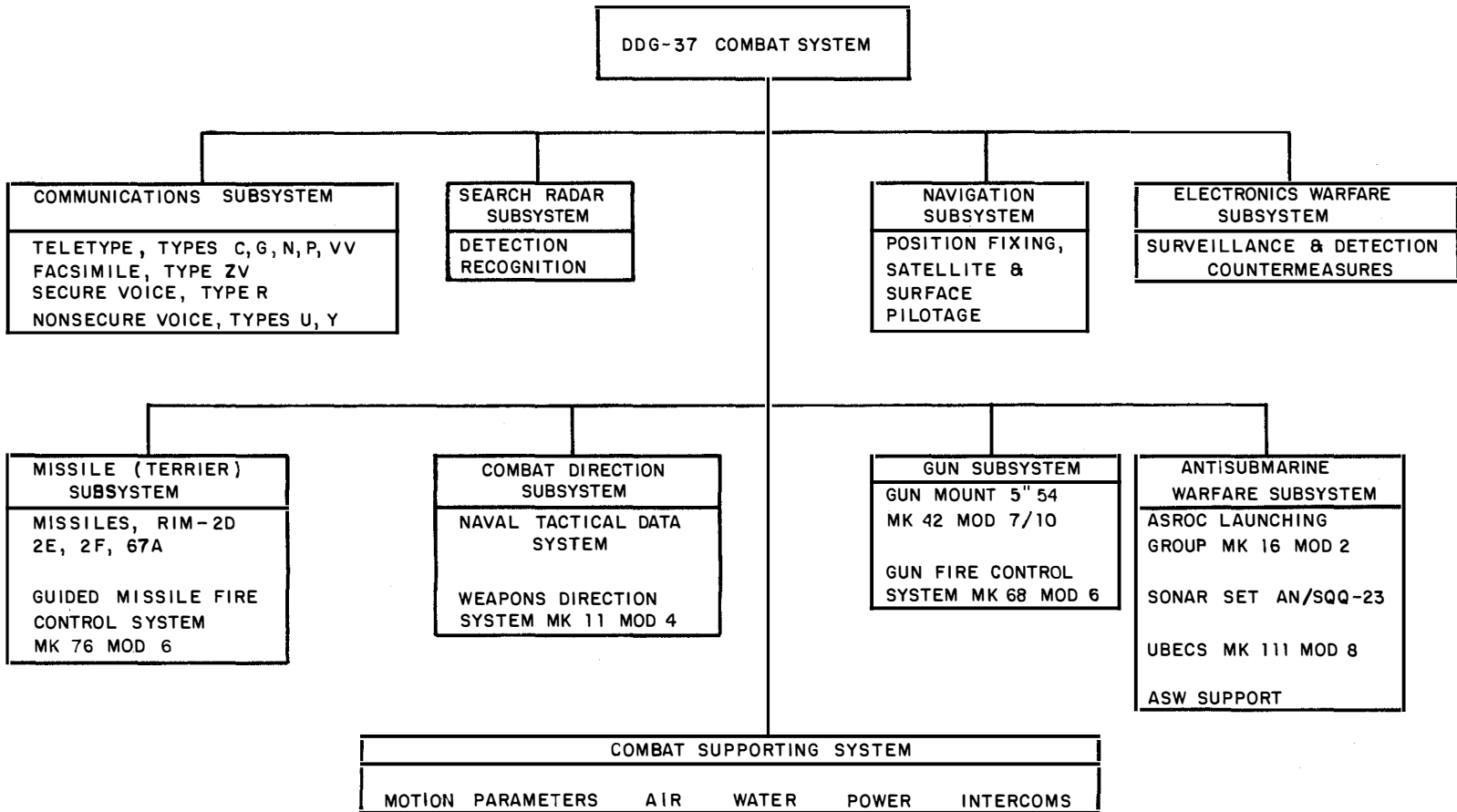


Figure 2-8.--(U) Technological configuration of the DDG-37 (AAW Mod) combat system (U).

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technicians, and communications technicians. Fire control technicians and electronics technicians (radar) are in the search radar maintenance group, and data systems technicians and fire control technicians are in the naval tactical data maintenance group.

(U) The systems technician is a senior maintenance supervisor, knowledgeable in all systems, systems test equipment, systems alignment and test procedures, systems

documentation, and the design inputs-outputs of all system components. All of this expertise is within the systems test staff.

(U) Note that those ratings in figure 2-7 that are marked with an asterisk serve a dual role of working for the system technical officer, as a member of the ship's electronics repair team (SERT), as well as working under their respective division officers, performing normal operational duties.

## **CHAPTER 3**

# **BASIC CONCEPTS OF EW**

(U) Electronic warfare encompasses and is an integral part of all forms of conventional warfare. In some cases, it is also the prime function of unconventional warfare techniques and special naval and marine operations. Consequently, it is of particular significance in all naval operations.

(U) Electronic warfare (EW) spans the entire electromagnetic spectrum and is a military activity which can influence the control and employment of the total electromagnetic acoustic environment. EW employs electromagnetic equipment, systems, tactics, and techniques for the purpose of:

1. Determining hostile activity in the electromagnetic spectrum,
2. Exploiting hostile use of the electromagnetic spectrum,
3. Advancing naval use of the electromagnetic spectrum.

The functional relations of EW are shown in figure 3-1.

(U) Electronic warfare is military action involving the use of electromagnetic energy to determine, exploit, reduce, or prevent hostile use of the electromagnetic spectrum and action which retains friendly use of the electromagnetic spectrum.

There are three divisions within EW:

1. Electronic warfare support measures (ESM)
2. Electronic countermeasures (ECM)
3. Electronic counter-countermeasures (ECCM)

(U) **ELECTRONIC WARFARE SUPPORT MEASURES.**—Are actions taken to search for, locate, record and analyze radiated electromagnetic energy for the purpose of exploiting such radiations in support of military operations.

(U) **ELECTRONIC COUNTERMEASURES.**—Are actions taken to prevent or reduce an enemy's effective use of the electromagnetic spectrum.

(U) **ELECTRONIC COUNTER-COUNTERMEASURES.**—Are actions taken to ensure friendly effective use of the electromagnetic spectrum despite the enemy's use of EW.

### **OBJECTIVE OF EW**

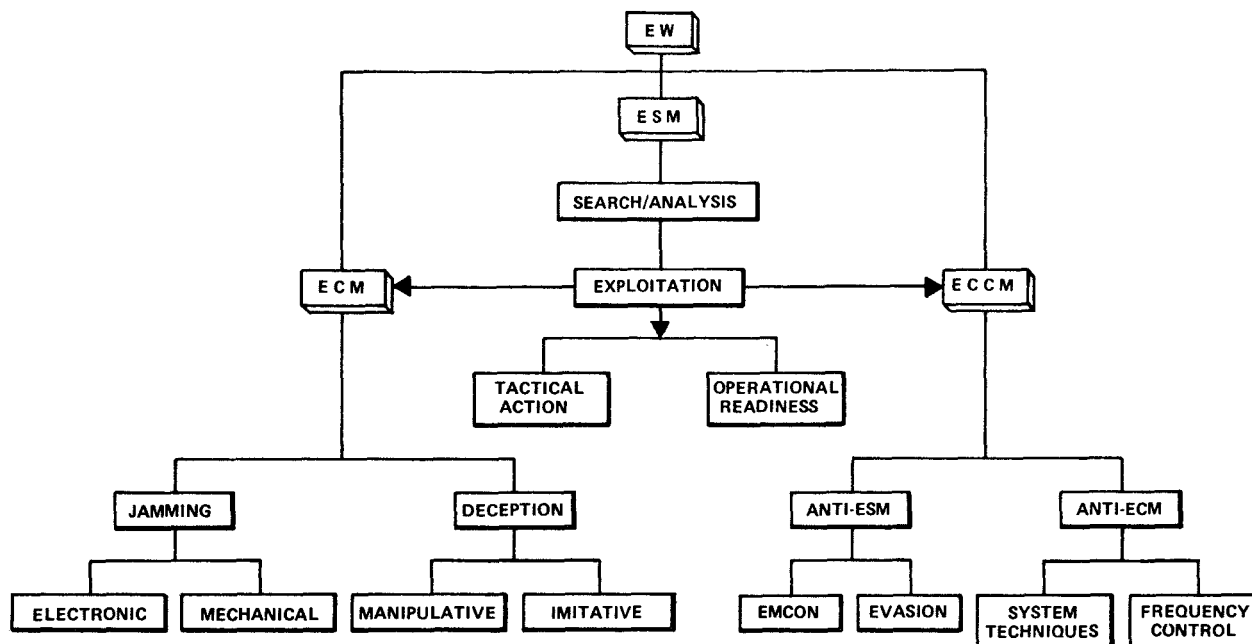
(U) The objective of naval EW is to ensure the continuing freedom of the seas by providing operational commanders with an integrated capability to take action using the electromagnetic spectrum, to be aware of hostile intent, to counter hostile action, and to protect our own or friendly forces.

(U) This objective includes:

Determining the existence, location, disposition, and threat potential of all significant weapons, sensors, and communication systems that use electromagnetic radiations.

Denying an enemy the effective use of his electromagnetic systems by destroying them, degrading them, or rendering them ineffective.

Ensuring the effectiveness and security of fleet electromagnetic capability regardless of

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74.199

Figure 3-1.—(U) Functional relationships of EW Operations (U).

intentional or unintentional counteraction from any source.

(U) The ever-broadening aspects of electronics, optics and acoustics and their integral relationship to all types of warfare, establishes the foundation of EW. All military evolutions conducted today depend on electronic equipment and radiated electromagnetic energy. Electronic subsystems are a part of nearly every weapons system in modern warfare and effective employment of this equipment can and does determine the success of military engagements. Therefore, EW must be considered as a prime factor in planning and executing all operations involving naval forces.

(U) Modern electronic methods impose an increasingly severe reduction of action and reaction time in warfare. Naval forces must possess a fully integrated awareness of the electromagnetic environment in which they are operating. This awareness must go beyond radar and communications frequencies and extend to

all areas of the spectrum where a threat can exist.

(U) The need to maintain adequate security of EW activities will continue as a vital factor in naval operations. This security must assist in advancing national defense while ensuring that it imposes no delays in military or state response to any aggressor.

(U) Warfare today and in the future will be waged on a dynamically important battleground, the electromagnetic spectrum. For this reason, naval forces require the full support of electronic monitoring capabilities and coordinated effort to gain and maintain United States superiority in an EW environment.

## POLICY

(C) Fleet EW is maintained as a dynamic and progressive program by all command levels in order to provide effective naval support to national security and international relations and to ensure continuing freedom of the seas.

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(C) It is essential that all echelons of command possess a thorough knowledge of potential threats which exist in the electromagnetic spectrum in order that vigorous employment of countermeasures or protective measures can be initiated maintaining the highest possible state of fleet EW readiness.

(C) The following factors guide commands and activities in the preparation for and the conduct of EW:

#### **Emission Control (EMCON)**

(C) Fundamental to the conduct of EW and applicable to all naval operating forces is the preservation of security by means of undetected movement. To this end, basic electronic emissions policy is to radiate only that electronic equipment necessary to accomplish the assigned mission. The ability to operate under conditions of electronic silence for extended periods, employing electronic support measures (ESM) as a primary information source, is a fundamental consideration in every aspect of operational readiness. No less important is the ability to provide absolute control of all electromagnetic emissions within our forces at the unit, task group, and task force level.

#### **Operational Capability**

(C) Fleet operating forces must maintain an integrated and self-supporting ESM capability which will advance the performance and ensure the success of assigned missions. This capability will provide the information necessary to conduct effective ECM and ECCM or to direct tactical action.

#### **Electronic Warfare Intelligence (EWI)**

(C) Electronic warfare intelligence (EWI) is the product resulting from the collection, evaluation, analysis, integration, and interpretation of all available information concerning foreign nations or areas of operations

which are immediately or potentially significant to EW.

1. (C) The intelligence community is responsible for producing and disseminating all source intelligence and intelligence information pertaining to the support of EW.

2. (C) Tactical commanders are provided with intelligence information which permits a continuing evaluation of the effectiveness of friendly and enemy operations.

3. (C) Maximum use is made of the capabilities of theater electronic intelligence centers in support of EW.

4. (C) Electronic warfare support measures provide:

a. (C) Information and data from all sources, including COMINT and ELINT, which combined is known as Signal Intelligence (SIGINT), to provide direct tactical support to fleet units.

b. (C) Guidance concerning electromagnetic collection objectives.

c. (C) Coordination in developing electronic information collection, processing, and dissemination techniques.

#### **Procedures For Development Of Tactical Concepts**

(C) With the introduction of new, major electronic equipment into the fleet, there is an increasing need to develop advanced concepts for their use within an active fleet environment during early introduction stages. In each such instance, CNO will request fleet assistance to obtain the following:

1. (C) Compatibility between new equipment and existing shipboard EW systems, together with particular limitations and capabilities resulting from combined usage.

2. (C) Advanced tactical concepts in the employment of new equipment/systems which appear promising.

3. (C) Equipment deficiencies which are susceptible to immediate remedial action to follow-on production line equipment.

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4. (C) Changes to existing installation policies which appear warranted, resulting from testing present tactics and developing new concepts.

**System Efficiency**

(C) The rapid growth of the enemy air- and surface-launched missile threat is such that all EW means available must be properly coordinated and brought in full measure to bear against the enemy weapons and weapons systems. This objective can only be accomplished when all EW systems and equipments are maintained in peak operating condition by pursuing a vigorous program of preventive maintenance and by regular use of the various testing and calibration facilities available to verify the effectiveness of the preventive maintenance program. The task force commander should be notified immediately of any change in the EW system status of any ship under his tactical command which would result in decreased EW force readiness.

**Training**

(C) The prosecution of EW involves exceedingly short reaction times; therefore, equipment maintenance and operational proficiency for readiness against potential enemy forces must be measured in consideration of this fundamental fact. A primary requirement is the establishment of uniform standards in personnel training to ensure the highest degree of maintenance and operator effectiveness.

**Personnel**

(C) The growing complexities of EW require that procedures for enlisted training, identification, and periodic proficiency testing be applied for the qualification of personnel assigned EW tasks.

**Exercises**

(C) The rapid reaction characterizing EW operations require that a maximum degree of training be accomplished within a realistic electronic environment provided by active fleet exercises. Simulation training, together with routine in-port drills, may supplement but

cannot substitute for this requirement. Fleet commanders must make full and frequent use of all available ESM, ECM, and ECCM equipment in both surface and air training exercises. They should be jointly scheduled when feasible to provide the highest degree of mutual training support within a "live" surface/air environment. Radiating and nonradiating training devices, simulators, film, and other EW aids should be employed to augment both training afloat and ashore, wherever possible.

**Security**

(C) A major continuing objective is to deny an enemy of the United States Navy the EW capabilities, tactics, and doctrine, particularly those which can be exploited by the enemy during wartime. The necessity for maintaining adequate security must not, however, serve the enemy by restricting fleet readiness in the use of EW when needed. The enemy has developed an exceptional appreciation of EW and clearly understands the dependence of naval weapons systems on electronics. Paramount to security considerations is jamming, which generally involves two aspects, electronic and non-electronic jamming.

(C) ELECTRONIC JAMMING.—The use of ECM in training exercises within probable intercept range of Sino-Soviet bloc radars, computed as one and one-half times the normal acquisitional range of Sino-Soviet bloc electronic equipment may be permitted, provided that such use does not furnish information on EW tactics or new equipment nor does it afford opportunity for ECCM practice by Sino-Soviet forces. Current issues of Sino-Soviet Bloc Radar Order of Battle (ROB) are used to determine locations and range of their electronic equipment. When outside the probable intercept range of Sino-Soviet bloc equipment, all of the current operational ECM equipment not specifically prohibited may be used in training exercises, provided care is taken to prevent interception of signals by Soviet ELINT air and sea collection activities and subject to the normal precautions against interference with other rightful users of the electromagnetic spectrum.

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(C) NONELECTRONIC JAMMING.—Chaff may be used in EW training exercises provided sufficient precautions are taken to ensure that there is no interference with civilian public utilities. Rope is particularly hazardous since it can cause a short to high voltage-transmission lines, thus creating fire and safety hazards to civilian personnel. Accordingly, rope may be dropped without prior approval when beyond 150 miles from land. Inside an air defense identification zone (ADIZ), clearance to drop rope must be requested from the appropriate fleet commander. Rope may be dropped only if wind force and direction are such as to preclude the rope from drifting over land.

## **CONTROL**

(C) Control is the authoritative direction exercised by a commander through his designated representative or control agency over the operation of EW facilities and installations. In scope, EW control ranges from the broad authority exercised over EW operations by officers on the staff and fleet level to the immediate control of equipment and operators which is exercised by officers on the shipboard level.

### **Control of EW**

(C) Positive control of ESM is required to ensure efficient use of equipment and personnel available to the force. Since ECM is detectable by the enemy, it must also be rigidly controlled and carefully coordinated to ensure that it is used only when it provides a tactical advantage which outweighs the advantages of continuing silence or emission control. It is equally important to ensure that ECM does not interfere with other operations of the force such as communications transmissions, ELINT collection, deception, and other intelligence activities of own force. Control of ECM is essential to ensure that only those equipments necessary to complete the assigned mission are radiated. Controlling these functions heightens

the chance of succeeding in the planned operation.

### **Planned Control**

(C) Normally, planned control is exercised through the medium of plans or orders in which the force and its various components are assigned certain EW tasks to be performed in support of an operation. Control is also exercised through suitable correspondence from appropriate commanders to specific units. Usually, all necessary information regarding planned control is set forth in the EW communications, intelligence, and deception annexes and appendices of an operation plan or order. Active control is exercised through various methods of communication. During naval operations, control is normally exercised over one of the coordination nets or other suitable communication circuits as specified in the applicable operation order.

### **Tactical Control**

(C) Tactical Control is required to ensure efficient use of equipment and personnel available to the force. Proper ESM procedures must be followed to ensure maximum interception of enemy electronic activity. Normally, ECM is detectable by the enemy; thus it must be controlled and carefully coordinated to ensure that it is used when it provides a tactical advantage which may outweigh the advantages of continuing in a silent emission control condition. It is equally important to ensure that ECM does not interfere with other operations of the force such as:

1. (C) Active sensors
2. (C) Communications transmissions
3. (C) ESM
4. (C) Other ECM, including deception
5. (C) Other intelligence activities of own forces.

Control of those active techniques used in ECCM is necessary to ensure maximum advantage to own forces. Control of all these functions will assist in the successful accomplishment of the planned operation.

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(C) EW control functions include:

1. (C) Detailing and coordinating the operations of intercept and jamming guardships.
2. (C) Keeping own forces informed of the status of own and friendly electronic and acoustic equipment.
3. (C) Establishing communications circuits for EW reporting
4. (C) Evaluating EW intercept reconnaissance data, coordinating this information with combat information received from other sources, and disseminating the information to own and friendly forces.
5. (C) Planning evasive maneuvers on the basis of known limitations of the enemy's detection equipment, and carrying out those maneuvers to avoid detection.
6. (C) Setting, supervising, and enforcing the observance of EMCON.
7. (C) Ordering unscheduled jamming or deception against enemy electronics and acoustics if necessary for the defense of the force or the success of the mission.
8. (C) Executing approved jamming or deception plans.

**CONTROL RESPONSIBILITIES**

(C) Overall control of EW is exercised by the officer in tactical command (OTC) within the limitations of the operation plan in effect. The OTC supplements fleet policy and doctrine with special instructions for ESM, ECM, and ECCM as necessary. He selects the condition of silence to be observed and, where authorized, makes the initial decision for use of unscheduled jamming and/or deception as required by the tactical situation. In the single or multi-threat environment, the OTC should, when practicable, delegate his EW coordination function to the commanders best suited to fulfill them expeditiously. The EW control responsibility for anti-air warfare (AAW) units normally is delegated to the anti-air warfare commander (AAWC). If delineation of EW control is desired or needed in the multi-threat environment, the OTC provides specific instructions to warfare

commanders covering delegated functions in order to ensure effective employment of available EW assets. A unit assigned EW control duties is termed the EW coordinator (EWC).

**EW Coordinator**

(C) The EWC may coordinate the EW effort of many ships and aircraft (AAW groups), may be one ship of the search attack unit (SAU), or may be an amphibious ship assigned to coordinate the EW efforts of the amphibious ships in company.

(C) Following the guidelines of the OTC, an EWC normally performs these functions:

1. (C) Assigns intercept guards to units under his control;
2. (C) Coordinates and controls EW reporting and ESM/ECM;
3. (C) Maintains and enforces EMCON for his units;
4. (C) Provides the OTC with evaluated EW information and recommendations.

(C) Although the OTC retains responsibility for his control duties, he delegates most of the duties to the assigned EWC.

**Task Force/Group Commander**

(C) Overall responsibility for controlling and coordinating EW measures in the task force/group is assigned to the task force/group commander. He ordinarily delegates authority for control to members of his staff, including the task force/group operations officer, and EW officer. Responsibilities of staff officers and EW personnel are described in the following paragraphs.

**Staff Operations Officer**

(C) The staff operations officer normally is responsible to the commander for the overall conduct, coordination, and control of EW operations. He is directly superior to the staff CIC and EW officer.

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**Staff CIC Officer**

(C) The staff CIC officer is responsible for coordinating combat information received from the various ships in company. He maintains an appropriate display based on this information and keeps the OTC informed of changes in the tactical situation. He may also perform such specific functions as detailing guardships; designating reporting circuits; giving rapid designations; and issuing general warnings for contacts made by intercept units.

**Staff EW Officer**

(C) The staff EW officer is specifically assigned to EW control. He is normally responsible to the staff operations officer for recommendations regarding the planning, organization, execution, and control of EW operations and training within the limits of his organization.

**Staff Watch Officer**

(C) A staff watch officer may be designated to perform on a watch-to-watch basis the duties designated to the specific staff officers above. Duties could include:

1. (C) Direct control of intercept search;
2. (C) Monitoring ESM;
3. (C) Control of jamming;
4. (C) Deception operations of ships in company;
5. (C) Designation of intercept and jamming guardship;
6. (C) Such additional EW functions as may be prescribed.

**Electronic Warfare Coordinator**

(C) When assigned, the EW coordinator is responsible for the following:

1. (C) Assigning intercept guards.
2. (C) Coordinating the overall ESM effort;
3. (C) Monitoring and enforcing emission control plans;

4. (C) Ensuring that all ships respond properly to all commands;
5. (C) Providing OTC with evaluated EW information concerning the threat and the EMCON condition in effect.

**Commanding Officer**

(C) Control in single units is exercised by the CICs of each unit. The commanding officer, however, is responsible for overall control of EW operations aboard and for the conduct of all EW operations assigned to the ship by higher authority. He normally delegates EW functions to subordinates in the operations department.

**Operations Officer**

(C) The operations officer is responsible for the conduct, coordination, and control of all EW operations aboard. During ship readiness Condition 1, he may be the evaluator in CIC while the CIC officer under his direction continues as the direct supervisor.

**CIC Officer**

(C) During Condition 1, the CIC officer integrates the EW information with other combat information. The CIC watch officer performs this function during Conditions 2 and 3.

**EW Officer**

(C) The EW officer (EWO) is responsible for:

1. (C) Organization, supervision, and coordination of EW including knowledge of ESM, ECM, and ECCM;
2. (C) Planning and execution of such EW measures as may be ordered;
3. (C) Supervision, training, qualification, and assignment of all EW operators and the training of CIC watch officers and other personnel connected with EW operations, including weapons department and communications personnel;

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4. (C) Maintenance of an intraship and intraforce collection, evaluation, and dissemination facility for intercept information;

5. (C) Maintenance of an effective ship's ESM organization capable of executing duties such as intercept search, direction finding, and EWC within an assigned force;

6. (C) CIC and EW watches being provided with a current electronic order of battle (EOB) for friendly, potentially non-friendly, and enemy forces;

7. (C) Coordination of intercept search as ordered by the EWC;

8. (C) Advice and assistance to the operations officer as to proper employment of available ESM, ECM, ECCM, including means and techniques in use for communications countermeasures, radar countermeasures, acoustic countermeasures, evasion, and deception;

9. (C) Establishment of a rapid and effective means for the execution and monitoring of an emission control plan within the ship;

10. (C) Operation of all EW equipment;

11. (C) Control of the ship's EW operations during readiness Condition 1.

**EW Watch Officer**

(C) Under supervision of the CIC watch officer, the EW watch officer—

1. (C) Controls the EW reporting nets;
2. (C) Supervises the filtering of information of the EW plot;
3. (C) Evaluates and disseminates EW data.

**Electronics Material Officer**

(C) The electronics material officer (EMO) is responsible for the maintenance, repair, and calibration of EW equipment. Specifically, the EMO—

1. (C) Supervises the electronic techniques;
2. (C) Instructs EW operators regarding the overhaul and maintenance of shipboard electronic equipment and PMS program;

3. (C) Prepares maintenance routines for EW equipment not covered by the PMS program;

4. (C) Compiles an equipment log that indicates maintenance effectiveness, and lists harmonics and other spurious responses which may be experienced on certain frequencies during intercept search;

5. (C) Advises the preceding officers in technical matters concerning EW equipment.

**EW Watch Supervisor**

(C) Under the supervision of the EW officer and/or EW watch officer, the EW watch supervisor—

1. (C) Assists the EW officer in maintaining the EOB;

2. (C) Supervises the monitoring of the electronic environment, EW reporting net recorders, EW plotter, status boardkeeper, and ECM operator;

3. (C) Supervises on-watch training as directed by the EWO;

4. (C) Supervises and instructs all EW operators in the current PMS for all EW equipment.

**Intercept Search Operator**

(C) The intercept search operator conducts an alert search for signals in frequency bands assigned and analyzes and DF's signals intercepted.

(C) The Assistant Intercept Search Operator—

1. (C) Records characteristics of intercepted enemy transmissions in the electronic intercept log;

2. (C) Keeps equipment ready to record intercepted signals on audio tape and photograph them as they appear on the analysis scope;

3. (C) Records in the ECM log ECM employed against an intercepted enemy signal;

4. (C) Assists the EW watch officer with intelligence publications and information;

5. (C) Operates broad band intercept equipment as required.

#### **EW Reporting Net Recorder**

(C) The EW reporting net recorder monitors the EW reporting nets and reports and records pertinent information.

#### **EW Plotter**

(C) The EW plotter maintains a plot of DF and enemy jammer bearings and position areas indicating time, racket number, and so on.

#### **Status Board Keeper**

(C) The status board keeper maintains a display of current EW information and relays it as directed. This information includes:

1. (C) Own ship intercept and radar guard assignments;
2. (C) EMCON in effect;
3. (C) Radiation characteristics of equipment on ships in company and of enemy equipment likely to be intercepted;
4. (C) EMCON violations;
5. (C) ECM employed against enemy equipment.

#### **ECM Operator**

(C) The ECM operator keeps the equipment ready and in the proper mode for operation as directed by the EW or CIC watch officer.

#### **Weapons Officer**

(C) The weapons officer is responsible for the conduct, coordination, and control of all functions within the weapons department. He is guided in his actions by the operations officer and the EW officer and will not violate EMCON without notifying those officers of the intended actions nor without the express permission of the commanding officer. Along with the EW officer, he is responsible for the supervision, training qualifications, and assignment of all

weapons department personnel in matters of EW.

#### **ASW Officer**

(C) The ASW officer is responsible for:

1. (C) Coordinating (through the EW officer) with the engineer and the first lieutenant an effective quiet ship bill;
2. (C) Inspecting to ensure effectiveness of the quiet ship bill when instituted;
3. (C) Training Sonarmen, both shipboard and ashore, to maintain and operate all ASW acoustic equipment;
4. (C) Writing and maintaining an effective ASW doctrine;
5. (C) Training Sonarmen in classifying targets, and in using various gambits, such as random keying of sonar console, Fanfare, alternating active and passive modes of sonar, underwater telephone, and the torpedo detector;
6. (C) Supervising sonar and UB plot during readiness Condition 1 and 1AS;
7. (C) Advising commanding officer of various tactical uses of ASW acoustic equipment. In addition, the ASW officer is also responsible for the operation of all ASW equipment according to established equipment standards.

#### **Fire Control Officer**

(C) The fire control officer is responsible to the weapons officer for the conduct, coordination, and control of fire control equipment. He is guided in his action by the weapons officer and EW officer and will not violate EMCON without notifying the EW officer of the intended action nor without the express permission of the commanding officer. He also is responsible for training fire control personnel in ECCM techniques and equipment factors of the fire control equipment.

### **ELECTRONIC WARFARE SUPPORT MEASURES**

(C) Interception, analysis, and evaluation of enemy electromagnetic emissions are the first

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steps in conducting effective EW. Electronic warfare support measures (ESM) is the division of EW involving these actions. ESM provides a source of EW information required to conduct ECM, ECCM, threat detection, warning, evasion, target acquisition, and homing. Specific objectives of ESM are to:

1. (C) Obtain tactical/strategic information concerning the location of enemy weapons and installation.
2. (C) Obtain tactical/strategic information concerning the location, composition, and movements of enemy units.
3. (C) Obtain information concerning enemy intentions and order of battle.
4. (C) Provide information which can be used to counter electronically controlled weapons systems.

5. (C) Provide information concerning the effectiveness of own force ECM and ECCM activities.

6. (C) Provide information on the technical characteristics and probable state of an enemy's electronic potential. Figure 3-2 shows the functional relations of ESM.

(C) ESM can be employed or conducted while remaining electronically silent. This capability enables a unit or force to gather valuable information concerning the intentions and capabilities of an enemy without radiating its own electronic devices.

(C) The primary method of conducting ESM is by employing passive intercept equipment and tactics. This method consists of searching for electromagnetic radiations to determine their existence, source, and pertinent characteristics.

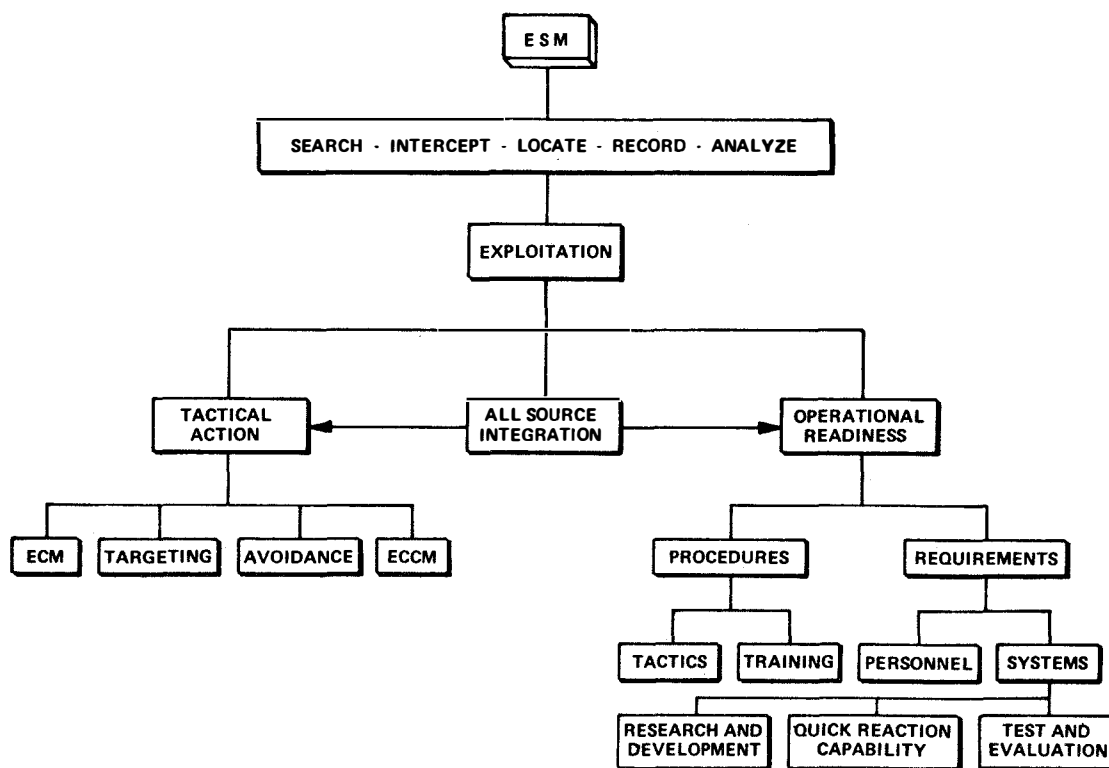


Figure 3-2.—(U) Functional relationships of Electronic Warfare Support Measures (U).

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**PHASES OF ESM**

(C) There are four basic phases to ESM operations—

1. (C) Search and detection;
2. (C) Location and tracking;
3. (C) Signal analysis;
4. (C) Evaluation.

(C) Search and detection are accomplished by searching the usable portion of the electromagnetic spectrum, particularly those frequencies suspected of being used by the enemy for radar detection and tracking, communications, navigation, IFF, or missile control. This method of detection normally is used without radar when surprise or evasion is the primary consideration. Warning of enemy activity may be obtained earlier by ESM than by any other method of detection. The effectiveness of the intercept search phase of ESM depends mainly on the enemy operating his electronic equipment.

(C) All electromagnetic transmissions are susceptible to DF techniques. The location and tracking phases of ESM are accomplished by taking bearings on intercepted signals to obtain a position, and then tracking the emitter on polar, geographic or navigation plots.

(C) Signal analysis furnishes data on the technical characteristics of enemy electronic weapons and devices. Certain signal characteristics are read directly from the intercept system displays. Tactical information gained by signal analysis provides a basis for:

- (C) Threat signal recognition
- (C) Use of ECM
- (C) Attack reaction
- (C) Tactical evasion
- (C) Employment of other defensive capabilities

It further provides material for detailed intelligence study by research and development agencies.

(C) Rapid analysis of enemy or unidentified signals is mandatory. Identification, evaluation, and required ECM are immediate considerations.

After satisfying these considerations further data are recorded on reports and logs.

(C) During electronic reconnaissance of enemy installations, intercept search is planned and deliberately conducted to obtain complete data on the enemy signal characteristics. This data may be used for planning future combat operations.

(C) Signal evaluation is based on data obtained in the first three phases of ESM and may indicate:

1. (C) Degree of threat
2. (C) Position of the enemy
3. (C) Course and speed of the emitting units
4. (C) Force composition
5. (C) Type and quality of enemy electronic equipment

(C) Accurate information and evaluation of enemy transmissions are aided by a knowledge of known enemy emitter parameters.

**Intercept Search By  
Type of Unit**

a. (C) SURFACE SHIPS. Intercept search used by a group of ships is best conducted by a picket or screen ship on the perimeters of the force. This employment:

1. (C) Ensures earliest possible detection.
2. (C) Reduces radiation interference from centrally located ships.
3. (C) Provides more accurate DF cross bearings.

The value of intercept search by surface ships is primarily that of providing warning of an enemy's presence prior to or in lieu of its detection by radar. The fact that intercept search can also be used as a valuable tool in identification should not be overlooked.

(C) Surface ships can conduct reconnaissance sweeps in a manner similar to aircraft. High speed should be employed during

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the sweep to optimize the DF bearing spread. Ships have the advantage of superior navigation accuracy, minimizing emitter site location errors. However, ships are relatively vulnerable and their low antenna height causes many emitter sites to be screened. Bistatic radar-equipped pickets can be deployed in proximity to enemy coasts to locate coastal early warning radars and detect surface search radar-equipped craft ashore.

(C) ESM must be used at all times when the normal CIC watch is established, and maximum tactical use of intercept equipment must be made. For effective intercept, the same ship ordinarily should not be assigned both radar and intercept guard duties at the same time. NTDS units can fix target location more rapidly by the exchange of individual ship bearing lines via Link 11 (computer to computer). Subsequent fixes will be displayed on NTDS consoles.

b. (C) AIRBORNE UNITS, because of their speed and antenna height, can conduct area intercept search and provide:

1. (C) Maximum early warning advantage
2. (C) Tactical updating of EOB
3. (C) ECM against enemy radar
4. (C) Strike support
5. (C) Monitoring of own force EMCON.

(C) ESM equipped air (e.g. EA3B, EP3E, etc.) can provide threat warning for the task force and/or terminal threat/MIG warning to tactical aircraft. Airborne EW intercept systems may provide an extension of the task force sensors to detect and locate launch platforms, provide warning of impending missile launch (secure teletype or UHF voice), and fine grain analysis of the intercepted signals. ESM aircraft, as well as surface and sub-surface units, are capable of identifying enemy ships by hull number when not in visual contact by correlating certain intercepted parameters with a current PRF-to-HULL number file. This

technique is called hull-to-emitter correlation (HULTEC).

(C) Primary limitations of aircraft for intercept search are restricted equipment capacity, limited number of operating personnel, and relatively short time on station. Also, the extent to which ESM DF bearing information may be relied on varies with individual aircraft.

(C) The problems in airborne intercept search operations are similar to those in reconnaissance. However, once detected, the enemy force can be tracked to determine its course and speed.

(1) TRACKING PROCEDURE. The problem of locating a radar signal source is primarily one of using homing techniques or plotting DF bearings. The usual procedure is to close the signal source until the signal is strong enough to provide a good indication of its direction. Once the bearing has been obtained the aircraft course is altered to:

1. (C) Obtain a more rapid change of bearing
2. (C) Obtain a greater spread in bearing lines
3. (C) Cause bearings to fall within sectors not affected by aircraft shadow areas.

(2) BEARING ACCURACY. ESM tracking depends directly on the accuracy of the bearings obtained and their relationship to a known position. Normally, the known position is the location of the ESM aircraft. However, when using Base Line Plotting techniques or BRIGAND methods, the need for exact location of the intercepting aircraft is less critical than in more conventional methods.

(C) It is particularly important that maximum effort be placed on obtaining accurate bearings. Bearings may be obtained from back and side lobes as well as main lobes; however, main lobe bearings are usually more accurate because of a higher signal-to-noise ratio.

c. (C) SUBMARINES are well adapted for gathering tactical and strategic information on enemy electronic activities. As pickets for a surface task force, submarines can be assigned to



conduct intercept search and other electronic operations.

### INTERCEPT GUARDS

(C) Intercept guards within a force are controlled by the OTC. He assigns individual ships to guard (monitor) particular frequencies. Emphasis is placed on areas in which previous intelligence has indicated the enemy is transmitting. All intercepted enemy or unidentified signals must be reported to the OTC. Normally, a ship is assigned to search one frequency band per operating position, because the time delay in shifting from one band to another reduces the effectiveness of the operation.

(C) Every intercept guardship, whether aircraft or surface, must be stationed close enough to the force to maintain reliable communications. When an intercept guard assignment is delegated to a unit, operators assume responsibility for ensuring that no enemy electronic radiation within the assigned band goes undetected. To accomplish the mission, equipment must be in top-notch condition, and skilled personnel must be employed as operators.

(C) Intercept operators are assigned by frequency or frequencies as indicated in one of the following publications:

1. (C) Indicator numbers from NWP-33, Appendix D.
2. (C) Tactical signals from ATP-1 Volume II, Chapter 20 and Table E.
3. (C) Item numbers corresponding to specific signals in "Radiation Characteristics of Electronic Equipment" (DST-1730S-465-(YR)) are assigned as intercept guards when the nomenclature is known of a specific threat signal. This increases the probability of intercept because an operator on a particular unit is looking for one specified signal.
4. (C) Intercept guards may be assigned by using page numbers from Threat Emitter Guides, where the parameters of each threat signal are listed on separate pages. Threat Emitter Guides may contain information on threat signals not listed in "Radiation Characteristics of Electronic Equipment".

### ESM EQUIPMENT

(U) ESM equipment is used to detect, locate, analyze, and record electronic emissions throughout the electromagnetic spectrum. It provides United States forces with the capability of gaining tactical and strategic intelligence from enemy electronic activity of all types while remaining undetected by the enemy.

#### Intercept Receivers

(C) The fundamental piece of equipment in any ESM system is the intercept receiver. Intercept receivers are classified according to method of searching the frequency spectrum. The basic types are narrowband and wideband. These receivers are used to detect enemy electromagnetic emissions as a function of frequency and to provide selected signal outputs to displays, signal analyzers, recorders, and warning devices. Receivers may be capable of automatic signal processing and identification thereby providing threat warning for pre-programmed threats. Outputs of these receivers may also be used to automatically gate ECM deception and/or jamming equipment.

(C) Discrimination circuits which respond to certain signal characteristics may be provided with any receiver to accept or reject appropriate signals. Interference caused by your own ship's radars is eliminated by using pulse blanking equipment. This blanking equipment is rather simple in design and simple to program but, due to the requirement for a trigger pulse from those systems to be blanked, ships systems must be thoroughly understood.

(U) NARROWBAND RECEIVER.—Narrowband receivers are the most common type used for ESM. Normally, they are superheterodyne receivers with excellent selectivity, sensitivity and stability. These receivers cover a wide range of frequencies but can accept only a narrowband of frequencies at any given time. To cover the entire frequency range of the receiver, it is necessary to move or tune the acceptance bandwidth. Tuning units (tuners) provided for this purpose cover a frequency of about one octave (frequency is doubled in one octave) and several tuners are

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used to cover the receiver range. The receiver is manually or automatically tuned through the desired portion of the spectrum.

(C) The principal advantage of narrowband receivers is their selectivity, which permits signal analysis and recording with a minimum of interference from undesired signals.

(C) If the frequency of a signal which is to be intercepted is known, the necessity for tuning the receiver through a range of frequencies is eliminated, and the probability of detecting a signal is very high. When it is necessary to search a relatively large portion of the spectrum, the probability of signal detection increases by using rapid scan. Signal detection probability is reduced if it is necessary to shift tuners in order to cover the desired portion of the spectrum.

(C) The rapid scanning receiver is a narrowband receiver which is electronically tuned or swept in frequency at a very high rate. Electronic tuning eliminates the single octave limitation inherent in mechanical tuners. A panoramic frequency display presents the signal environment for a warning capability equivalent to that of a wideband receiver. For signal analysis, the sweep may be stopped to provide the normal narrow band receiver audio and video outputs.

(C) An important capability of the rapid scanning receiver is realized in its use as a threat signal warning receiver where only the portion of the frequency spectrum that contains a known threat emitter is swept.

(C) **WIDEBAND RECEIVERS.**—Wide band or direct detection receivers simultaneously intercept all signals within the full range of the receiver frequency coverage and within the intercept limits of their intercept antenna. The use of channelized crystal video receivers will permit higher sensitivities to be obtained and will permit detection to be defined to more specific areas in the band. A different version of the wide-open receiver that is proving to be quite valuable is the Instantaneous Frequency Measuring (IFM) receiver system. This system not only provides both wide and narrow band reception capabilities, but permits instantaneous read-out and storage of the frequency parameters. These receivers can provide an audio

or video warning of signal activity within their frequency range.

(C) Wide band receivers have a high signal detection probability over a broad portion of the spectrum. They frequently are used in conjunction with narrow band receivers to provide increased signal detection probability over a broad frequency range while the narrow band receiver provides effective signal analysis. Other advantages of this type of receiver include simplicity, light weight, and compactness.

(C) Wide-open receivers are relatively ineffective in environments with a high signal density since they have a poor signal discrimination capability. Care must be exercised in the operation of wide-open receivers in the presence of high intensity radiations. If they are not blanked during own ship's high powered emissions, they are susceptible to receiver overloading and consequent crystal failure.

(C) **HYBRID RECEIVER.**—A hybrid receiver is one in which both wide band and narrow band capabilities are incorporated, thus retaining the capabilities of both types and overcoming the limitations inherent in each. A hybrid system may be either a basic crystal video system with crystal video channel(s), or a superheterodyne system, or both. The presence of the crystal video section improves probability of detection, the superheterodyne portion improves analysis capability, particularly frequency determination.

(C) **IFM RECEIVER.**—An IFM (Instantaneous Frequency Measuring) receiver is a wide band receiver capable of measuring frequency instantaneously on a pulse by pulse basis. A basic IFM receiver consists of a frequency discriminator, detectors, video amplifiers, processor, and a display. IFM receivers provide 100% probability of the intercept with good frequency resolution and accuracy. The addition of an RF preamplifier in an IFM receiver provides superheterodyne sensitivities. Principle use of an IFM receiver is for automatic spectrum surveillance in an ESM system. A common display used with an IFM system is a calibrated polar display in which frequency is indicated by polar position of the

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strobe(s) and relative signal strength (signal amplitude) is indicated by strobe length.

(C) **MICROSWEEP RECEIVER.**—A microswEEP receiver is a basic superheterodyne receiver utilizing a very fast sweeping local oscillator capable of sweeping an octave in one microsecond. The probability of detection is significantly better than that of a slower superheterodyne receiver and is achieved by the faster sweep rate. Incorporation of dispersive filters and pulse stretching by means of a recirculating delay line loop enhance the probability of detecting incoming pulses. A panoramic display of spectrum signal activity is a commonly used display.

### Receiving Antennas

(C) Fixed ESM antennas consist of omnidirectional arrays for good initial detection and performance. For optimum performance, receiving antennas must be located to observe the maximum unobstructed field and be as high as possible to reach the greatest intercept horizon range.

(C) Direction finding (DF) antennas may be either fixed array antennas, or high gain antennas which are rotated at variable speeds. When used in conjunction with the appropriate receiver and display, the direction that a signal is coming from is indicated by a lobe that appears on the display. Fixed array antennas have the same advantages as omnidirectional antennas and they employ sum and difference networks to determine the direction of the signal source.

### Displays

(C) Displays are provided with ESM equipment to:

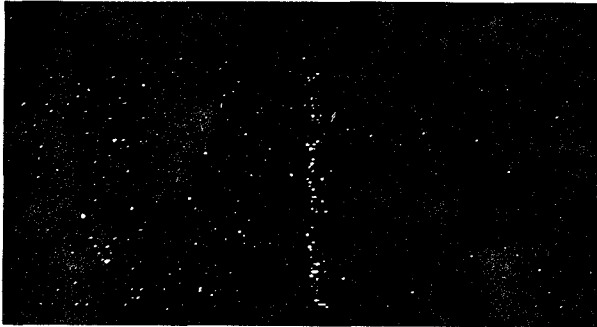
1. (C) Alert the operator to a signal
2. (C) Present a view of the intercepted frequency range
3. (C) Provide for analysis of intercepted signal
4. (C) Determine the bearing of the source of an intercepted signal

(C) **OPERATOR ALERTING.**—Commonly associated with threat signal warning receivers, usually is provided by an alarm system and a flashing light. Normally, the audio output of the receiver, via headset or speaker, will initially alert the operator to the threat signals whose unique sound characteristics permit ready identification. Signal source displays take several forms including:

1. (C) Signal amplitude versus azimuth display
2. (C) Signal strobe display on a PPI scope or superimposed on a radar display as in **BIG LOOK**
3. (C) PPI display of intercepted radar signals and reflections as in the **BRIGAND** technique
4. (C) IFM (or Polar) which displays signals as radial stobes on a CRT
5. (C) Digital or MPD (Multi-Purpose Display), which provides the operator with Line of Bearing stobes and an alpha-numeric display of signal parameters.

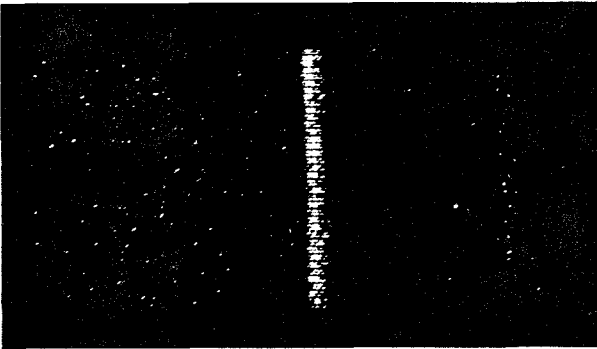
(C) **ACQUISITION SCOPE.**—Some ESM systems utilize an acquisition scope to indicate the presence of a signal within the frequency band being searched. This scope uses a raster type scan and the sweep moves back and forth in the horizontal plane, synchronized with mechanical and/or solid state electronic tuners and from top to bottom through the assigned frequency band. When a signal is detected within the band a bright spot is presented at the signal frequency as shown in figure 3-3, views A through C.

(C) **PANORAMIC DISPLAY.**—Panoramic displays indicate signal frequency versus amplitude, usually in XY coordinates, but they can use polar coordinate form as in displays for IFM (Instantaneous Frequency Measuring) systems. The panoramic presentation permits visual observation of the intercepted portion of the frequency spectrum. In the case of a wideband or swept receiver system, the scale permits simultaneous observation of signals throughout the entire frequency range of the receiver. A narrowband receiver system panoramic frequency display presents only the

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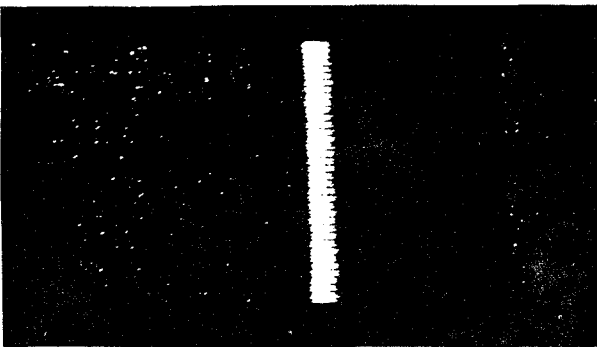
32.16.2

Figure 3-3a.—(U) Acquisition Scope; weak pulsed signal, pulse width 10 microseconds, PRF 1000 pps (U).



32.16.3

Figure 3-3b.—(U) Acquisition Scope; medium strength pulsed signal, pulse width 10 microseconds, PRF 1000 pps (U).



32.16.4

Figure 3-3c.—(U) Acquisition scope; strong pulsed signal, pulse width 10 microseconds, PRF 1000 pps (U).

signals within the acceptance band of the receiver. In this case, the display is calibrated to indicate all of the frequencies above and below the tuned frequency within the band-width of the receiver. The modulation of the intercepted signal will provide, on the panoramic display, unique variations in pulse amplitude and/or pulse position, depending on the type of modulation, providing the operator an opportunity to quickly determine another fingerprint of the intercepted emission.

(C) PULSE ANALYZERS.—The pulse analyzer provides a display which permits electronic analysis of the intercepted signal. Pulse analyzers are used to determine:

1. (C) Pulse repetition rate;
2. (C) Pulse width and shape;
3. (C) Scan characteristics;
4. (C) Pulse position;
5. (C) Pulse modulation.

The pulse analyzer uses a multi-gun oscilloscope display to present the intercepted pulse on several traces with different time bases. The shorter time base traces are used to expand the pulse as much as possible to permit accurate shape and width determination. The longer time base traces are used to present more than one pulse within a trace, permitting accurate determination of PRF by measuring the time between pulses.

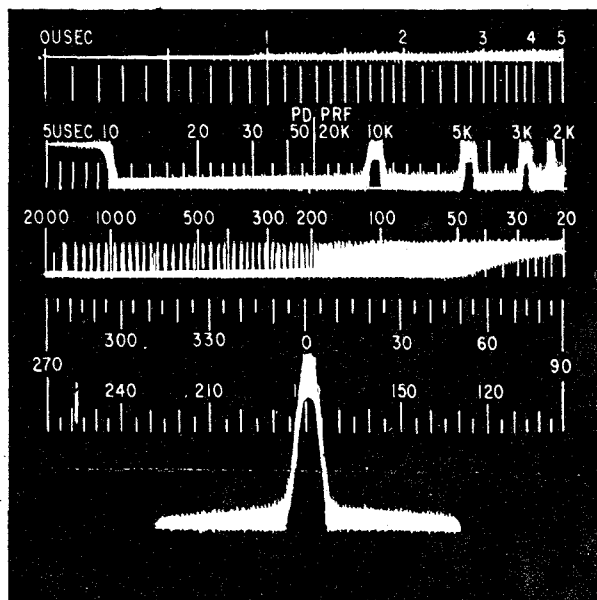
(C) COMBINATION DISPLAYS.—Most ESM systems utilize a single combination display as shown in figure 3-4. The top three lines make up the analysis display, lines four and five are the DF display; and the bottom line is the panoramic display. The operational use of the combination display is discussed in subsequent topics.

(C) AUDIO PRESENTATION.—The audio output of the ESM system also provides tactical information to the operator. The antenna

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rotation rate or the scan rate of the target emitter is determined by timing the periods between energy bursts, as heard in the headset. Certain types of scans produce a unique repetitive variation in the tone, providing the operator with the most accurate means of scan identification. The pitch of the audio signal is determined by the PRF of the emitter, and the operator can estimate the PRF simply by listening to the signal.

(C) CAMERAS.—Photographs should be taken of signals presented on the analyzer scope and of radar jamming, interference, or deception presented on the radar and analyzer scopes. Various cameras are used for analyzer and radar scope photography. The Polaroid camera has the advantage of providing a print for immediate evaluation as well as for laboratory analysis. In the event a camera is not available, a carefully prepared sketch of the pulse analyzer, panoramic, or radar repeater presentation, accompanied by a verbal description of signal behavior, can be beneficial to the analyst.



74.201

Figure 3-4.—(U) Combination display showing a strong pulsed signal (U).

## ELECTRONIC-COUNTERMEASURES

(C) Electronic-countermeasures (ECM) is the division of EW involving actions taken to prevent or reduce the enemy's effective use of electronic equipments. This objective is accomplished by employing either singly or in combination:

(C) Jamming to deny or falsify information to the enemy.

(C) Deception to simulate or alter electro-magnetic emissions.

Figure 3-5 shows the relationship of the ECM functions.

### JAMMING ECM (JECM)

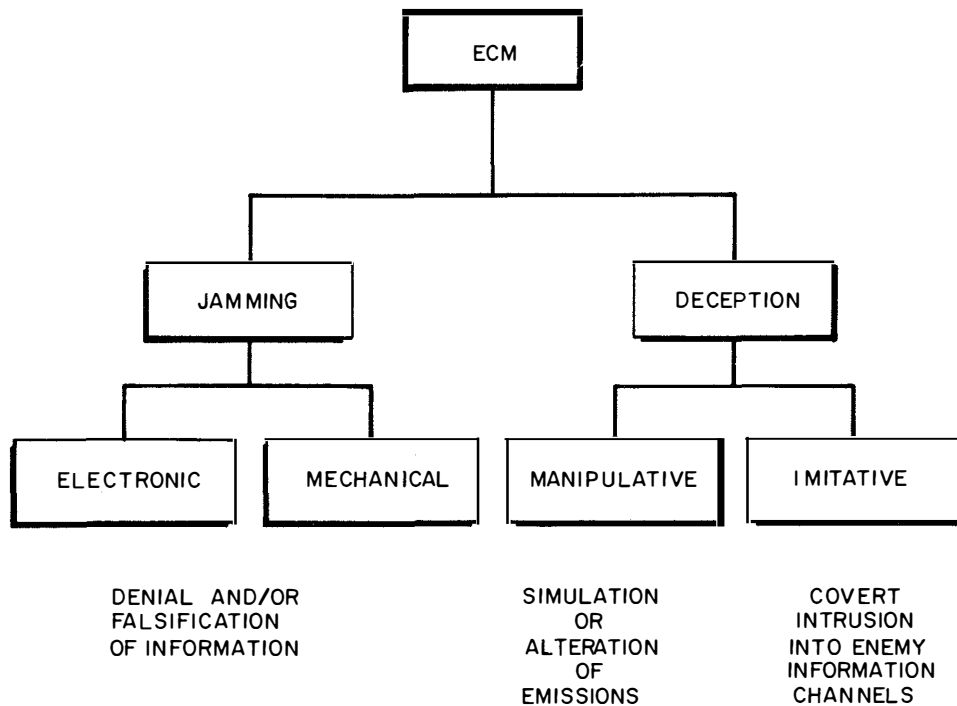
(C) Jamming ECM is the deliberate radiation, reradiation, or reflection of electromagnetic energy with the object of impairing the use of electronic devices, equipment, or systems being used by an enemy. The purpose of jamming is to deny the enemy full use of his electromagnetic sensors and control systems.

(C) Jamming is employed when the tactical advantage of emission control and silence is outweighed by the possible advantages of transmitting and introducing electromagnetic emission energy into enemy receiving systems. It is primarily employed against electronic equipment which is known to be strongly suspected of furnishing valuable information to the enemy.

### Planning Considerations

(C) Careful planning is essential for the effective use of jamming. It ensures the necessary coordination and minimizes the interference which can be created in friendly systems.

(C) IMPORTANCE OF ESM, INTELLIGENCE, AND TACTICAL UPDATE.—Before jamming operations may be planned in detail, accurate and complete electronic warfare intelligence (EWI) must be available concerning enemy electronic systems.

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74.216

Figure 3-5.—(U) Relationship of ECM functions (U).

A complete up-to-date picture of the enemy's concentrations and dispositions allows the planner to take advantage of the weaker links in the total system. In cases where sufficient equipment is not available to totally neutralize an enemy's capability, it is essential to concentrate available assets on those areas that provide the most valuable operational information, such as

1. (C) Height-finding radars,
2. (C) Fire control radars,
3. (C) Missile control radars,
4. (C) Guidance frequencies,
5. (C) Tactical communications nets.

(C) **CONSIDERATION OF OWN FORCES.**—Planning considerations must include a determination of the friendly equipment and frequencies that are vital to the success of an operation and a jamming plan that will not dangerously deny or degrade the performance of this vital equipment.

#### Use By Various Units

(C) The use and type of jamming is generally governed by the:

1. (C) Tactical situation,
2. (C) Mission of the force,
3. (C) Types of ships and aircraft available for the operations.

Surface ships, aircraft, and submarines each have jamming advantages peculiar to them, and there are tactical applications for which each is best suited.

(C) Surface ships carry more powerful jammers, having more power and fewer restrictions on size and weight. However, the relatively short distance to the radar horizon seriously limits their coverage capability except in defensive operations and those offensive operations in which they are operating at relatively short ranges from enemy installations.

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(C) Aircraft are fast and maneuverable, and can reach positions untenable by surface forces. Their height gives them a far greater jamming range. Individual aircraft or groups of aircraft use a variety of ECM methods to protect themselves or to support surface forces.

(C) Jamming by submarines is limited because the submarine's primary advantage is being able to remain undetected in nearly all operations. However, its ability to remain on station in areas untenable by either surface ships or aircraft affords an advantage that may be utilized in some cases.

### **Jamming In Various Types Of Operations**

(C) Effective use of jamming will be determined by the tactical situation and will probably be used during:

1. (C) Air strikes,
2. (C) Anti-air warfare,
3. (C) Amphibious assault,
4. (C) Enemy guided missile attack.

(C) The use of jamming will depend on whether own force has been detected. If the force has not been detected, jamming will increase the possibility of early discovery. However, if the force has been visually sighted or detected by enemy radar, electronic and/or nonelectronic jamming will materially deter the enemy from tracking the force.

### **Jamming Concept**

(C) Jamming operations must be varied in accordance with the type of enemy equipment encountered. While intercept search is the same regardless of the type of enemy equipment in use, the tactical considerations governing jamming differ to some degree, depending on the equipment to be encountered and whether the measures are offensive or defensive in nature. Jamming is employed in connection with:

1. (C) Radar countermeasures (RADCM),
2. (C) Communications countermeasures (COMCM).

3. (C) Missile and controlled devices countermeasures (MCCM).
4. (C) Navigation countermeasures (NAVCM).
5. (C) Electro optical countermeasures (EOCM).

(C) Offensive jamming is employed against those portions of the enemy's electronic complex that are most susceptible and will deny the most vital information. Jammers should be activated when offensive forces are within normal detection range of enemy systems and should be used continuously throughout the offensive operation to deny or degrade information. Jamming against fire control and missile control radars should be initiated before attacking forces are within the lethal weapons envelopes of these systems.

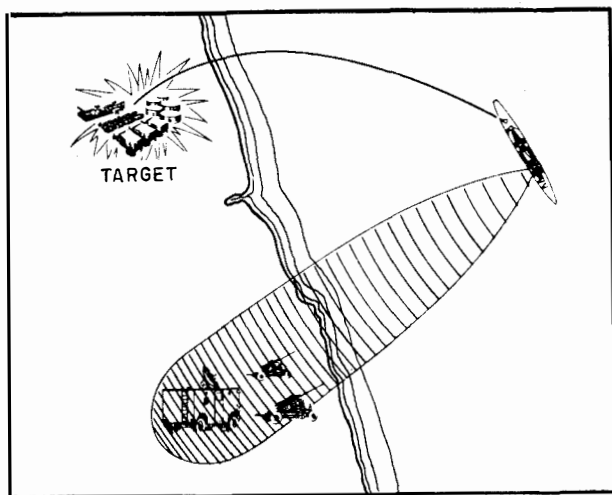
(C) Defensive jamming is used to protect our own forces. It should only be used during emergencies, because jamming increases the hazard of enemy home-on-jam devices, and reveals the position of the force.

(C) Nonelectronic jamming devices such as chaff and other reflecting materials are used to confuse and saturate enemy radars or radar-controlled devices. Friendly equipment as well as enemy equipment may be affected by reflecting materials and care must be exercised when employing these devices. Reflecting devices used in close proximity to friendly forces or operations may create more confusion and degradation to friendly systems than their employment warrants.

### **Electronic Jamming**

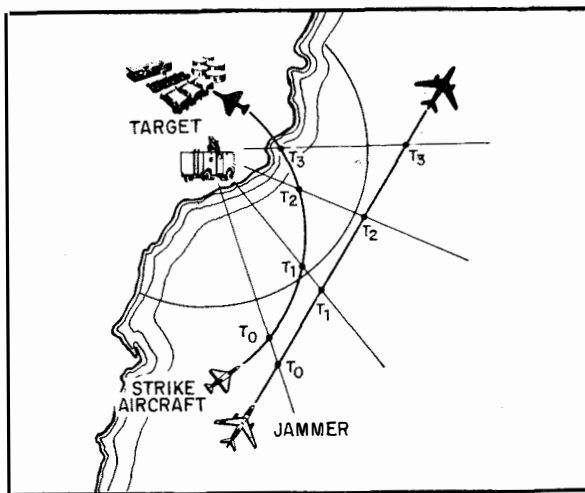
(C) Jamming may be classified as on-target or off-target jamming.

(C) ON-TARGET (SELF-SCREENING).—Jammers used by a unit for self-screening from enemy electronic detection devices are performing on-target jamming. This technique can be employed by either ships or aircraft. On-target jamming is the most efficient method of radar masking when ships are involved because supporting units are not required. Figure 3-6 illustrates a technique

**CONFIDENTIAL**

074.217

Figure 3-6.—(U) Example of on-target jamming (U).



074.218

Figure 3-7.—(C) Example of off-target jamming (C).

that may be employed by a naval vessel while performing a shore bombardment mission within the range of hostile shore batteries.

(C) OFF-TARGET (STAND-OFF).—Off-target jamming is used to support or screen units (ships or aircraft) that are potential targets to enemy electronic detection devices when the platform is not the immediate target. Off-target jamming is also referred to as stand-off jamming (SOJ) when the jamming platform does not enter the weapons envelope.

(C) Off-target jamming is used primarily to support air operations. An airborne jamming platform supports, at a stand-off distance, attack/reconnaissance aircraft just prior to entry into and while within the weapons/reconnaissance surveillance envelope. Figure 3-7 illustrates an SOJ technique employed in support of strike operations.

(C) DETERMINING EFFECTIVENESS OF JAMMING.—Determining the immediate results of jamming is a major problem in every operation involving ECM. The first indications of effective jamming are normally apparent to the intercept operator if the enemy takes any ECCM action such as frequency shifting, PRF or

PW shift, or any detectable shift in mode of operation (circular scan to sector scan, lock-on mode to acquisition or search mode, etc.). However, absence of any detectable indication of effectiveness does not imply that jamming on that frequency is ineffective.

### Nonelectronic Jamming

(C) Chaff and other nonelectronic jamming methods can be used to obtain a tactical advantage and may be employed by ships or aircraft. Chaff is metallic strips packed in units of various lengths and quantities, with each unit applicable to a given frequency. Chaff cut to lengths equal to about one-half the wave length of the victim radar is usually effective. The quantity of chaff to be used in each drop depends on the frequency of the radar it is used against and the size of the unit or units to be screened.

(C) To be effective, chaff should be used generously. In some cases, it appears on radar scopes as individual blips similar to those produced by aircraft. In other cases, a long mass of blips may appear close together. Chaff packages are dropped at intervals close enough to make it impossible for an operator to separate

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a single blip of an aircraft or ship from the mass of chaff echoes.

(C) Chaff must be dispensed at a distance sufficiently ahead of and above the forces to be screened so that the forces are covered at the time jamming (screening) is desired. Plans for dispersal patterns should be based on:

1. (C) Wind conditions,
2. (C) Type of reflector material to be used,
3. (C) Time element,
4. (C) Number and disposition of units to be screened.

Reflectors dispersed too low or too high an altitude may be insufficiently scattered to have optimum jamming effect and may permit radars or missiles to detect true echoes through the chaff pattern. Dispersal patterns must be continually renewed if screening is desired over an extended period.

(C) Chaff is most successful against fire control and missile control radars. For this purpose, it may be dropped at a random rate in an effort to break lock-on, create false targets, and prevent automatic tracking rather than to screen a force. Chaff used against anti-aircraft and missile fire can also cause proximity fuzes to detonate prematurely by presenting false target information.

(C) The average rate of fall of chaff is 100 to 400 feet per minute, depending on wind conditions and altitude of drop (the higher the drop point—the higher the rate of fall). The fallout rate varies with the horizontal movement of the material, which is approximately the same as the prevailing wind at the particular altitude. When chaff is dispensed from high altitudes, it may be widely dispersed long before reaching the surface, thus decreasing the effectiveness of the pattern.

(C) Aircraft dispense chaff by automatic dispenser or rockets. Ships use projectiles, mortars, or rockets. Chaff reaches its maximum effectiveness within a minute after it is dropped or ejected. Effects may be expected to last from 30 minutes to several hours depending on the altitude at which it is dispensed.

## **DECEPTION ECM**

(C) Deception ECM (DECM) is the deliberate radiation, reradiation, alteration, absorption, or reflection of electromagnetic energy in a manner intended to mislead an enemy in the interpretation or use of information received by his electronic systems. There are two categories of deception; manipulative and imitative. (See figure 3-5.) Manipulative deception is the alteration or simulation of friendly electromagnetic radiations to accomplish deception. Imitative deception is the introduction of radiations into enemy channels which imitates his own emissions.

### **DECM Concept**

(C) The purpose of deception ECM is to mislead an enemy by electromagnetic means and thus reduce the effectiveness of his electronic systems. The ultimate result must be to minimize or eliminate the destructive capability of enemy weapons systems. The time to initiate deception measures and the duration of employing them is of paramount importance if full effectiveness is to be realized. If activated too soon, DECM can reveal the presence of the unit or force using it. Applied too late, the DECM may be obvious and thus the deception is a failure. In some cases, the employment of deception is required for only a limited period of time. This would be the case with a friendly carrier striking force. The enemy must destroy the carrier before her aircraft are launched if an attack on the enemy is to be prevented. Applying deceptive measures to make small ships and boats appear as carriers to enemy sensors would force him to use other means to determine the true target. Such multiple target deception may gain the time necessary to ensure that the strike mission is launched.

(C) Electronic warfare cover is action associated with deception. It is designed primarily to supplement security and to prevent the recognition of force capabilities, dispositions, and intentions. Cover and concealment is intended to maintain the enemy in a state of ignorance, whereas deception embraces active measures which can induce an enemy to make an erroneous estimate of the

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situation. Cover enhances security, and may prevent an enemy from obtaining information which could reveal the hoax of a deception plan. For this reason, cover is an essential element to EW deception.

(C) The security classification of deception ECM tactics and operations precludes any further discussion of the subject in this manual. Additional information can be found in the current edition of NWP-33, NWP-34 and current OPSEC/OPDEC instructions.

**ECM Equipment and Devices**

(C) ECM equipment and deception devices are employed to nullify the usefulness of enemy electronic equipment by jamming to deny him receipt of information or by deception to provide him with false information. Only the imagination and ingenuity of the individual limits the possible use of any electronic radiator or reflection device in ECM.

(C) COMCM EQUIPMENT.—Equipment used for communication countermeasures may be of special design, or standard communications equipment may be employed, provided suitable modulation is used to jam the particular type of system. The more common types of COMCM equipment modulation are named according to the audio sounds they produce.

(C) NOISE.—Random amplitude and frequency modulation creating a very strong static.

(C) SAW.—Frequency modulated signal which produces a distinctive audio warble.

(C) RANDOM SAW.—Similar to saw modulation except that the frequency of the random saw varies the discontinuous jumps as compared with the steady frequency change of saw.

(C) RANDOM KEYING.—Modulated CW type signal, which is turned on and off at a varying rate to simulate keying speeds from a few words per minute to 30 or 40 words per minute.

(C) BAGPIPES.—Amplitude modulation which produces many different audio tones in rapid sequence. This method is extremely effective against voice circuits.

(C) RADCM EQUIPMENT.—Radar jamming equipment produces random noise or signal-like emissions for the purpose of interfering with enemy radars. Jammers capable of obscuring information are referred to as “masking jammers” as opposed to repeater transponders which enhance echo return.

(C) The use of masking jammers results in “snow,” “strobing,” and noise spikes on the target radar scope. In radars which employ automatic gain control or automatic noise limiting circuits such as AGC, IAGC, and ANL, a blanking out of the scope may occur when masking jammers are used against them.

(C) The four basic techniques of electronic jamming are spot, sweep, frequency search and lock, and barrage.

(C) Spot jammers are narrowband, manually tunable transmitters which may be modulated in frequency or amplitude by random noise or by a periodic signal. They are employed on a one jammer versus one radar basis and must be manually set on the victim radar frequency.

(C) Sweep jammers are narrowband, automatically tunable transmitters that sweep back and forth through a frequency band at a predetermined rate, up to several thousand sweeps per second. The same types of modulation may be employed as in the spot jammer. Sweep jammers may also double as spot jammers. The primary difference between the two is the automatic tuning capability.

(C) Frequency search and lock jammers use a transmitter in which a narrowband jamming signal can be tuned over a broad frequency band and the signal locked on a particular frequency. This is essentially a spot jammer with the additional feature of an automatic lock-on capability. The jammer receiver determines the frequency and tunes the transmitter to this frequency. The advantage of this type jammer is its speed in detecting and jamming a threat signal. It concentrates power into a narrowband and can be used to follow a frequency shifting radar.

(C) Barrage jammers are wideband noise or frequency modulated transmitters which deny the use of frequencies over a wide portion of the electromagnetic spectrum. One of the most effective types of barrage jammers is the wideband noise jammer. It has the ability to jam multiple radars and to cover the entire range of radars capable of frequency diversity or agility.

(C) **NONELECTRIC DEVICES.**—Nonelectronic devices present false targets to the victim radar. They may be considered as jamming or deception devices, depending on their intended purposes. Devices of this type include chaff, rope, and decoys.

(C) Chaff is the name used for resonant dipoles, usually lightweight strips of foil or metalized paper dropped from aircraft or dispersed from bursting shells or rockets. Each chaff strip acts as a reflector to return an echo to enemy radar equipment.

(C) The reflecting ability of chaff depends largely on the accuracy with which the reflectors are cut to the frequency of the victim radar. The ideal chaff strip length is 0.475 times the wavelength of the radar frequency. Normally, the chaff strips affect all radars operating within 5 to 20 percent of the frequency to which they are cut. They are particularly effective in jamming radars which have poor resolution. Figure 3-8 shows some of the various sizes of chaff and the frequencies that they are used against.

(C) Rope consists of ribbons of reflecting foil from 400 to 700 feet long and one-half inch wide. Rope normally has a piece of cardboard attached to each end to balance it in a horizontal position as it falls. As it falls, twists, and turns, it presents the victim radar various aspects, some of which return strong echoes. Rope is most often used for jamming and/or concealment against radars with frequencies below 350 MHz. Figure 3-9 shows a single ribbon or rope. It is not uncommon to have both chaff and rope packaged in a single bundle, thus providing responses over a broad band of frequencies.

(C) Another device used to present false targets on enemy radars is the decoy. Decoys are used to present false air and surface targets or to cause a small target to produce a large echo, thus

making it difficult for the enemy to evaluate the threat. Devices commonly employed as decoys include corner reflectors, gulls, and kites. Corner reflectors are small metal strips arranged perpendicularly. These reflectors simulate a very large target, returning extremely large echoes to any radar that detects them.

(C) Gulls are made up of a corner reflector or any other good reflecting material installed on a buoy. The gull is cast adrift in the sea to simulate a ship. The movement of a gull depends entirely upon the sea currents.

(C) Kites are made up of a reflector attached to a balloon, and are released into the air to simulate an aircraft. The movement of a kite depends upon the winds encountered. The winds at high altitudes normally have a high velocity. A kite flying in these strong winds can very easily be mistaken for a jet aircraft by an enemy radar operator.

### **ELECTRONIC COUNTER-COUNTERMEASURES**

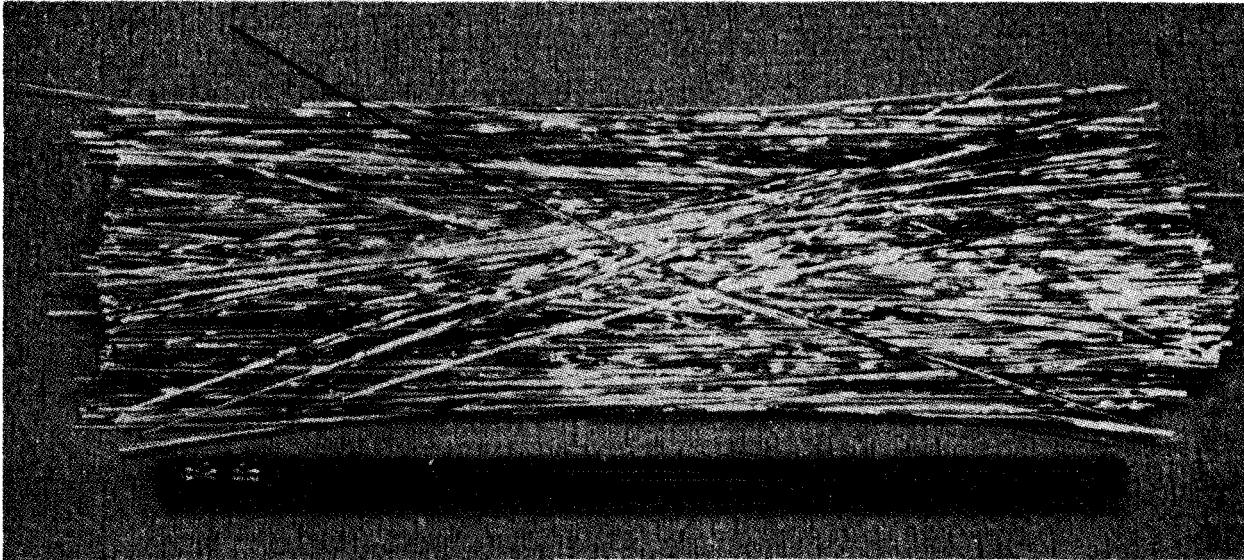
(C) Electronic counter-countermeasures (ECCM) optimize the electromagnetic capabilities of own forces by negating the effectiveness of enemy EW actions. This is accomplished by employment of:

1. (C) Emission control (EMCON)
2. (C) Tactical evasion
3. (C) Anti jam circuits
4. (C) Frequency diversity and agility
5. (C) Operator technique and training
6. (C) Tactical action

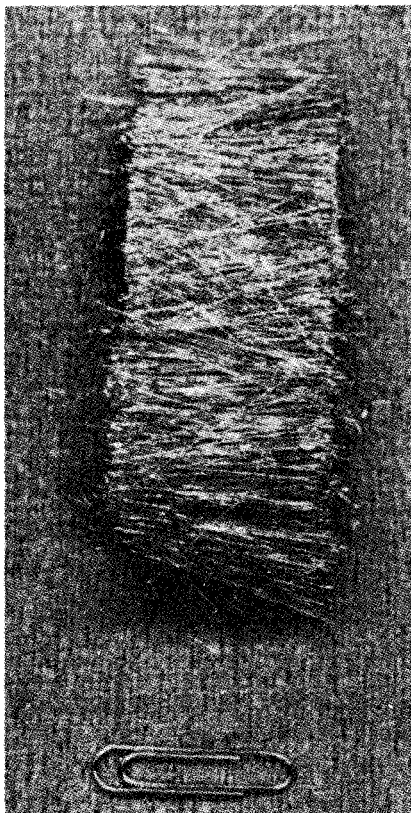
Figure 3-10 shows the functional relations of ECCM.

(C) Naval operations frequently take place over extended periods and in limited geographical areas where an enemy has ample opportunity to employ his EW capability. Any potential enemy can be expected to possess the technical ability to use EW measures equivalent to our own. Consequently, United States forces must maintain effective control of own electromagnetic emissions and thereby reduce the success of the enemy ESM. When ECM is used against United States forces, it is equally

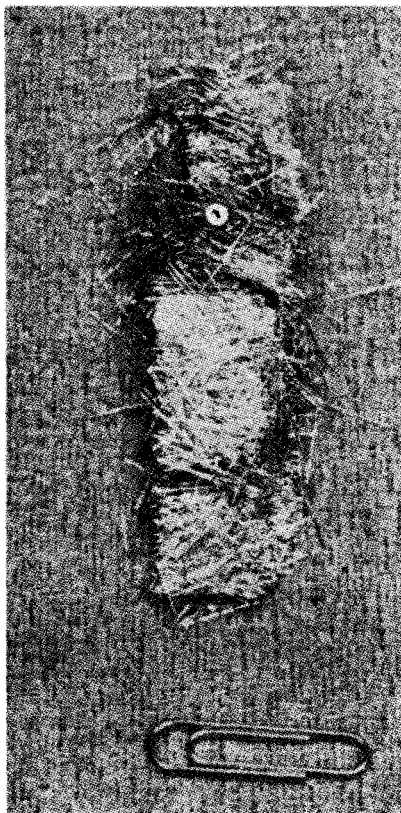
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**C-BAND CHAFF (700 MHz)**



**G-BAND CHAFF (4300 MHz)**

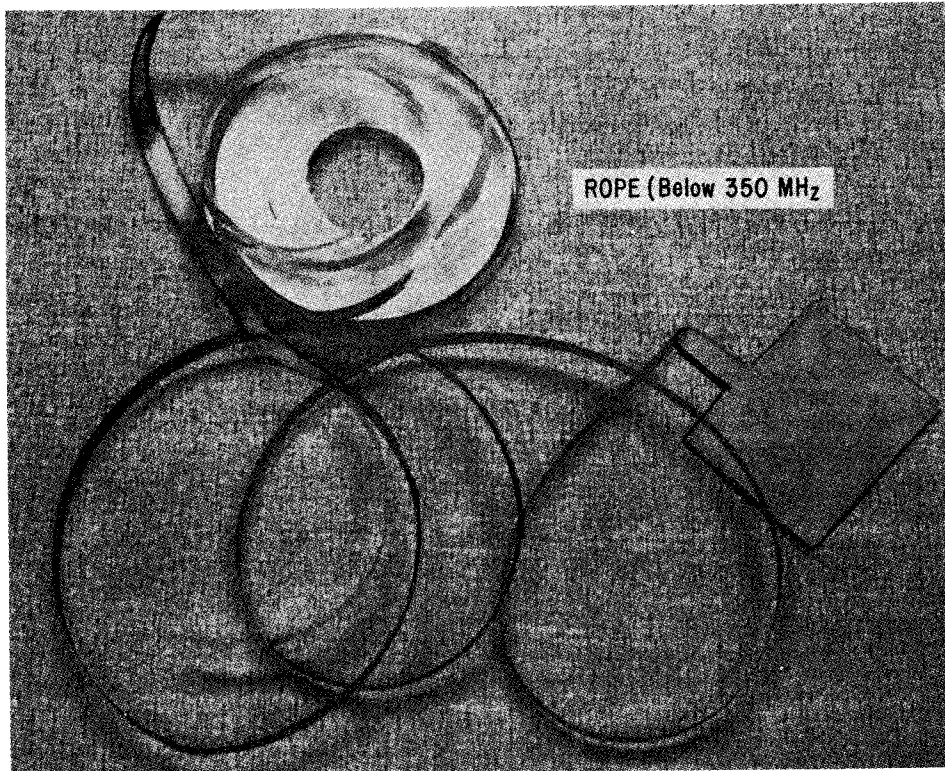


**I-BAND CHAFF (9000 MHz)**

Figure 3-8.—(C) Various lengths of chaff showing frequencies that they affect (C).

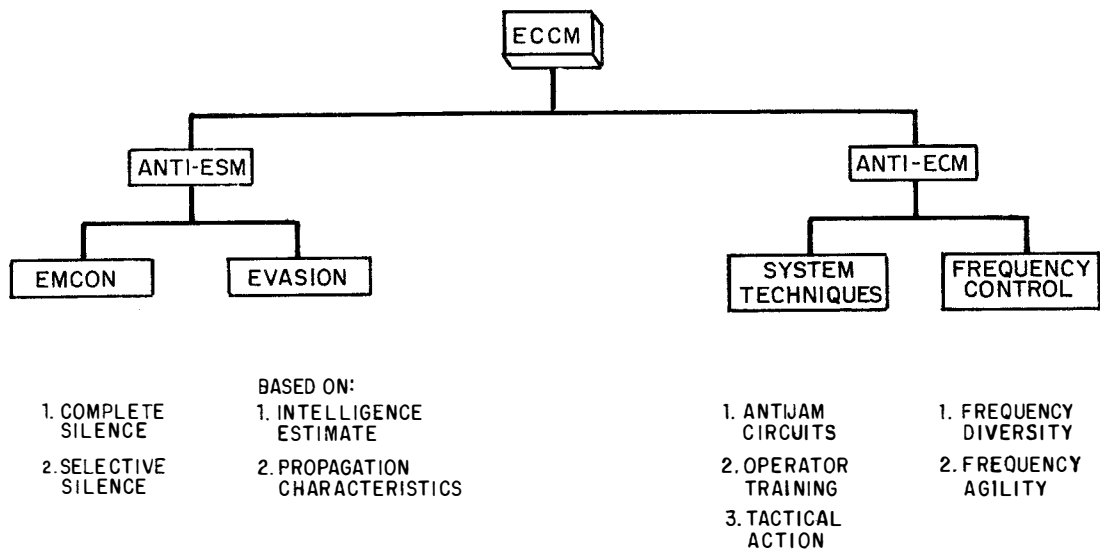
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Figure 3-9.—(C) Single ribbon of rope (C).



74.221

Figure 3-10.—(U) Functional relationships of electronic counter-countermeasures (U).

**CONFIDENTIAL****Table 3-1.—(C) Radar Guards (C)**

ALFA-----	Long-range air search. The dividing line between guards ALFA and BRAVO is 34 miles from the formation, except in formation with ships equipped with long-range radars, in which case long-range air search will be from 75 miles to the extremity. This is not to be considered a sharp line; the guards are to overlap about 5 miles each side of the dividing line.	ECHO-----	Altitude determination.
BRAVO-----	Short-range air search.	ECHO ONE-----	Scan in elevation from minus 30' to plus 3°00'.
CHARLIE-----	Medium-range air search. This guard overlaps guard ALFA and covers distances 30 to 75 miles from the formation.	ECHO TWO-----	Scan in elevation from plus 2°30' to 5°00'.
DELTA-----	Low flying aircraft search.	ECHO THREE---	Scan in elevation from plus 4°30' to plus 7°30'.
		FOXTROT-----	Long-range surface search.
		GOLF -----	Short-range surface search. The dividing line between guards FOXTROT and GOLF is approximately 5 miles beyond the screen; the dividing line is not sharp, the two guards are to overlap.
		HOTEL -----	As directed by current operation order.
		INDIA -----	RECOGNITION GUARD
		ZULU -----	Zenith watch.

074.233

important that such action be detected and that adequate countermeasures be applied. To achieve and maintain an effective ECCM capability requires planning and training.

#### **RADAR GUARDSHIP**

(C) To minimize the number of equipments operating within a force, radar guards are

assigned to individual ships. Only the guardship is allowed to operate the equipment specified in the radar guard assignment. Radar guards are assigned in accordance with ATP-1 ( ) Volume 1 or as modified by the OpOrder in use. Table 3-1 reflects radar guard assignments as listed in ATP-1 ( ) Volume 1. Unless the duty is limited to a sector, the guardship is responsible for full 360-degree coverage.

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## **CHAPTER 4**

# **ESM SYSTEMS**

(U) ESM equipment is used to detect, locate, analyze, and record electronic emissions throughout the electromagnetic spectrum. It provides U.S. forces with the capability to gain tactical and strategic intelligence on enemy electronic activity of all types while remaining undetected by the enemy. Only the basic principles and general types of equipment used in ESM systems are covered in this chapter.

### **INTERCEPT RECEIVERS**

(U) The fundamental piece of equipment in any ESM system is the intercept receiver, which governs the general capabilities and limitations of the system. The overall system, of course, is affected by all basic and associated system components.

(U) Intercept receivers are classified as narrowband and wideband, according to methods of searching the frequency spectrum. Intercept receivers detect enemy electromagnetic emissions as a function of frequency and provide selected signal outputs to displays, signal analyzers, recorders, and warning devices. Receivers may be capable of automatic signal processing and identification, thereby providing threat warning for preprogrammed threats. Outputs of these receivers may also be used to gate automatically ECM equipment including deception repeaters and chaff launching devices.

(U) Discrimination circuits which respond to certain signal characteristics may be provided with any receiver to accept or reject appropriate signals for display. Pulse signals which originate

on board may be blanked by a video blanker (described in chapter 6), a rather elaborate installation that must receive pretrigger pulses from all own ship's radar transmitters that interfere with the intercept receiver.

(U) The remainder of this chapter describes some of the narrowband and wideband receivers used in ESM. They have been chosen only because they are representative of ESM receivers; they may or may not be on board your ship.

### **NARROWBAND RECEIVERS**

(U) Narrowband receivers are the most common type used for ESM. Normally, they are superheterodyne receivers with excellent selectivity, sensitivity, and stability. Their units have a wide range of frequency coverage but can only accept a narrow band of frequencies at any given time. To provide coverage of the entire frequency range of the receiver, it is necessary to move or tune the acceptance bandwidth. Tuning units (heads) provided for this purpose have a frequency coverage of about one octave (frequency is doubled in one octave), and several tuning heads are used to cover the receiver range. The receiver is manually or automatically tuned through the desired portion of the spectrum.

(U) The principal advantage of narrowband receivers is selectivity, which permits signal analysis and recording with a minimum of interference from undesired signals. Additional filters may be employed to increase the capability of the receiver to reject undesired



signals. These receivers are also adaptable to operation in conjunction with spot jamming transmitters to determine and set jamming frequencies.

(U) If the frequency of a signal which is to be intercepted is known to an accuracy within the limits of the acceptance band of a narrowband receiver, the necessity for tuning the receiver is eliminated and the probability of signal detection is very high. When it is necessary to search a relatively large portion of the spectrum, the signal detection probability increases with the use of rapid scan. Signal detection probability is reduced if it is necessary to shift tuning heads in order to cover the desired portion of the spectrum.

(U) The rapid scanning receiver is a narrowband receiver which is electronically tuned or swept in frequency at a very high rate. Electronic induction tuning eliminates the single octave tuning limitation inherent in mechanical tuners. The panoramic frequency display presents the signal environment for a warning capability equivalent to that of a wideband receiver. For signal analysis, the sweep may be stopped to provide the normal narrowband receiver audio and video outputs.

(U) An important capability of the rapid scanning receiver is realized in its use as a threat signal warning receiver where only the portion of the frequency spectrum that contains a known threat emitter is swept. The output of this receiver normally is applied to both audio and video alarm systems.

#### AN/WLR-1

(U) Figure 4-1 shows a diagram of a typical narrowband receiving set. The set is a representative AN/WLR-1 countermeasures equipment. It rapidly analyzes a received signal by simultaneous direction finding, pulse analysis, and panoramic display. Rapid scanning techniques and a long-persistence raster display enhance the probability of intercepting a signal. A servo-driven, direct-reading counter shows the frequency of the intercepted signal.

(U) The frequency range is covered by nine RF tuners which overlap in frequency. Any one of the tuners may be selected by means of a band selector switch. Either automatic frequency scan or manual tuning is available. In frequency scan operation, the range of a tuner is covered in a few seconds. In manual operation, a tuning knob in conjunction with a servosystem controls the frequency of the RF tuner. A signal storage facility enables the operator to return to previously stored frequencies by depressing one of ten select pushbuttons. The RF band on which any particular signal is stored is shown by an indicator adjacent to each select pushbutton.

(U) The acquisition indicator (scan indicator) has a raster-type presentation. Some presentation examples are illustrated in figure 4-2. The horizontal sweep is synchronous with the tuner as it is scanned through the frequency range. The vertical sweep is driven by a sawtooth voltage having a period of 2 minutes. Suitably stretched, detected signals are applied as intensity modulation to the cathode-ray tube and appear as a vertical series of spots, while noise forms a random pattern. Detection of signals below noise level is possible because of visual integration. The scan indicator retains information for approximately 2 minutes, allowing manual return to a detected signal for storage or analysis.

(U) The analysis indicator is a five-gun cathode-ray tube. The demodulated output of the received signal (AM, VIDEO, or FM) is presented by the first three guns on three sequentially triggered traces for measurement of pulse duration and repetition frequency. The first scale is exponential and the second and third scales are logarithmic. The fourth gun provides linear direction finding information on two calibrated scales separated vertically by 1 inch. Each scale represents  $180^\circ$  of rotation. The electron beam traverses the rectangular path in synchronization with the antenna rotation. A received signal causes vertical deflection of the spot, proportional to the signal strength, at a point on the scale corresponding to the signal bearing. The lower trace (fifth gun) on the analysis indicator is a panoramic presentation of a portion of the frequency spectrum. The trace



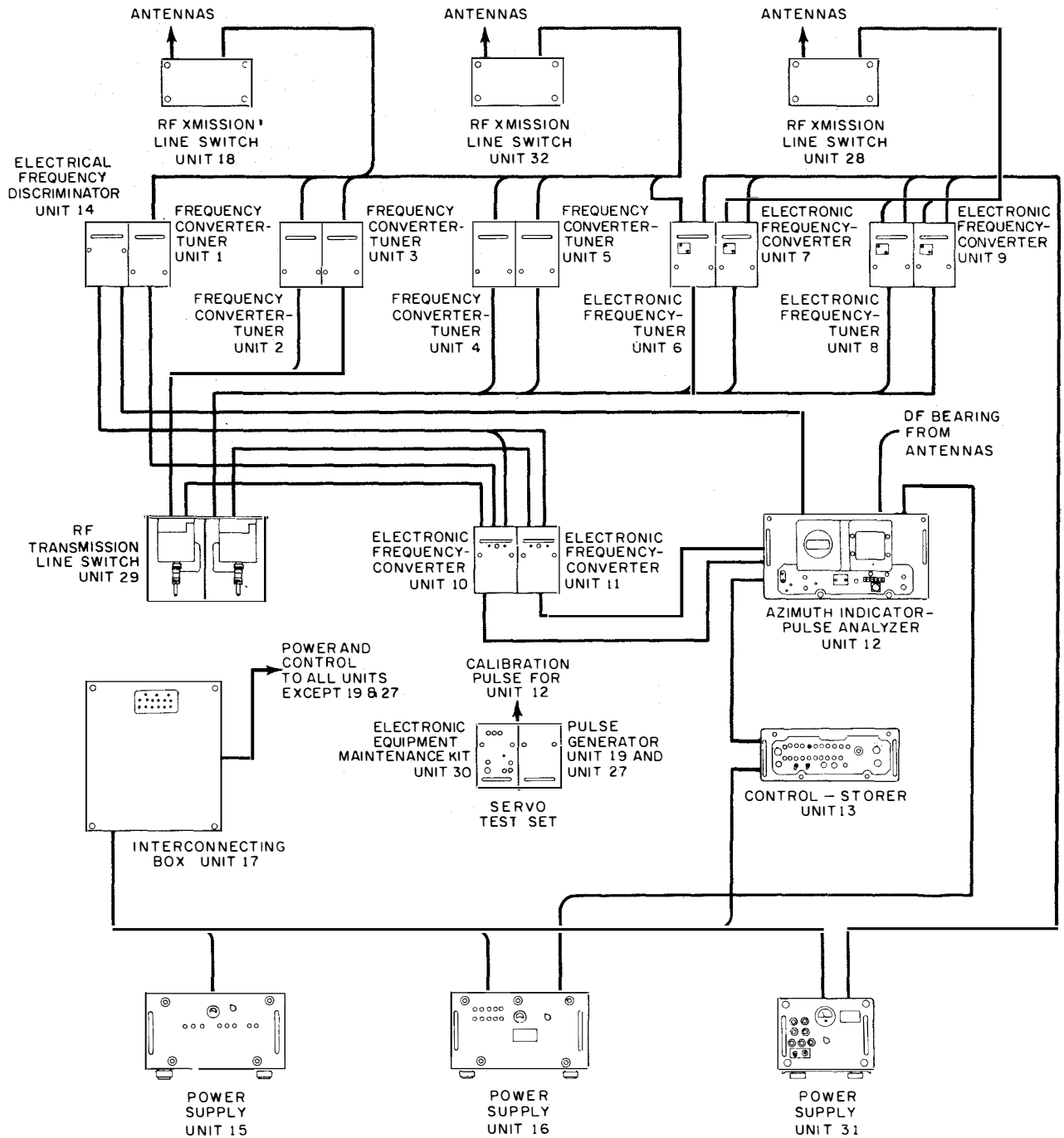
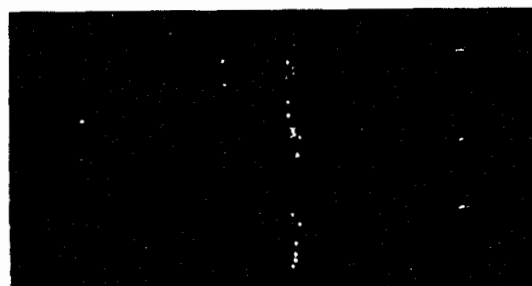


Figure 4-1.—(U) Countermeasures receiving set relationship of units (U).

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WEAK CW SIGNAL

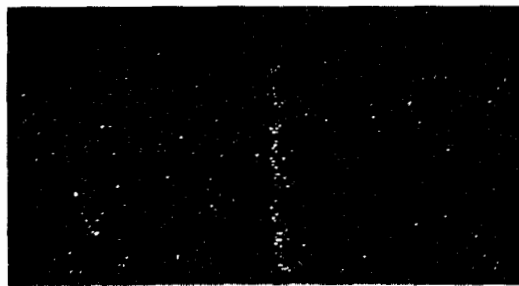
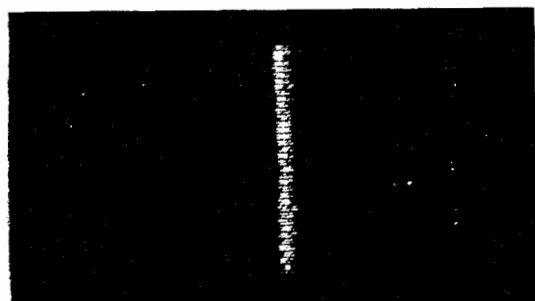
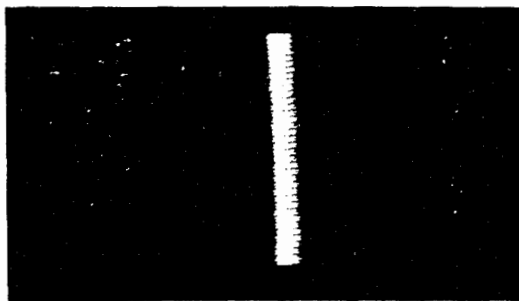
WEAK PULSED SIGNAL,  
PULSE WIDTH 10 USEC, PRF 1 kHzMEDIUM STRENGTH PULSED SIGNAL,  
PULSE WIDTH 10 USEC, PRF 1 kHzSTRONG PULSED SIGNAL,  
PULSE WIDTH 10 USEC, PRF 1 kHzVERY STRONG  
PULSED SIGNAL, PULSE WIDTH  
10 USEC, PRF 1 kHz

Figure 4-2.—(U) Acquisition scope presentations (U).

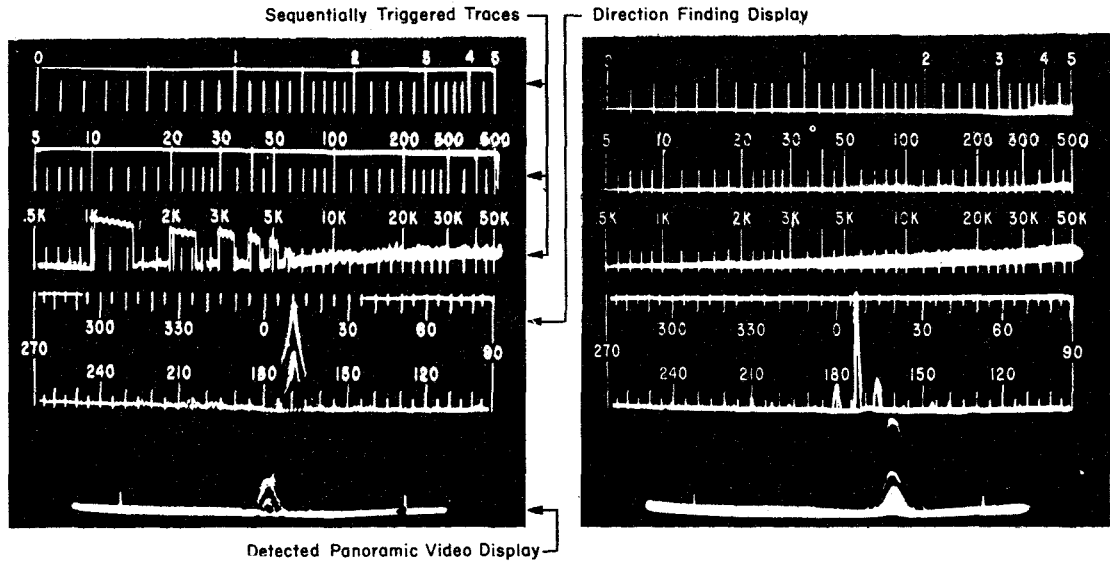
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is 5, 10, or 20 MHz wide (depending on the RF tuner in use) centered about the tuner frequency. Figure 4-3 shows some analysis indicator presentations.

#### System Analysis

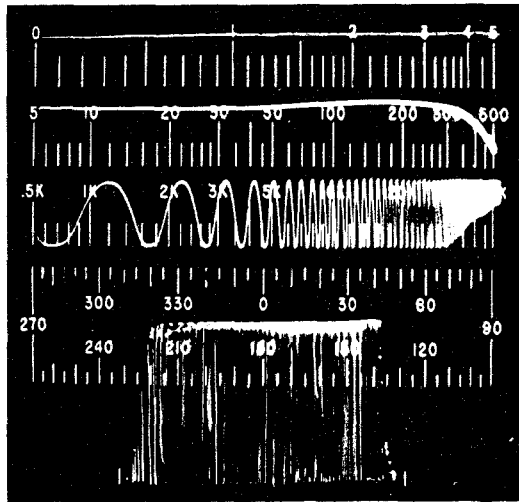
(U) Figure 4-4 is a block diagram of the countermeasures receiving set. The three RF transmission line switches (units 18, 32, and 28)

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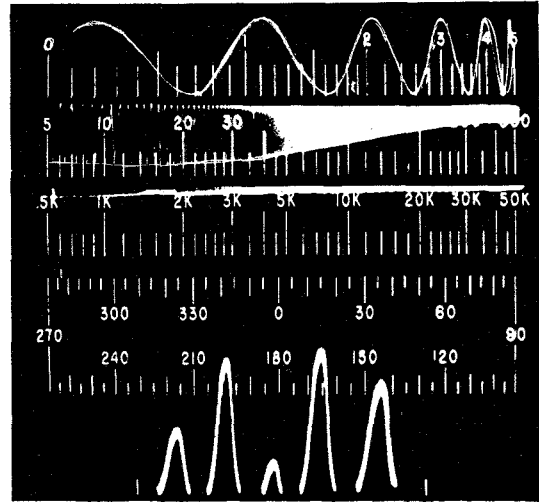


DF DISPLAY, 1 kHz  
 SQUARE WAVE, ANTENNA SPEED 300 RPM,  
 BEARING 170 DEGREES

DF DISPLAY,  
 CW SIGNAL, ANTENNA SPEED 40 RPM,  
 BEARING 170 DEGREES



FM SIGNAL SINE WAVE  
 DEVIATION 6 MHz PEAK TO PEAK, MODULATION  
 FREQUENCY 1 kHz

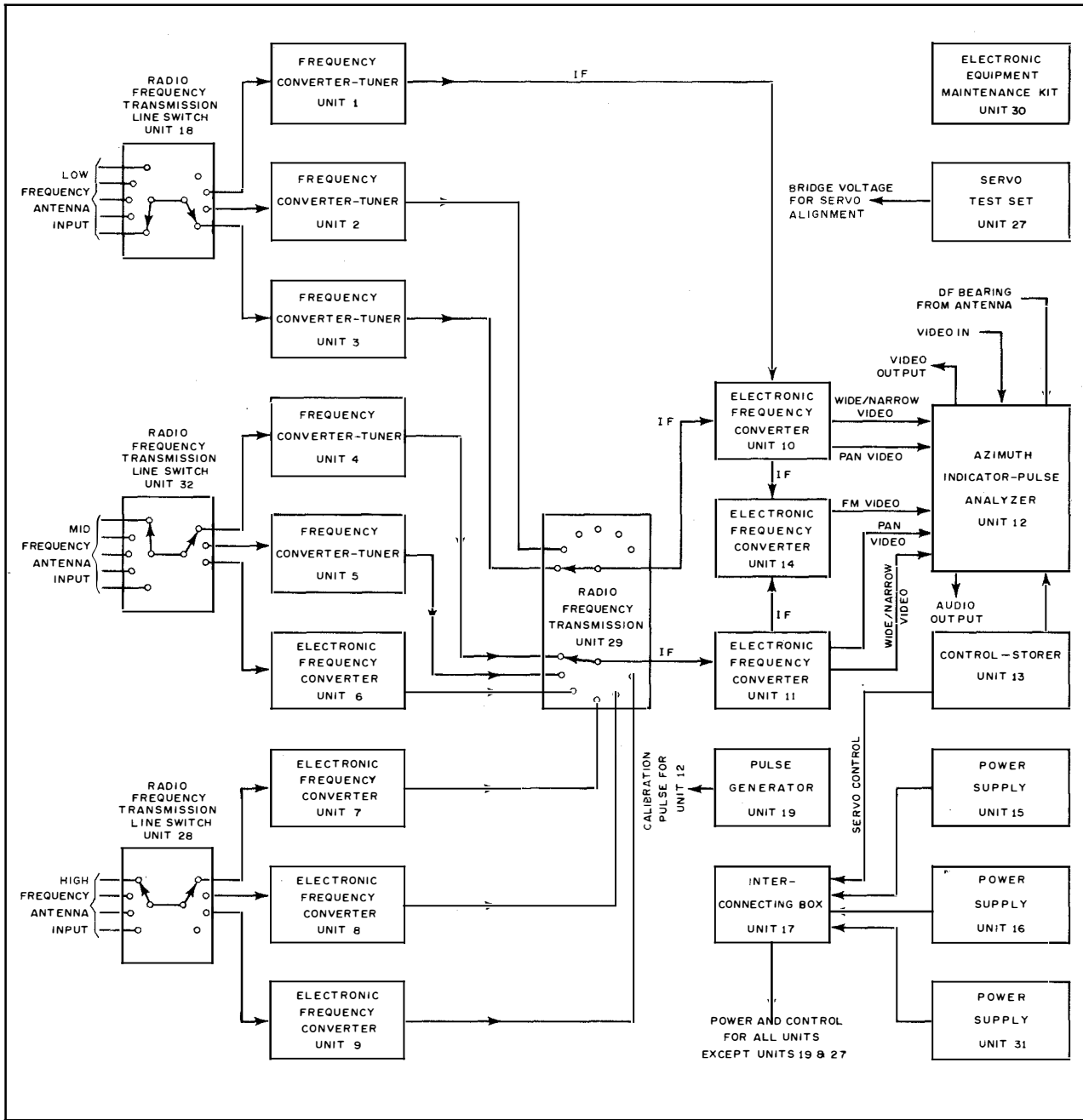


FM SIGNAL, SINE WAVE  
 DEVIATION 6 MHz PEAK TO PEAK, MODULATION  
 FREQUENCY 1 MHz

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Figure 4-3.—(U) Analysis indicator presentations (U).

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32.3(67C)

Figure 4-4.--(U) Countermeasures receiving set block diagram (U).

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are used to select the proper antenna and connect it to the proper RF tuner. The antenna switches are controlled by the BAND SELECTOR and ANTENNA SELECTOR switches. The system contains nine RF tuners (units 1 through 9), one RF tuner being used on each band. The unit number corresponds to the band number, i.e., unit 2 is for band 2, unit 7 for band 7, etc.

(U) Each RF (frequency converter) tuner consists of a preselector, a local oscillator, and an IF preamplifier. The preselector and local oscillator are tuned by a servo tuning system (not shown) which is coupled to an automatic scan generator control during analysis operation. On band 1, the IF output of unit 1 is coupled directly to the electronic frequency converter (unit 10). On bands 2 and 3, the IF outputs of units 2 and 3 are coupled through the radio frequency transmission line switch (unit 29) to unit 10. On bands 4 through 9, unit 29 selects an IF signal from one of the high frequency RF tuners (units 4 through 9) and applies it to the electronic frequency converter (unit 11). Note that three different IFs are used, one for band 1, another for bands 2 and 3, and the third for bands 4 through 9. The frequency converter units contain wide-bandwidth IF amplifiers, narrow-bandwidth IF amplifiers, and detector circuits which supply video signals to the azimuth indicator-pulse analyzer (unit 12). During FM operation, an IF signal from one of the frequency converter units is applied to the electrical frequency discriminator (unit 14) which supplies a video signal to unit 12 for analysis. All operating controls for the system are contained on the front panel of unit 12 and the control-storer (unit 13).

(U) Power for all units except the pulse generator (unit 19) and the servo test set (unit 27) is provided by three power supplies (units 15, 16, and 31). The interconnecting box (unit 17) contains switching relays for operation of the system.

(U) The pulse generator (unit 19) provides pulse outputs for calibration of the pulse analysis display of unit 12, and has a self-contained power supply. The servo test set

(unit 27) is used to align the servo potentiometers in the RF tuners and is stored in unit 19. The electronic equipment maintenance kit (unit 30) contains special maintenance tools and cables and provides storage for unit 12 accessories.

#### **Radio Frequency Transmission Line Switches**

(U) Radio frequency transmission line switches are used to switch the proper OMNI or DF antenna to the RF tuner in use. The countermeasures system uses three units. Units 18 and 32 are used for the low-frequency range tuner bands 1, 2, and 3, and for 4, 5, and 6, respectively. Unit 28 is used for high-frequency bands 7, 8, and 9. The units operate identically.

#### **Radio Frequency Transmission Line Switch (Unit 28)**

(U) The purpose of the RF transmission line switch (unit 28) is to switch the proper OMNI or DF antenna to the RF tuner in use. The unit provides switching for the high frequency range antenna used on bands 7, 8, or 9.

#### **Lower Band Frequency Converter-Tuners (Units 1 through 5)**

(U) The lower band frequency converter-tuners (units 1 through 5) are used to cover the frequency range of bands 1 through 5. See table 4-1 for band frequency coverage. The units are almost identical and so are treated together. A block diagram of the unit is shown in figure 4-5.

(U) The input signal from the antenna is applied through the filter assembly and the RF preselector (also through the RF amplifier in band 1) to the crystal mixer where it is mixed with a signal from the local oscillator to produce the IF signal. The magnitude of the local oscillator injection is monitored by the OSC INJECT meter on the front panel of the azimuth indicator-pulse analyzer. Both the RF preselector and the local oscillator are tuned by the servomotor.

**CONFIDENTIAL**

Table 4-1.—(U) Tuner Characteristics (U).

BAND	FREQ IN MHZ	BANDPASS WIDE/NARROW		IF IN MHZ	LOCAL OSC
1	50-100	3	.25	36.7	ABOVE
2	90-180	5	.25	60	ABOVE
3	160-320	5	.25	60	ABOVE
4	300-600	10	.8	160	ABOVE
5	550-1100	10	.8	160	ABOVE
6	1000-2600	20	.8	160	ABOVE
7	2300-4400	20	.8	160	BELOW
8	4300-7350	20	.8	160	ABOVE
9	7050-10750	20	.8	160	BELOW

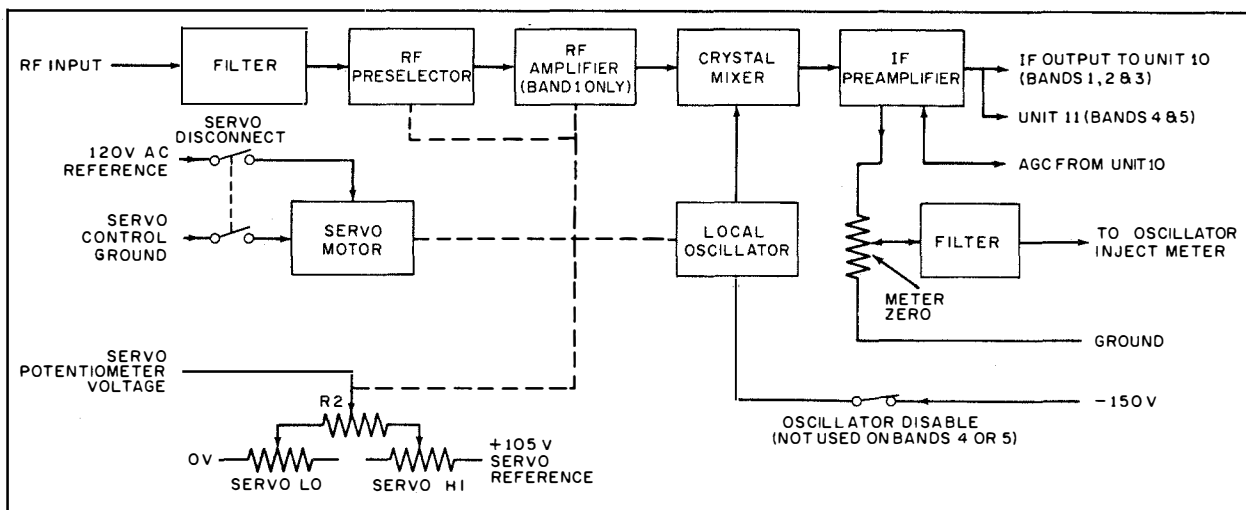


Figure 4-5.—(U) Frequency converter tuner (bands 1 through 5), block diagram (U).

32.4(67C)A

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(U) The output of the crystal mixer is applied to the IF preamplifier which amplifies the IF signal to a level suitable for transfer through coaxial cable to the electronic frequency converter (unit 10, or to unit 11 in the case of bands 4 and 5). The preamplifier (figure 4-5) consists of two low-noise input stages followed by two stagger-tuned amplifiers (not shown). These four stages amplify signals in a bandwidth centered at the IF. Gain control voltage from unit 10 is applied to the last two stages of the preamplifier of the band 1 RF tuner and to the last stage of the preamplifier in the RF tuners for bands 2 through 5.

(U) The servomotor (discussed below) is mechanically linked to the RF preselector, local oscillator, and servo-reference potentiometer R2. The motor is also linked to the RF amplifier of the band 1 RF tuner. The potentiometer R2 provides positioning information to the servosystem.

(U) **SERVO-TUNING MECHANISM.**—A functional diagram of the servo-tuning mechanism is shown in figure 4-6. During normal operation, the servomotor tunes the RF preselector, the band 1 RF amplifier, and the local oscillator circuits. The servomotor also

drives servo-reference potentiometer R2 which supplies positioning information to the servosystem. A cam on the servo drive shaft actuates a band-limit switch which, in turn, operates the TUNER LIMIT indicator lamp on the front panel of the azimuth indicator-pulse analyzer. This enables the operator to check the operation of the servo-tuning system. The RF preselector tuning spindle of bands 4 and 5 servo-tuning mechanisms (figure 4-7), is actuated by the preselector cam. Frequency alignment of the RF preselector is obtained by using a series of eccentric adjustments to change the shape of the cam. The oscillator tuning spindles are actuated by the oscillator cam. Frequency alignment of the local oscillator is also obtained by using a series of eccentric adjustments to change the shape of the cam. During test, the RF tuner can be manually tuned by first setting the SERVO DISCONNECT switch to the OFF position and then rotating the calibrated frequency dial on the servo drive shaft. A built-in dial lock prevents accidental rotation of the dial. End stops on the dial prevent the servomotor from overrunning during a malfunction and damaging the tuning mechanism. A clutch mechanism in the servo-drive assembly prevents damage to the servomotor.

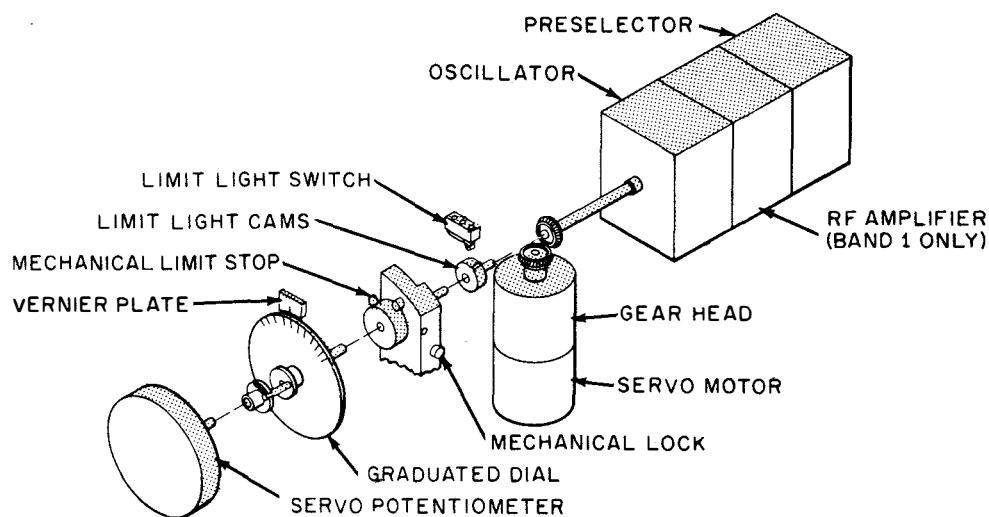
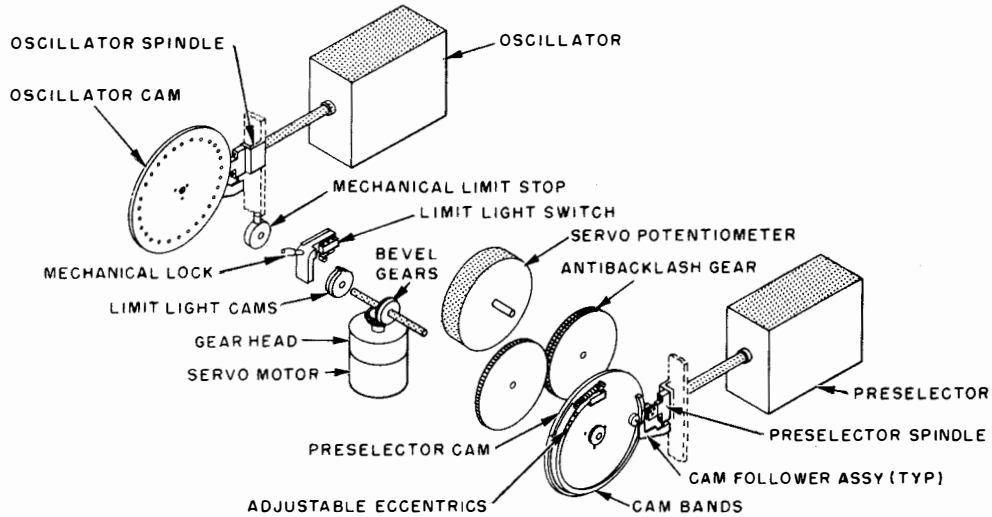


Figure 4-6.—(U) Servo tuning mechanism (bands 1 through 3), functional diagram (U).

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CONFIDENTIAL



67.253

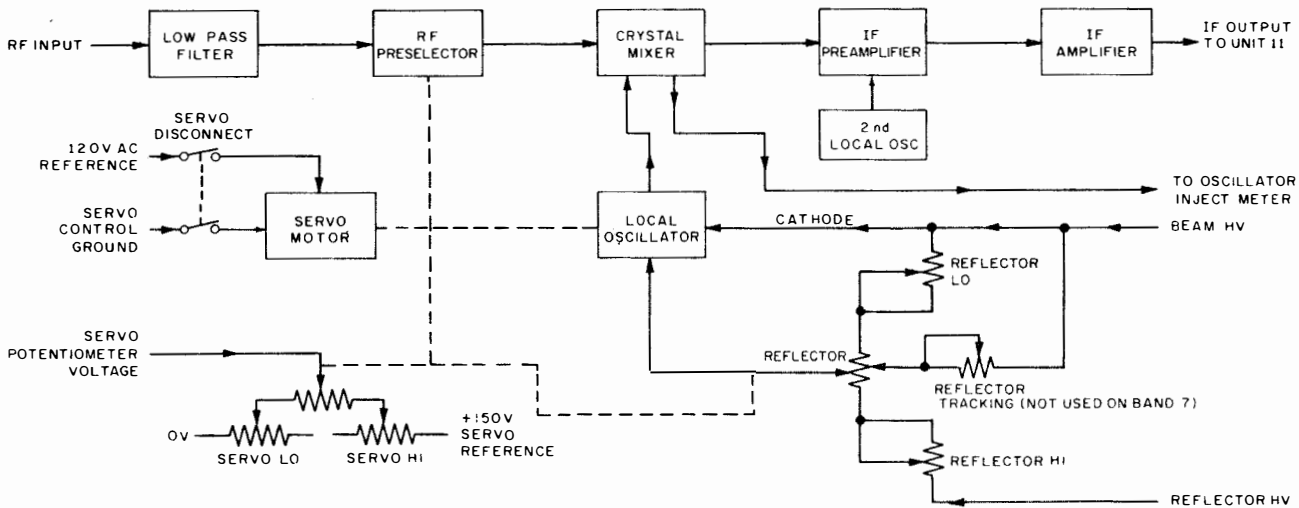
Figure 4-7.—(U) Servo tuning mechanism (bands 4 and 5), functional diagram (U).

Upper Band Electronic Frequency Converters (Units 6 through 9)

(U) Units 6 through 9 are used to cover the frequency range of bands 6 through 9. See table

4-1 for band frequency coverage. A block diagram of the units is shown in figure 4-8.

(U) The input signal from the antenna is applied through the low-pass filter and RF preselector to the crystal mixer where it is



32.4(67C)B

Figure 4-8.—(U) Electronic frequency converter (bands 6 through 9), block diagram (U).

CONFIDENTIAL



mixed with a signal from the klystron local oscillator to produce the first IF signal.

(U) The output of the crystal mixer is applied to the IF preamplifier where it is amplified and then heterodyned with a signal from the second local oscillator to produce the final IF signal. This IF signal is applied to the IF amplifier which amplifies the signal to a suitable level for transfer through coaxial cable to the electronic frequency converter (unit 11).

(U) The servomotor is mechanically linked to the RF preselector, first local oscillator, reflector voltage potentiometer, and servo-reference potentiometer. A functional diagram of the servo-tuning mechanism is shown in figure 4-9. The servo-tuning mechanism of

these RF tuners is similar to that described for the lower frequency units. The servo potentiometer of units 6 through 9 is of dual construction, one section for controlling the klystron-reflector voltage and the other section for servo referencing.

**Radio Frequency Transmission Line Switch (Unit 29)**

(U) RF transmission line switch (unit 29) (figure 4-4), is a coaxial switch consisting of two six-position coaxial relays. The purpose of the switch is to select one of the RF tuner IF outputs and connect it to the respective frequency converter.

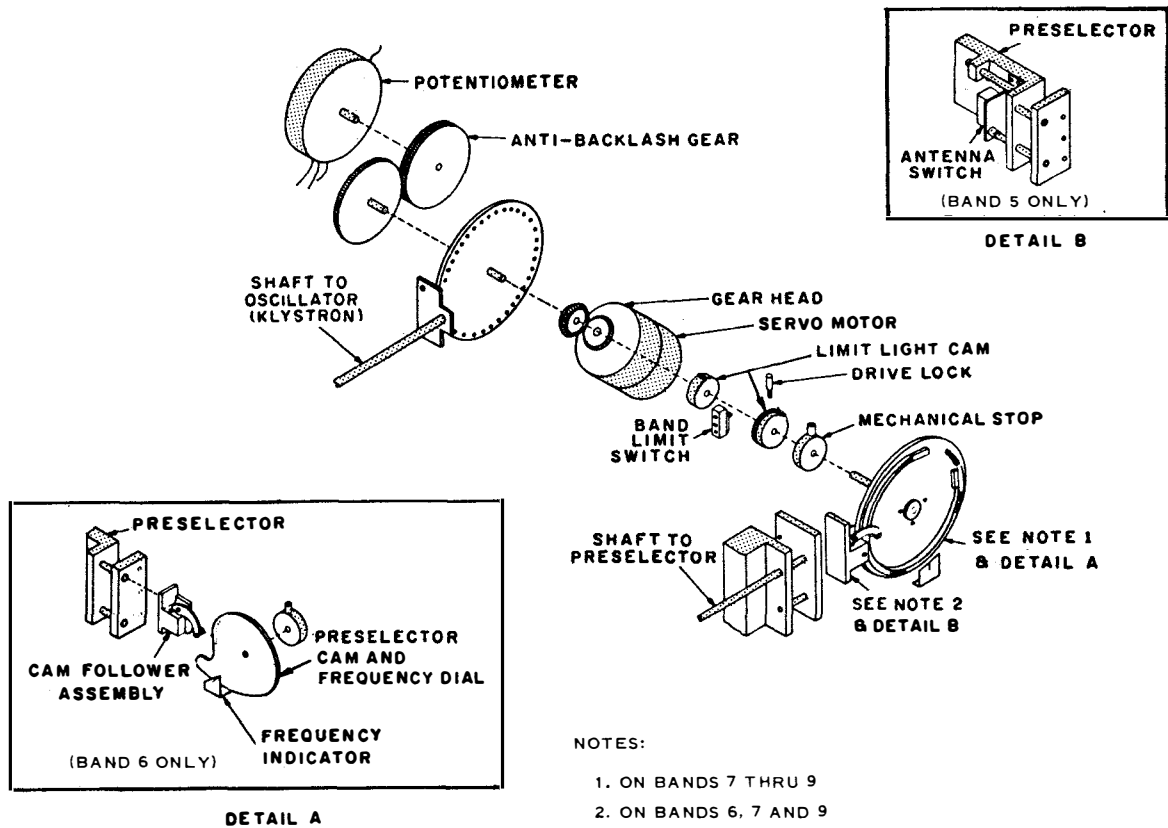


Figure 4-9.—(U) Servo tuning mechanism (bands 6 through 9), functional diagram (U).

**CONFIDENTIAL****Electronic Frequency Converter (Unit 10)**

(U) The electronic frequency converter (unit 10) amplifies and detects the IF signal from units 1, 2, or 3.

(U) Outputs include a wideband and a narrowband video signal, a panoramic horizontal sweep voltage, a panoramic video signal, an automatic gain control (AGC) voltage, and an IF output for frequency-modulated (FM) signals. Signal flow through unit 10 is shown in the block diagram of figure 4-10.

(U) The RF tuner is selected by the BAND SELECTOR switch on the control-storer (figure 4-4). Units 2 and 3 have the same IF output (figure 4-10) which is amplified in the wideband mixer and applied to the first broadband IF amplifier. However, the lower IF output of unit 1 is first mixed in the wideband mixer-amplifier with a signal generated by the crystal local oscillator to obtain the necessary IF output for application to the IF amplifier. The required amplification and bandwidth is obtained by a seven-stage, stagger-tuned amplifier (the broadband IF amplifier).

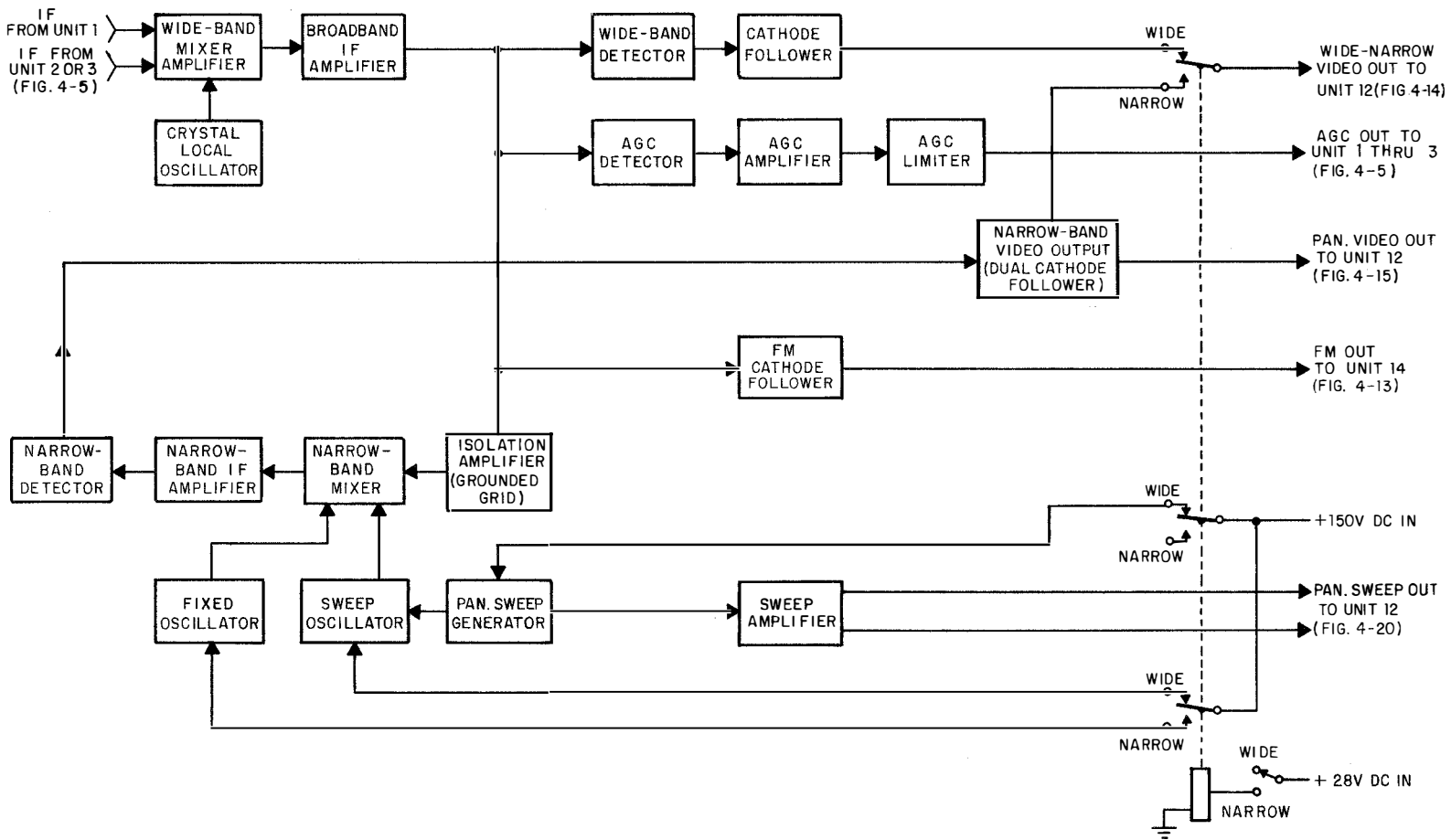
(U) The output of the broadband IF amplifier is applied to a wideband detector, FM cathode follower, grounded-grid isolation amplifier, and AGC detector. The wideband detector demodulates the IF signal and the resultant video signal is applied to the cathode follower, which provides wideband video output. During wideband operation, the BANDWIDTH MC switch on the control-storer is in the WIDE position and the WIDE-NARROW relay is deenergized (as shown). Therefore, the output of the cathode follower is connected through the normally closed contacts of the relay to unit 12. The FM cathode follower is used to provide an IF output to unit 14 without loading the tuned circuits of the main IF amplifier. The isolation amplifier applies the amplified IF signal to the narrowband mixer.

(U) When the FUNCTION SELECTOR switch (figure 4-11) is the AM-AGC, FM-MFC,

or FM-AFC position, the AGC voltage provided by the AGC amplifier is connected to the IF amplifier (figure 4-5) for automatic gain control. When the switch is in the AM-AGC or VIDEO position, or when the SCAN switch (on the control-storer) is depressed, manual control of signal gain is provided by the GAIN control potentiometer in unit 13.

(U) During wideband operation of the system, the WIDE-NARROW relay is in the deenergized (WIDE) position as shown. The fixed oscillator is therefore disabled and local oscillator injection to the narrowband mixer is provided by the frequency sweep oscillator. The output of the isolation amplifier and the varying frequency output of the sweep oscillator are mixed in the narrowband mixer. The sweep oscillator is driven by a sawtooth waveform which is generated by a panoramic sweep generator and applies to a voltage-variable capacitor (not shown). The narrow-band mixer output is the difference between the isolation amplifier output and the sweep oscillator frequency. The narrowband mixer output, amplified by the narrowband IF amplifier and detected by the narrowband detector, is applied to the narrowband video output circuit (which is a dual cathode follower). The video output of one-half of the dual cathode follower is applied to unit 12 for display in the panoramic sweep. The panoramic sweep generator provides linear horizontal deflection on the panoramic sweep of the analysis display so that the video position on the sweep indicates the IF signal frequency relative to the center of the IF bandpass. For example, if the video appearing on the panoramic sweep is centered, the IF signal is also centered in the IF bandpass.

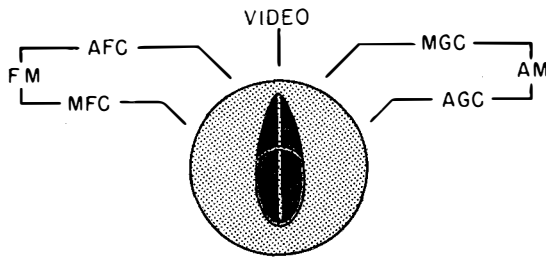
(U) When it is desirable to differentiate between two signals that are in the wide bandwidth, the operator selects the narrowband circuits by setting the BANDWIDTH switch in the NARROW position. This energizes the WIDE-NARROW relay, which disables the panoramic sweep generator and the sweep oscillator. This allows a signal in the center of the wide IF bandpass to be connected to the narrowband mixer. The narrowband IF amplifier provides a narrow bandwidth output which is



61

Figure 4-10.—(U) Electronic frequency converter (unit 10), block diagram (U).

67.255

**CONFIDENTIAL**

67.256

Figure 4-11.—(U) Function selector switch (U).

detected by the narrowband detector, as previously stated. The narrowband output of the other section of the dual cathode follower narrowband video output circuit is applied through the contacts of the WIDE-NARROW relay to unit 12.

#### Electronic Frequency Converter (Unit 11)

(U) The electronic frequency converter (unit 11) amplifies and detects the IF signal output from any one of the six high-frequency RF tuners. The unit performs the same function as that of unit 10 and the operation is similar. The primary difference is the frequency of the IF channel.

(U) Signal flow through unit 11 is shown in the block diagram of figure 4-12. The RF tuner used is selected by the BAND SELECTOR switch on the control-storer. The required amplification and bandwidth is obtained by a nine-stage, stagger-tuned IF amplifier. The SWEEP WIDTH relay selects the sweep width for the frequency sweep oscillator. The relay position determines the frequency scanning range of the narrowband mixer. The relay is automatically switched to the wide position during operation on bands 6 through 9.

(U) The AGC operation for unit 11 is the same as that for unit 10. The panoramic sweep generator circuit is also the same operation, with the exception of the SWEEP WIDTH relay which changes the frequency deviation range of

the sweep oscillator in accordance with the particular RF tuner used.

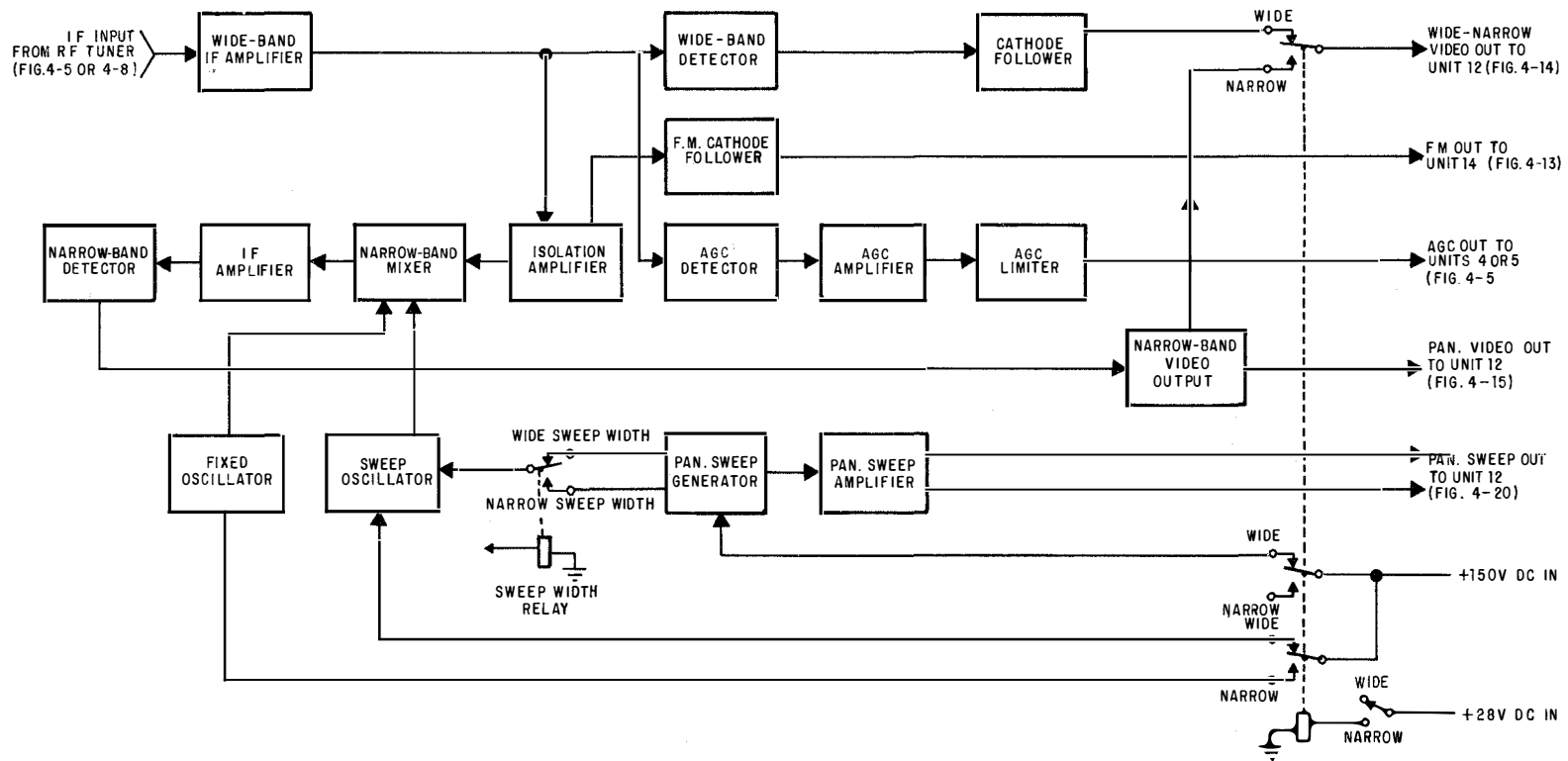
#### Electrical Frequency Discriminator (Unit 14)

(U) The electrical frequency discriminator (unit 14) supplies the demodulated signals obtained from the FM carrier to the azimuth indicator-pulse analyzer for display and analysis. The FM signal is obtained from either unit 10 or 11. Two discriminators (figure 4-13) are used to demodulate the FM carrier signals. One has a narrow bandwidth and the other a wide bandwidth. The discriminator used is selected by the FM BANDWIDTH switch on the control-storer front panel. Relay switching connects the proper discriminator to the video amplifier and selects the deviation sensitivity of the discriminators in accordance with the FM BANDWIDTH switch position.

(U) A block diagram of unit 14 is shown in figure 4-13. During operation with the first three low-frequency tuners, relay K1 is energized and the signal from unit 10 is applied to the IF amplifier limiter. However, during operation on bands 4 through 9, relay K1 is deenergized and the signal is provided by unit 11. This signal is mixed with a signal generated by the 1st oscillator to obtain the necessary signal for application to the IF amplifier-limiter.

(U) The IF amplifier-limiter removes amplitude modulation before application to the wide bandwidth discriminator. The signal from the amplifier-limiter is applied through a cathode follower limiter to an amplifier and a mixer. When the FM BANDWIDTH switch is in either of the two wide bandwidth positions, the wide bandwidth discriminator is connected to the video amplifier, through the discriminator relay switching, by relay K3. If the FM BANDWIDTH switch is in the wider of the two positions, the minimum deviation sensitivity output of the discriminator is connected to the input of the video amplifier by the discriminator relay switching action. When the FM BANDWIDTH switch is in the narrower of the two wideband positions, the maximum deviation

**CONFIDENTIAL**



63

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Figure 4-12.—(U) Electronic frequency converter (unit 11), block diagram (U).

67.257

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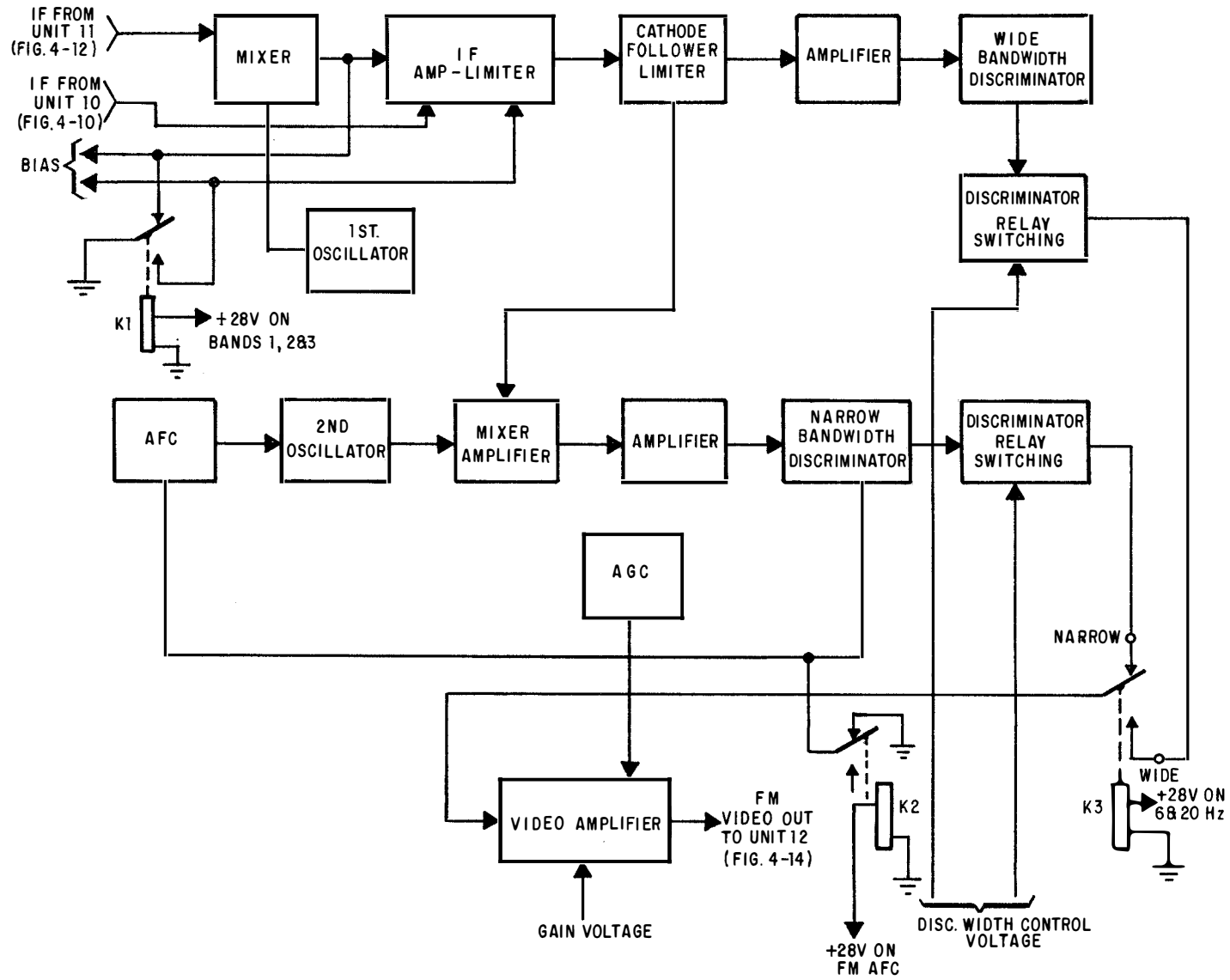


Figure 4-13.—(U) Electronic frequency discriminator (unit 14), block diagram (U).

67.258

sensitivity output of the discriminator is obtained by the discriminator relay switching and connected to the input of the video amplifier.

(U) The mixer amplifier heterodynes the IF signal from the amplifier-limiter with the output from the second oscillator to obtain an IF signal which is applied to the narrow bandwidth discriminator through an amplifier. When the FM BANDWIDTH switch is in one of the three narrow bandwidth positions, relay K3 is deenergized and the narrow bandwidth discriminator, through discriminator relay switching, is connected to the video amplifier. When the FM BANDWIDTH switch is in the narrowest narrow bandwidth position, the discriminator output is connected by relay switching to provide maximum deviation sensitivity. When the FM BANDWIDTH switch is in the center narrow bandwidth position, an intermediate deviation sensitivity is provided by the switching relay. With the FM BANDWIDTH switch in the widest narrow bandwidth position, the discriminatory relay switching arranges for minimum deviation sensitivity to be passed to the video amplifier.

(U) During operation with the FUNCTION SELECTOR switch in the FM-MFC position, relay K2 is deenergized (as shown) and the output of the 2nd oscillator is constant. However, when the switch is in FM-AFC position, K2 is energized and the average d.c. output of the narrow bandwidth discriminator is allowed to control the AFC circuit which can alter the output frequency of the 2nd oscillator slightly on either side of the normal center frequency. This enables the mixer amplifier output to remain constant in the presence of small input frequency changes.

(U) An AGC voltage is applied to the video amplifier to compensate for the change in gain of the IF amplifier-limiter or the video amplifier due to line voltage variation.

#### **Azimuth Indicator- Pulse Analyzer (Unit 12)**

(U) The azimuth indicator-pulse analyzer (unit 12) provides visual and aural presentation

of all intercepted signals (figure 4-4). Three forms of visual presentation are used. The first is an acquisition indicator using a raster-type presentation, the horizontal sweep being synchronized with the tuner frequency. The second is an analysis indicator which presents all analysis information simultaneously. The third signal frequency information is supplied on a direct reading frequency indicator.

(U) VIDEO INPUT CIRCUITS.—A block diagram of the video input circuits is shown in figure 4-14. The wideband or narrowband video signal from unit 10 or 11 is coupled to unit 12. Relay K1 selects the signal from unit 10 on bands 1, 2, and 3. On bands 4 through 9, the signal from unit 11 is selected. Relay K2 is controlled by the FUNCTION SELECTOR switch on the front panel of the control-storer except when scanning. When the SCAN pushbutton is depressed, relay K2 is deenergized. This prevents missing an AM or CW intercept during scan due to accidentally leaving the FUNCTION SELECTOR switch in the FM position. When analyzing in the FM positions, relay K2 is energized, connecting the video signal from the electrical frequency discriminator to the video circuits in unit 12. In the CAL position, DF switch S1 provides a DF calibration signal from the DF antenna control. Relay K3 disables the DF switch during scan operation. The external VIDEO IN jack on the front panel of unit 12 provides a means of using the indicator for analysis of signals from other receivers or a signal generator. The video signal input is applied to a cathode follower and to the 1st video amplifier. The cathode follower output is applied to the VIDEO OUT jack on the front panel of unit 12. The output of the video amplifier is applied to the delay line driver. The signal is delayed by the delay line and connected to the 2nd video amplifier. This amplifier signal is applied to the video output cathode follower for application to the SCAN display circuits (figure 4-15). Output from the 1st video amplifier is also applied to a sync driver and then through the sync amplifier to the sync output for application to the sync pulse generator in the analysis sweep circuit.

(U) SCAN DISPLAY.—The acquisition (scan) indicator presents the signal on a

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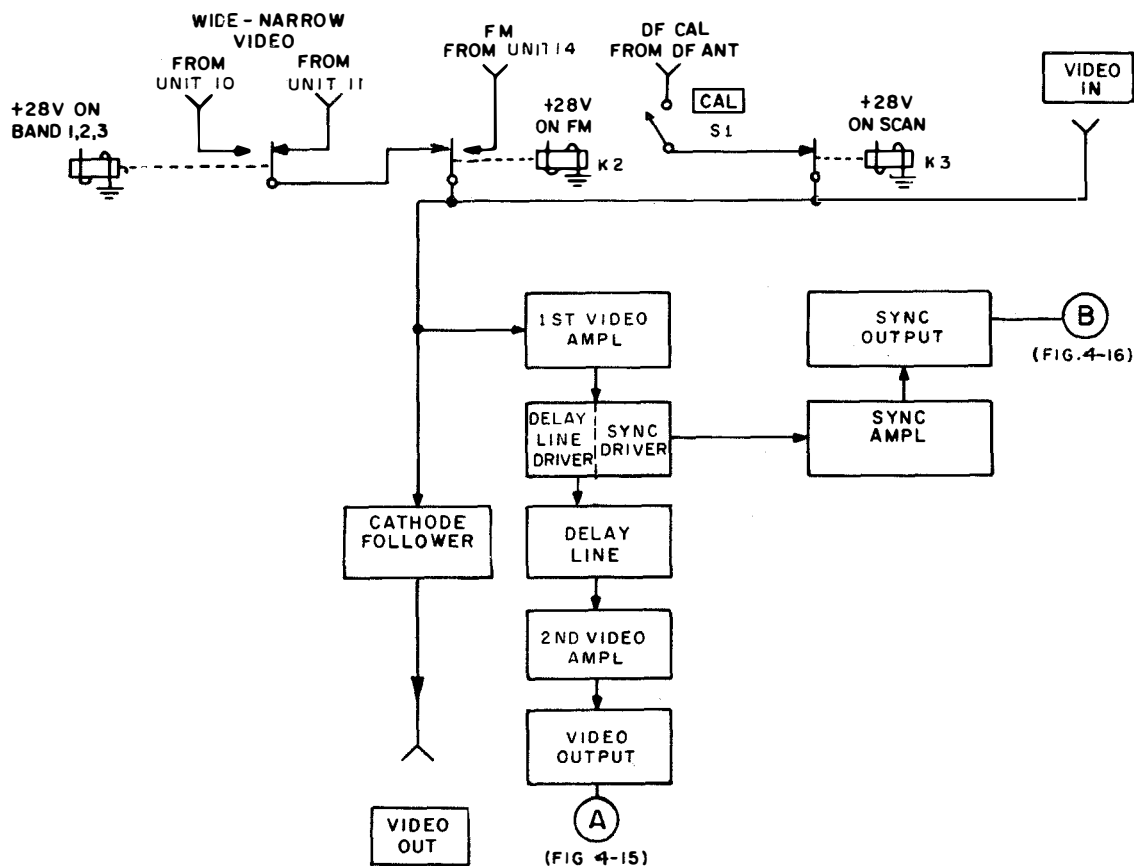


Figure 4-14.—(U) Video input circuits of unit 12, block diagram (U).

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raster-type display as intensified dots (figure 4-2). The horizontal sweep is synchronized with the tuner frequency. The vertical sweep is a timed sweep of 2 minutes. Visual presentation of a signal is achieved by repeating the horizontal traces below one another. Thus, a signal appears as a vertical line of intensified dots on the scan indicator, while noise appears as random dots. The scan display block diagram is shown in figure 4-15.

(U) Control voltage for the horizontal sweep is obtained from the RF tuner servo potentiometer, and is applied to the horizontal sweep amplifier, via the control-storer, to drive the horizontal winding of the deflection yoke of the acquisition display indicator.

(U) Video signals are applied to the cathode of the acquisition indicator. The video output circuit (figure 4-15) couples a video signal (A) to the 1st cathode follower; the signal then is applied through the 2nd cathode follower and pulse stretcher to a gated amplifier. A 0-5  $\mu\text{sec}$  positive gate (I) and a 5-500  $\mu\text{sec}$  positive gate (J) are coupled through the gate mixer to the gate cathode follower. A 0-500  $\mu\text{sec}$  positive gate produced in the gate cathode follower gates the amplifier. The video pulses applied to the 2nd cathode follower and pulse stretcher are stretched to 500  $\mu\text{sec}$ . These stretched pulses are applied to the gated amplifier. A 0-500  $\mu\text{sec}$  positive gate is also applied by a gating diode to the pulse stretching circuit to terminate the stretching at 500  $\mu\text{sec}$ . The video pulses are then

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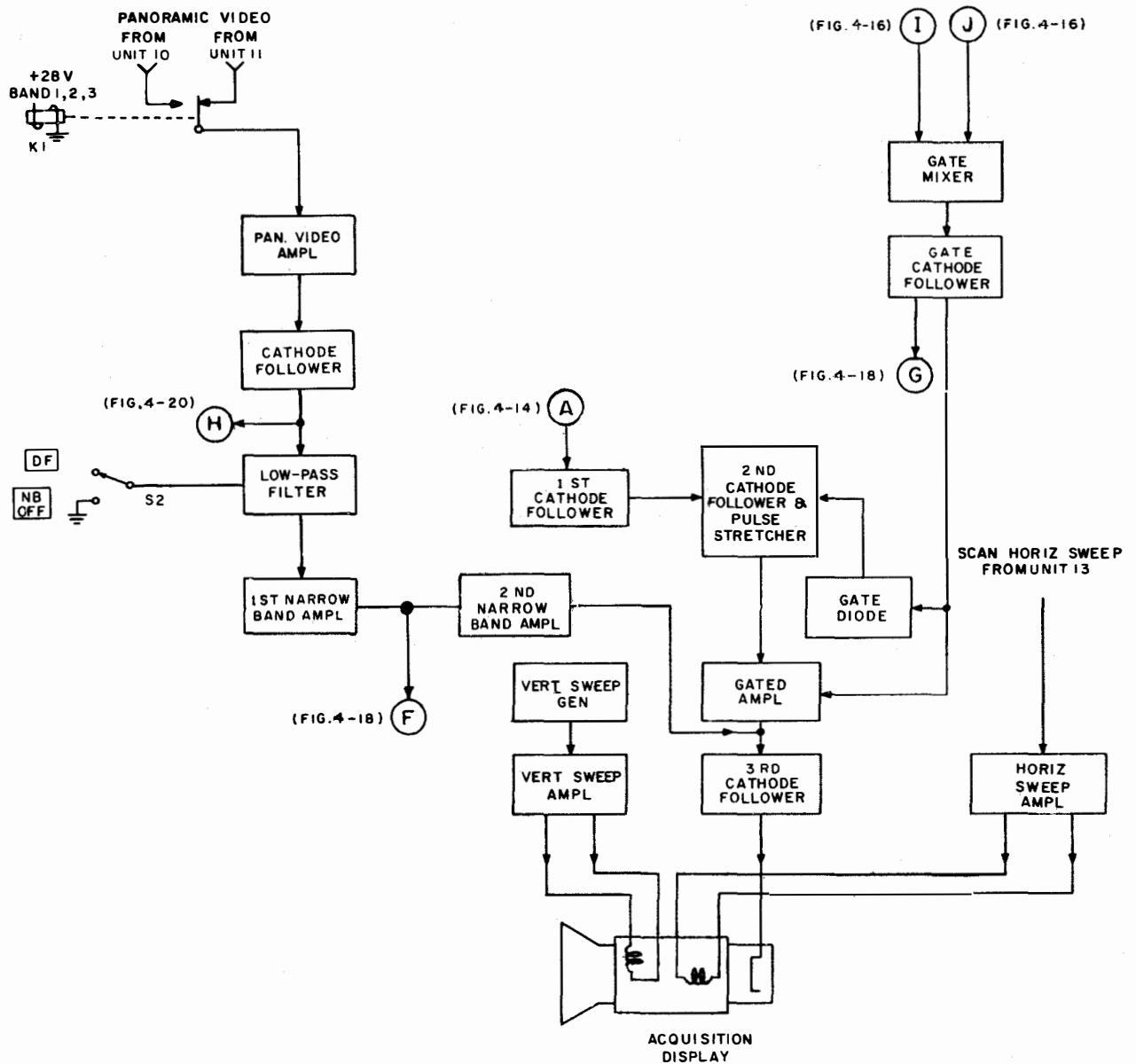


Figure 4-15.—(U) Scan display circuits of unit 12, block diagram (U).

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applied through the 3rd cathode follower to drive the cathode of the acquisition indicator in a negative direction.

(U) To obtain an indication on CW signals, a signal from the panoramic video is used. When the receiver is tuned to a CW signal, the panoramic video output is a series of pulses.

These pulses are caused by the heterodyne action between the frequency-sweep oscillator in units 10 or 11 and the CW signal. Relay K1 selects the signal from unit 10 on bands 1, 2, and 3, and from unit 11 on bands 4 through 9. The signal is applied to the pan-video (panoramic-video) amplifier. After amplification

**CONFIDENTIAL**

the signal is applied through the pan-video cathode follower to a low-pass filter. The filter passes only the low-frequency pulses produced by CW signals. The pulses are amplified by the 1st narrowband video amplifier and applied through the 2nd narrowband video amplifier and the 3rd cathode follower to the cathode of the acquisition scan indicator.

(U) SWEEP SYNC.—Figure 4-16 is a block diagram of the sweep sync circuits. The video signal (B) from the sync output (figure 4-14) is applied to a sync-pulse generator. Triggering level of the sync-pulse generator is determined by the setting of the SYNC LEVEL control on the front panel of unit 12. The sync pulse is amplified by the 1st gated amplifier and used to trigger the 5- $\mu$ sec multivibrator which produces a positive gate. The trigger derived from the trailing edge of this positive gate enables the 0-5 lockout multivibrator. The negative gate from the lockout multivibrator causes the gated amplifier to reject sync pulses for the gate time of the lockout multivibrator. During this rejection period the 5- $\mu$ sec multivibrator sweep circuits are allowed to recover, thereby ensuring stability of recurring sweeps. The positive gate from the 5  $\mu$ sec timing multivibrator is inverted by the paraphrase amplifier and applied as a negative-cutoff signal to the exponential sweep generator. A cathode capacitor in this circuit discharges through the cathode resistance and produces an exponential waveform. The waveform is amplified by a sweep amplifier and applied to the horizontal deflection plates of the 0-5  $\mu$ sec analysis indicator. A 5- $\mu$ sec positive gate from the cathode of the paraphrase amplifier is applied to a 0-5  $\mu$ sec intensity tailoring circuit. This RC tailoring network applies an intensification voltage to the intensity grid of the 0-5  $\mu$ sec analysis indicator gun.

(U) The operation of the 5-500  $\mu$ sec sweep is similar to the 0-5  $\mu$ sec sweep. The sync pulse applied to the 2nd gated amplifier is obtained from the trailing edge of the 0-5  $\mu$ sec multivibrator gate.

(U) The operation of the 500-50,000  $\mu$ sec sweep is also similar to the 0-5  $\mu$ sec sweep. The sync pulse applied to the 3rd gated amplifier is

obtained from the trailing edge of the 5-500  $\mu$ sec timing multivibrator gate. An exponential lockout is used in the 500-50,000  $\mu$ sec sweep. This exponential lockout is obtained from the trailing edge of the 49,500  $\mu$ sec positive gate from the logarithmic sweep generator.

**Signal Analysis Video**

(U) For signal analysis, the video signal is applied to the upper vertical plates of the signal analysis indicators. The signal analysis video circuitry is shown in figure 4-17. The video signal is delayed by a fraction of a microsecond with respect to the sync signal in order to start the sweeps before video is applied to the analysis indicator, thereby displaying the leading edge of fast rising signals. The video signal (A) is applied to the upper vertical deflection plate of the 0-5  $\mu$ sec signal analysis indicator from the video output circuit of figure 4-14.

(U) To increase pulse visibility at low writing speeds, pulse stretching is used on video signals applied to the 5-500  $\mu$ sec and 500-50,000  $\mu$ sec analysis indicator guns. Video signal (A), for display on the 5-500  $\mu$ sec indicator gun, is coupled through a cathode follower and applies to a pulse stretcher and cathode follower. A pulse stretch control voltage (C) from the 5-500  $\mu$ sec sweep amplifier (figure 4-16), applied through a stretch control amplifier, controls the amount of pulse stretching which is a function of writing speed. The lower the writing speed, the greater the amount of pulse stretching. The stretched pulse from the pulse stretcher and cathode follower is applied to the upper vertical deflection plate of the 5-500  $\mu$ sec signal analysis indicator gun.

(U) For the 500-50,000  $\mu$ sec vertical deflection, the signal from the cathode follower is applied to another pulse stretcher and cathode follower. The stretched pulse is then applied to the 2nd pulse stretcher. A stretch control voltage (D) from the 500-50,000  $\mu$ sec sweep amplifier of figure 4-16, applied through the stretch control amplifier, controls the amount of pulse stretching. The stretch control voltage increases the amount of pulse stretching as the writing speed of the 500-50,000  $\mu$ sec sweep

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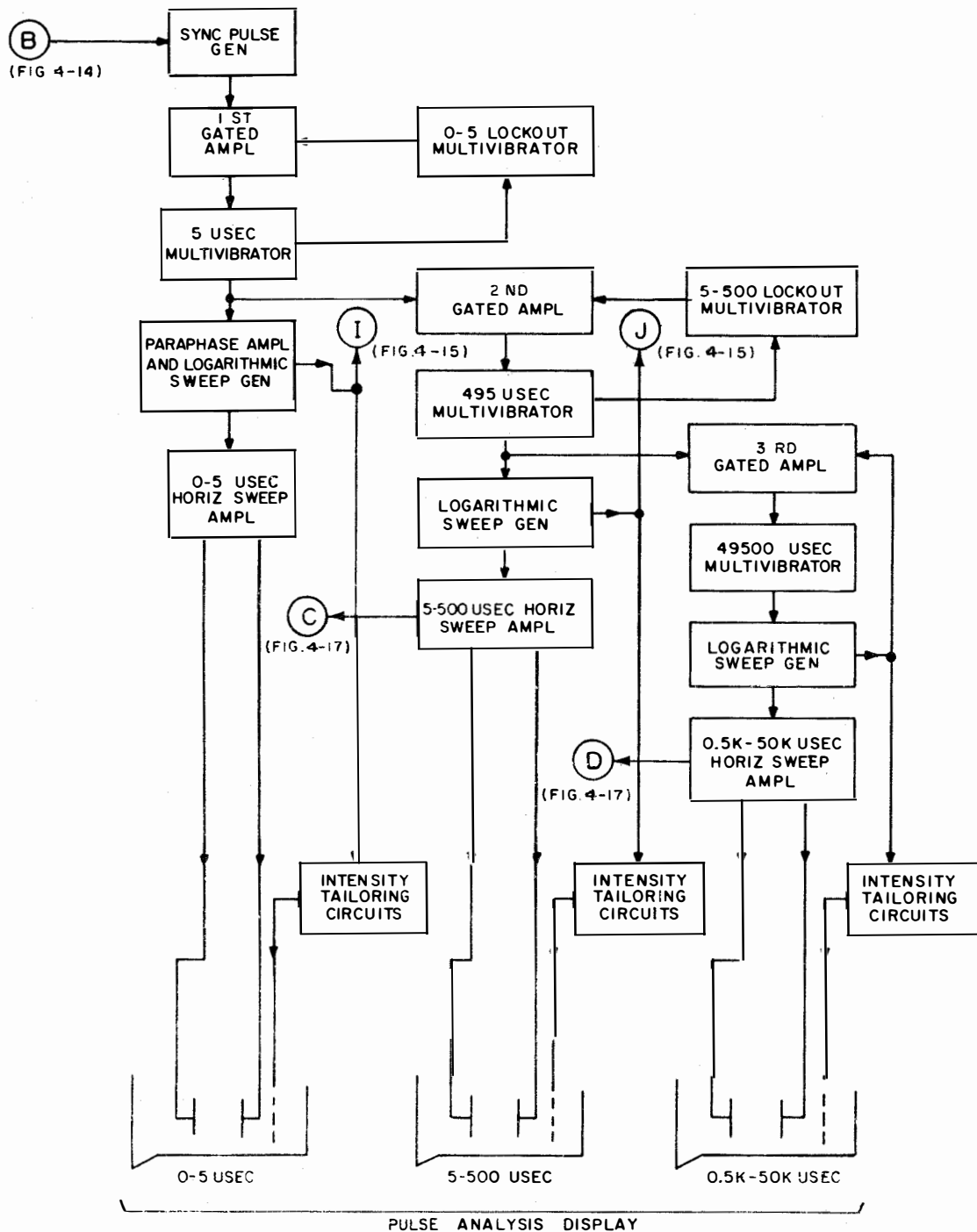
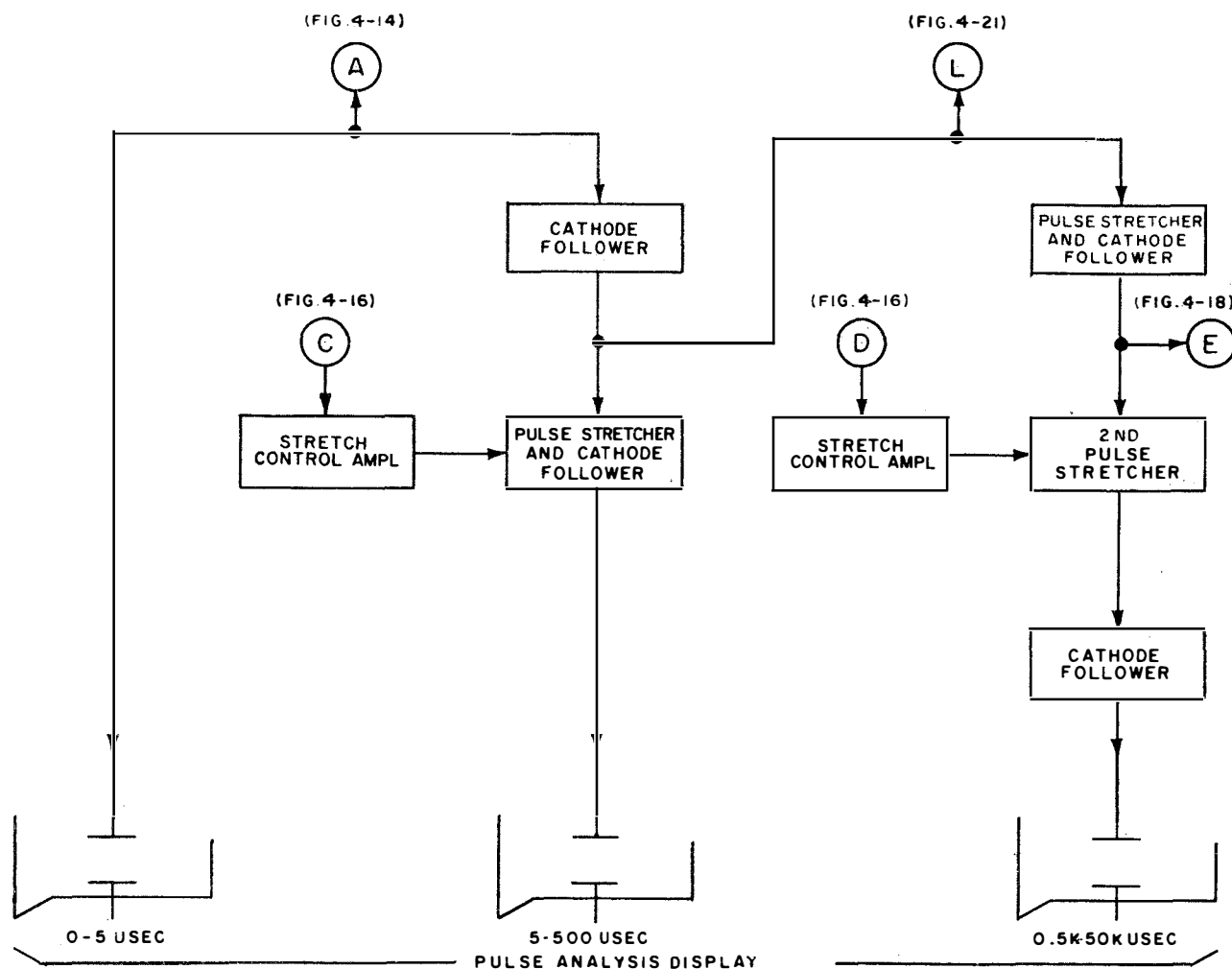


Figure 4-16.—(U) Sweep sync circuits of unit 12, block diagram (U).

67.261

**CONFIDENTIAL**

67.264

Figure 4-17.—(U) Signal analysis video circuits of unit 12, block diagram (U).

increases. The stretched pulse is applied from the cathode follower to the upper deflection plate of the 500-50,000  $\mu\text{sec}$  signal analysis indicator gun.

**(U) DIRECTION FINDING (DF) DISPLAY.**—The linear direction finding presentation is displayed on the analysis indicator scope (figure 4-3) as follows: Two horizontal traces are traced by a moving spot on the face of the analysis indicator. The left-to-right upper trace represents antenna rotation from  $270^\circ$ - $0^\circ$ - $90^\circ$ . The right-to-left

lower trace represents antenna rotation from  $90^\circ$ - $180^\circ$ - $270^\circ$ . As the antenna rotates slowly in a clockwise direction, the spot starts at  $0^\circ$  in the center of the upper trace and moves to the right to the  $90^\circ$  position. At the  $90^\circ$  position the spot drops suddenly to the lower trace and moves to the left past  $180^\circ$  at the center of the bottom trace to the  $270^\circ$  position at the left of the bottom trace. At the  $270^\circ$  position the spot jumps suddenly to the upper trace and moves toward  $0^\circ$  in the center of the upper trace. The spot indicates the angular position of the antenna whether the antenna is stopped or is

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rotating in either direction. Signals received when the antenna angular position corresponds to a position on the upper trace cause a downward deflection from the trace. Signals received when the antenna angular position corresponds to a position on the lower trace are displayed upward from the trace. The trace is intensified only when a signal is present. The following discussion is presented with the aid of the block diagram in figure 4-18.

(U) DF Sweep.—A modulated carrier system is used to generate a linear sweep from the angular rotation of the DF antenna. The DF carrier oscillator generates a carrier which is amplified by the carrier output amplifier. The output is applied to the antenna control unit. A two-phase resolver in the DF antenna control amplitude modulates the carrier. The resolver has two outputs (phases A and B). One is a sine function of the angular shaft position. The DF horizontal deflection circuits add the negative of the cosine function to the positive sine output. The result is two symmetrical waveforms for each  $360^\circ$  of resolver shaft rotation. Only one of these waveforms is required for each  $360^\circ$  of antenna rotation; therefore, the resolver is mechanically geared down in a 2-to-1 ratio from the antenna synchro receiver. To secure the desired relationship between the antenna and the DF display, the resolver is electrically positioned  $90^\circ$  ahead of the antenna. The resolver angle is equal to  $1/2 (0 + 90^\circ)$  where 0 is the antenna relative bearing. The amplitude of the modulation of the carrier signal at the two outputs of the resolver are the absolute value  $k \sin 1/2 (0 + 90^\circ)$ , where  $k$  is a constant. The absolute value  $k \cos 1/2 (0 + 90^\circ)$  output (phase A) is applied through the negative transformer to the negative rectifiers. The absolute value  $k \sin 1/2 (0 + 90^\circ)$  output (phase B) is applied through the positive transformer to the positive rectifiers. The output of the negative rectifiers is a negative voltage equal to the absolute value of  $k' \cos 1/2 (0 + 90^\circ)$ . The output of the positive rectifiers is a positive voltage equal to the absolute value of  $k' \sin 1/2 (0 + 90^\circ)$ . The  $k'$  constant is a constant differing from  $k$  by the

turns ratio of the transformers. The two transformer voltages are applied to a resistive adder and added at the grid of the horizontal sweep amplifier. The added voltage is equal to  $k' \cos 1/2 (0 + 90^\circ)$  minus  $k' \sin 1/2 (0 + 90^\circ)$ . These waveforms are shown in figure 4-19. The triangular waveform is amplified by the horizontal sweep amplifier and applied to the horizontal deflection plates of the DF display indicator gun. A DF horizontal skew correction voltage is applied to the sweep amplifier from an electronic switch.

(U) DF Sweep Shift.—If just the horizontal position of the spot were used to indicate the antenna angular position, every position of the trace except the end points would correspond to two possible antenna angular positions. To eliminate this ambiguity, the horizontal trace is shifted vertically each  $180^\circ$ . Each time an output of the resolver passes through a null point, the phase of the output carrier changes. The sine and cosine outputs of the resolver are in phase from  $270^\circ$ - $0^\circ$ - $90^\circ$  of antenna rotation and out of phase from  $90^\circ$ - $180^\circ$ - $270^\circ$  of antenna rotation. The sine and cosine outputs of the antenna resolver are coupled to a series of amplifier and clipper stages that produce square waves which are either in phase or  $180^\circ$  out of phase with the other. These square waves are applied to a phase detector. The phase detector is a push-pull amplifier which has an output when the two square waves are out of phase and no output when they are in phase. When the phase detector has an output, it is rectified to a positive voltage by a rectifier. The rectifier output is 0 volts from  $270^\circ$ - $0^\circ$ - $90^\circ$  and a positive voltage from  $90^\circ$ - $180^\circ$ - $270^\circ$ . This voltage is applied to the electronic switch which controls the deflection control tube. From  $270^\circ$ - $0^\circ$ - $90^\circ$  the upper deflection plate of the DF display indicator gun is positive with respect to the lower plate, and the electron stream is deflected to its upper position. From  $90^\circ$ - $180^\circ$ - $270^\circ$  the lower deflection plate is positive with respect to the upper plate, and the electron stream is deflected to its lower position. A DF vertical skew correction voltage from the horizontal sweep amplifier is applied to the vertical deflection amplifier.

CONFIDENTIAL

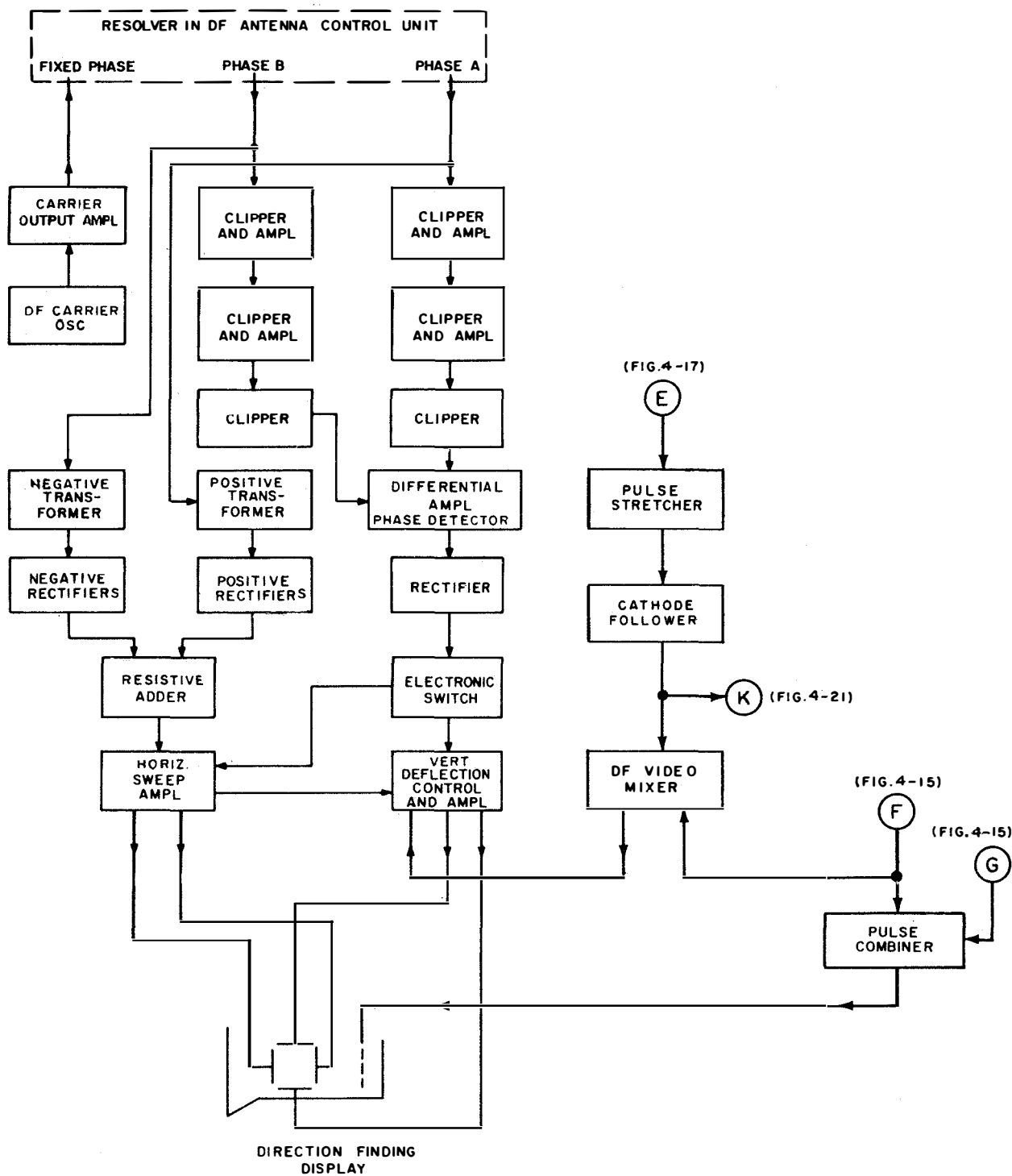
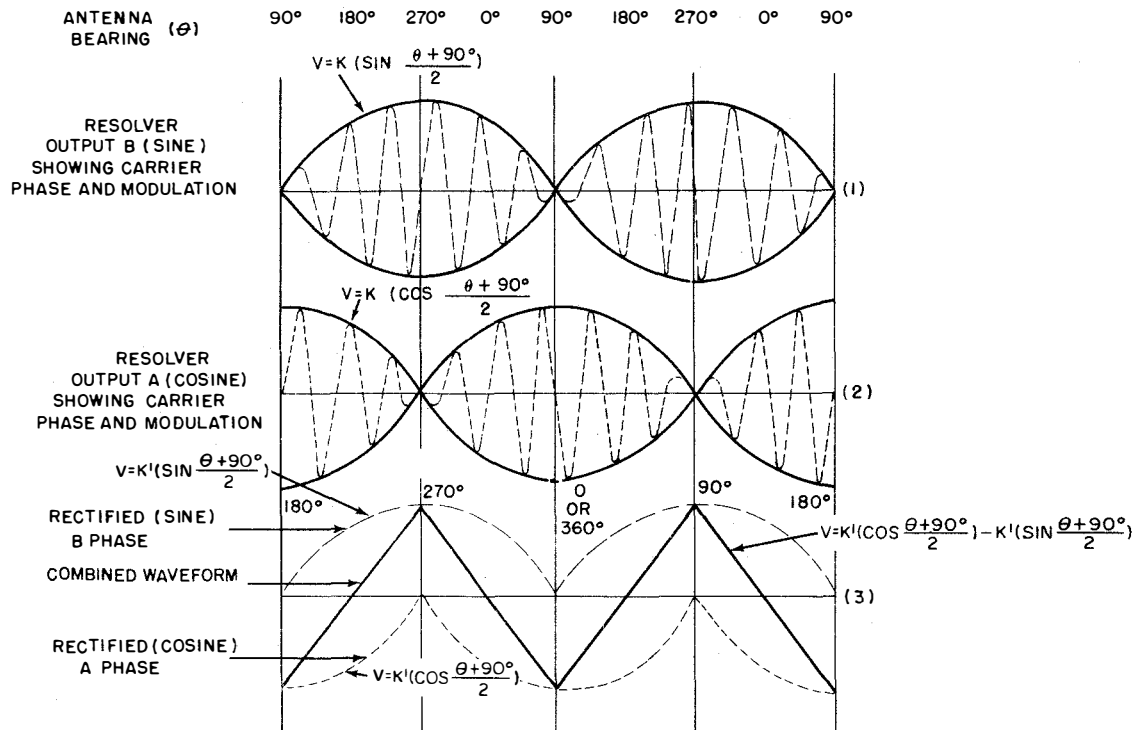


Figure 4-18.—(U) DF display circuits of unit 12, block diagram (U).

67.263

CONFIDENTIAL



32.18(67C)

Figure 4-19.—(U) DF horizontal sweep waveforms (U).

(U) DF Video Deflection.—Two signals are used to obtain vertical deflection for DF indications. A stretcher video signal (E) is taken from the pulse stretcher and cathode follower of figure 4-17. This signal is further stretched by another pulse stretcher. The output of the 2nd pulse stretcher is coupled by a cathode follower to the DF video mixer. To obtain an indication on CW signals, a panoramic video signal (F) from the low pass filter is amplified (figure 4-15) and applied to the DF video mixer. The output of the DF video mixer is applied to the vertical deflection amplifier. When the antenna relative bearing is in the range of  $270^{\circ}$ - $0^{\circ}$ - $90^{\circ}$ , one side of the vertical deflection amplifier is cut off and it applies a negative DF video voltage to the upper deflection plate of the DF display indicator gun. This causes a downward deflection of the electron stream. When the antenna relative bearing is in the range of  $90^{\circ}$ - $180^{\circ}$ - $270^{\circ}$  the other side of the amplifier is

cut off and thus a negative video voltage is applied to the lower deflection plate. This causes the electron stream to be deflected upward.

(U) Double DF Deflection.—If the repetition rate of a pulse signal is sufficiently high, pulse detection occurs in the panoramic video circuit and the low pass filter removes the pulses, but a detected envelope similar to the CW signal remains and is added to the wide-narrow video for presentation of the DF display. An extra spike is caused by this detected panoramic video signal. The position of this spike on the DF display varies since the panoramic circuit sweeps through the signal at different portions of the antenna pattern on successive sweeps. The appearance of this spike is a normal occurrence with high repetition signals. To some operators, the presence of the spike is objectionable and a handicap in reading the bearing. To alleviate this

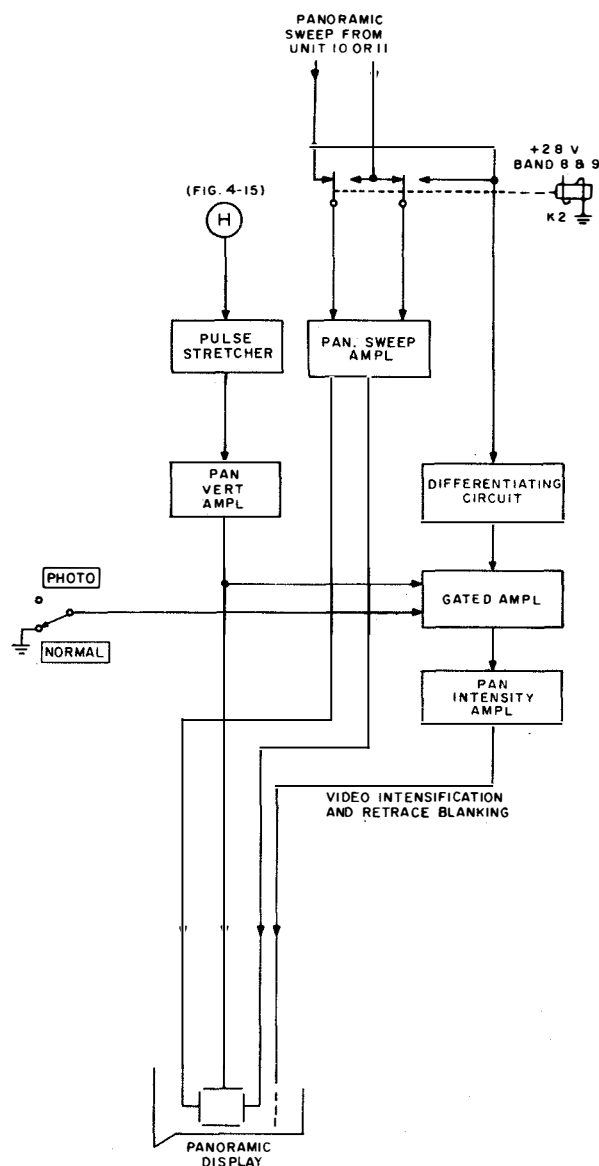
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difficulty, a DF switch (figure 4-15) is provided to allow the operator to remove the panoramic video (narrowband) signal by holding the switch in the NB OFF position. A spring return is used to preclude the possibility of accidentally missing CW intercept because the DF switch was left in the NB OFF position.

(U) DF Video Intensification.—Video intensification is used on the DF display to allow the base line to be suppressed. To obtain intensification on FM and AM signals, a 0-500  $\mu$ sec positive gate (G) from the gate cathode follower (figure 4-15) is applied to a pulse combiner. Narrowband video (F) (from the narrowband amplifier of figure 4-15) is also applied to the intensity grid of the DF display gun. This pulse intensifies the DF display only when a DF video deflection occurs.

(U) PANORAMIC DISPLAY.—The horizontal sweep voltage for the panoramic display is supplied as a push-pull sawtooth voltage by unit 10 or 11. A relay in the interconnecting box selects this signal from the proper frequency converter. The block diagram for this circuit is shown in figure 4-20. This signal is applied to reversing relay K2 to reverse the direction of the panoramic sweep on bands 7 and 9. Sweep reversal is necessary because the local oscillators in units 7 and 9 operate below the incoming signals, whereas the local oscillators in the other tuners operate above the incoming signal. The sweep signal is amplified by a panoramic sweep amplifier and then applied to the horizontal deflection plates of the panoramic display indicator gun. For all bands except 7 and 9, a positive sawtooth voltage is applied to the right horizontal deflection plate and a negative sawtooth voltage is applied to the left horizontal deflection plate. The panoramic sweep is from left to right with a rapid flyback. For bands 7 and 9, the polarity is reversed. On all bands, a signal on the panoramic display moves from left to right as the receiver is tuned higher in frequency.

(U) The video signal for the panoramic display is obtained from unit 10 or 11. (Relay K1 selects the panoramic video signal from the



67.265

Figure 4-20.—(U) Panoramic display circuits of unit 12, block diagram (U).

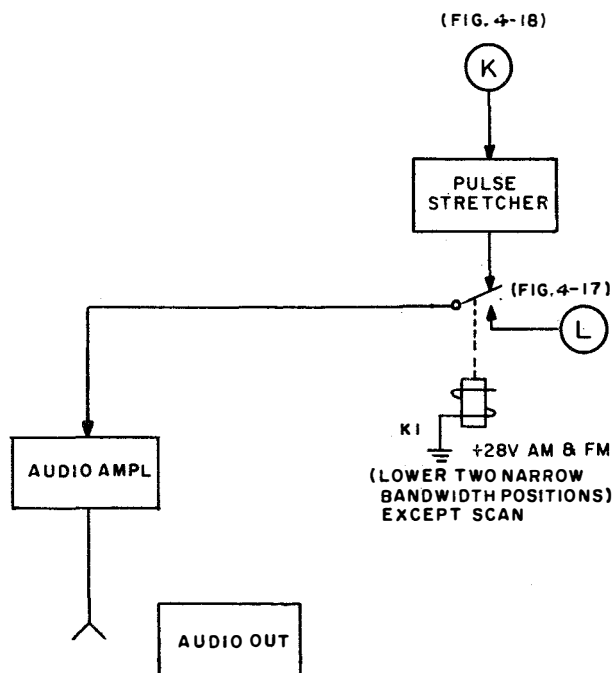
proper frequency converter.) The signal is amplified and applied through a cathode follower as shown in figure 4-15. This signal (H) is applied to a pulse stretcher whose output is amplified by the panoramic vertical amplifier and applied to the upper vertical deflection plate of the panoramic indicator gun.

**CONFIDENTIAL**



(U) The panoramic display is intensified only when a panoramic video signal from the panoramic vertical amplifier is applied to a gated amplifier. The signal is then clamped at a d.c. level controlled by the PHOTO-NORMAL switch. A signal for blanking the flyback of the panoramic sweep is also applied to the amplifier. The signal is obtained by differentiating the trailing edge of the positive sawtooth sweep voltage. The differentiating circuit applies a negative cutoff voltage to the gated amplifier. The output of the amplifier is amplified again by the panoramic intensity amplifier and applied to the intensity grid of the panoramic display indicator gun.

(U) AUDIO.—The audio circuit is shown in figure 4-21. In order to provide audible response in a headset, pulse stretching is necessary to provide audible frequency components from narrow pulses. The signal (K) is taken from the cathode follower of figure 4-18 and applied through the pulse stretcher. This output is



67.266  
Figure 4-21.—(U) Audio circuit of unit 12, block diagram (U).

applied to the audio amplifier through the contacts of relay K1. The signal is then coupled to the AUDIO OUT jack on the front panel. Relay K1 is energized when analyzing with the FUNCTION SELECTOR switch in either AM or FM with the FM BANDWIDTH switch in either of the lower two narrow bandwidth positions. These operating conditions are used for listening to voice communications, and pulse stretching of the audio signal is not used in order to prevent distortion of the voice modulation. Under these conditions, K1 connects the output (L) of the cathode follower (figure 4-17) to the audio amplifier.

(U) FREQUENCY INDICATOR-SERVO SYSTEM.—The purpose of the servosystem is to tune the preselector and local oscillator of the RF tuner in use and indicate the frequency to which that RF tuner is set. This is accomplished with two servoloops, one loop tuning the RF tuner and the other driving the frequency indicator. The tuner-servo has two modes of operation, scan and analysis. In scan, with the SCAN pushbutton switch depressed, the RF tuner is automatically tuned through its frequency range. In analysis, with one of the ten SELECT pushbutton switches depressed, the RF tuner frequency is controlled by the MANUAL TUNE knob. A block diagram of the servosystem is shown in figure 4-22.

(U) When one of the STORAGE CHANNEL SELECT pushbutton switches is depressed, scan-analysis relay K1 is deenergized and +28 volts is applied to the magnetic clutch. The clutch is energized, enabling the storage channel potentiometer to be controlled by MANUAL TUNE control. Voltage from the storage channel potentiometer is applied to the scan chopper through the relay contacts. In addition, a voltage from the tuner servo-potentiometer is also applied to the chopper, also through the relay contacts. If the output voltage of the tuner servo-potentiometer is lower than the storage channel potentiometer voltage, the output of the chopper will be in phase with the a.c. voltage applied to the chopper. After the phase is shifted 90° by the phase shift network, the



servomotor to rotate in the opposite direction, and output voltage of the tuner servo-potentiometer decreases. When the voltage of the tuner servo-potentiometer equals the voltage of the storage channel potentiometer, there is no error voltage output of the chopper and the motor stops.

(U) During operation, with the SCAN pushbutton switch depressed, relay K1 is energized; this connects the output of the sector-scan generator to the scan chopper. The chopper produces an a.c. output with an amplitude which is proportional to the d.c. output of the sector-scan generator. The chopper output is either in phase or  $180^\circ$  out of phase with the a.c. reference voltage. From  $T_0$  to  $T_1$  (figure 4-22), the output of the scan chopper is in phase with the voltage applied to the chopper. The resultant 60-Hz square wave is amplified and filtered to convert the square wave into a sine wave. The phase is also shifted  $90^\circ$  by a phase shift network. The sine wave is then applied through a paraphase amplifier and coupled to the push-pull amplifiers. The output of the push-pull amplifiers is coupled to the servomotor through an output transformer. The 60-Hz voltage at the transformer leads the a.c. reference voltage of the servomotor by  $90^\circ$ . This causes the servomotor to rotate in a direction which increases the voltage output of the tuner servo-potentiometer. The reverse is true when the 60 Hz lags the 120 v.a.c. reference. The voltage at the tuner servo-potentiometer is applied to the sector-scan generator by a cathode follower. The servomotor continues to rotate until the voltage output of the cathode follower becomes greater than the voltage of the tuner HI LIMIT potentiometer. This occurs at  $T_1$ . At this time, the sector-scan generator reverses its output. When the output is applied to the scan chopper, the chopper output is  $180^\circ$  out of phase with the a.c. reference voltage. After the phase is shifted  $90^\circ$  by the phase shift network, the voltage applied to the tuner servomotor lags the a.c. reference at the tuner servomotor, causing it to reverse its direction of rotation. When the servomotor rotates in the opposite direction, the output voltage of the tuner servo-potentiometer decreases. This continues until the output voltage of the

cathode follower becomes less than the voltage from the LOW sector-scan limit potentiometer. This occurs at  $T_2$  (figure 4-22), and the sector-scan generator again reverses its output to the chopper, and the cycle is complete.

(U) During analysis operation with one of the STORAGE CHANNEL SELECT pushbutton switches depressed, the frequency indicator gives a direct digital indication of the RF frequency of the RF tuner in use. This is achieved by applying the tuner servo-potentiometer voltage to the analysis chopper. When K1 is deenergized, a voltage is also applied to the chopper by the indicator potentiometer. If the voltage of the indicator potentiometer is lower than the voltage of the tuner servo-potentiometer, the output of the chopper is a square wave in phase with the a.c. voltage applied to the chopper. If the voltage of the indicator potentiometer is higher than the voltage of the tuner servo-potentiometer then the output of the chopper is a square wave  $180^\circ$  out of phase with the a.c. voltage applied to the chopper. The output of the analysis chopper is applied through an amplifier to the paraphrase amplifier. The phase shift network in the grid circuit of the amplifier shifts the phase  $90^\circ$ . The paraphase amplifier applies two equal signals  $180^\circ$  out of phase to the push-pull amplifier. If the output of the chopper is in phase with the a.c. reference applied to the chopper coil, voltage applied to the indicator servomotor leads the a.c. reference by  $90^\circ$ . The servomotor then rotates in a direction which increases the voltage output of the indicator potentiometer. If the output of the chopper is  $180^\circ$  out of phase with the a.c. reference, the motor rotates in a direction which decreases the voltage of the indicator potentiometer. The servomotor continues to rotate until the voltage of the indicator potentiometer equals the voltage of the tuner servo-potentiometer. When the two voltages are equal, the output of the chopper is a steady d.c. voltage and the servomotor stops. The frequency indicator is then set to the RF frequency of the RF tuner in use.

(U) During scan operation, the frequency indicator indicates the center frequency of the RF tuner in use. This is achieved by applying a scan-indicator reference voltage to the analysis chopper instead of the tuner

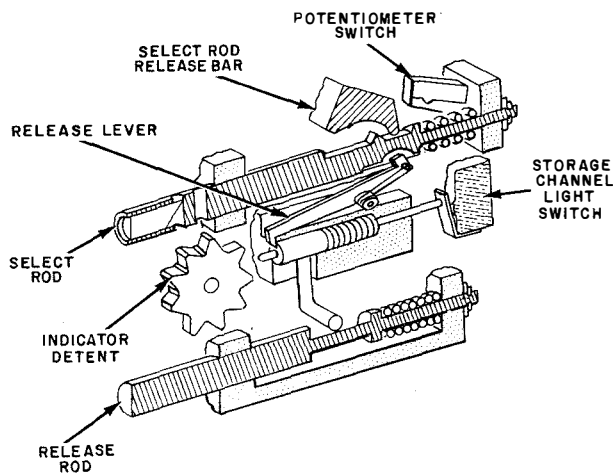
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servo-potentiometer voltage. When the SCAN pushbutton switch is depressed, relay K1 is energized, applying indicator-reference voltage which is obtained from the scan-indicator reference. The operation of the frequency-indicator servoloop is the same as the operation during analysis.

### Control-Storer (Unit 13)

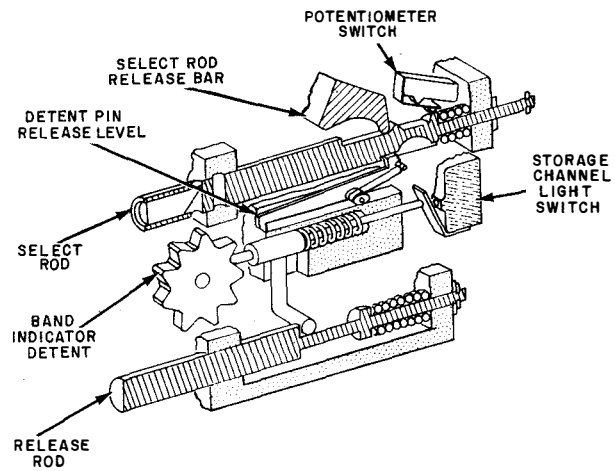
(U) The control-storer (unit 13) consists of operating controls, a tuner servo-amplifier (previously discussed), and a storage channel system. The storage channel system is a pushbutton channel selector which enables the operator to store and return to any of ten selected frequency positions. The storage channel pushbutton mechanisms in the RELEASE and SELECT positions are shown in figures 4-23 and 4-24, respectively.

(U) A schematic diagram of the first two storage channel switches is shown in figure 4-25. The storage channel system is composed of ten SELECT pushbutton switches, ten RELEASE pushbuttons, ten potentiometers, ten magnetic clutches, ten indicator lamps, and ten BAND



67.268

Figure 4-23.--(U) Unit 13 storage channel pushbutton mechanism in select position (U).

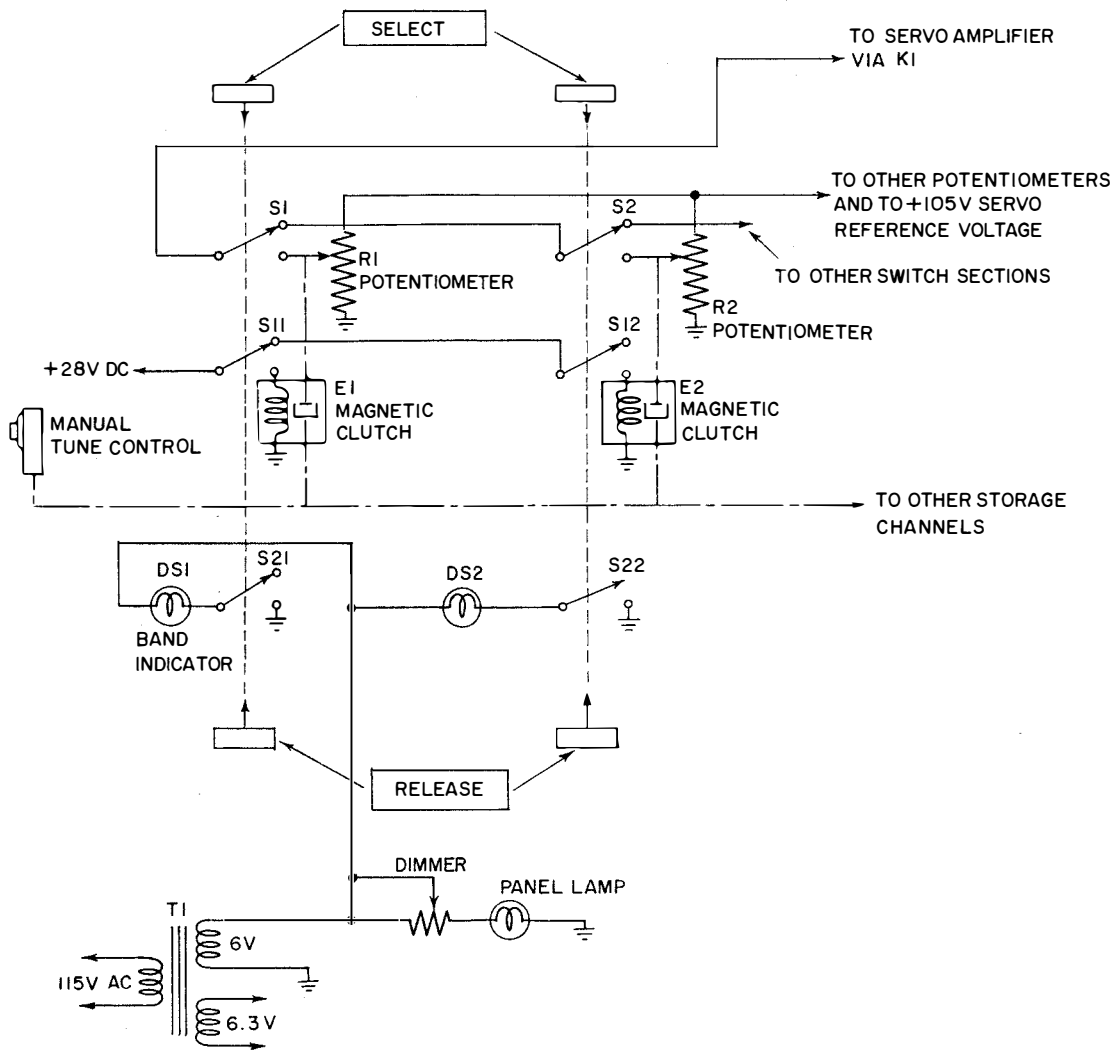


67.269

Figure 4-24.--(U) Unit 13 storage channel pushbutton mechanism in select position (U).

indicators. When one of the SELECT pushbuttons is depressed, the associated three switches, S1, S2, and S3, for example, are closed by a mechanical link to the pushbutton, and a detent locks the BAND indicator. A positive 28 volts is applied through the contacts of S2 to energize magnetic clutch E1. With the clutch energized, the arm of potentiometer R1 is moved by the MANUAL TUNE control. The positioning voltage at the arm at R1 is applied through the contacts of S1 and K1 to the servoamplifier where it is used as a reference to position the tuner servomotor. The 6-volt winding of transformer T1 provides operating voltage for the indicator and panel lamps. When the SCAN pushbutton or another SELECT pushbutton is depressed, the storage channel potentiometer remains in the position to which it was set and the BAND indicator remains locked. The RF tuner will automatically return to the selected frequency whenever the SELECT pushbutton is depressed, and the BAND SELECTOR switch is set to the band displayed on the BAND indicator.

(U) When the RELEASE pushbutton is depressed the indicator lamp is extinguished and



32.19(67C)

Figure 4-25.—(U) Storage channel switches of control-storer (U).

the detent is released, allowing the BAND indicator to rotate to the band number in use. The BAND indicator display is part of a dual permanent magnet assembly. One of the magnets in the assembly is geared to the shaft of the BAND SELECTOR switch, and the other is attached to the BAND indicator display ring and rotates on a bearing. With the detent released, the two magnets come into alignment which causes the BAND indicator display and the BAND SELECTOR to have an identical number.

### Power Supplies

(U) The purpose of two of the power supplies (units 15 and 16) is to convert the primary input into d.c. voltages for various units of the countermeasures system. The purpose of the other power supply (unit 31) is to convert the primary power input into d.c. voltages for the klystron oscillator in the four high-band RF tuners. Each power supply has a voltmeter and a

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VOLTAGE SELECTOR switch on the front panel of the unit to provide convenient monitoring of the power supply output voltages.

(U) POWER SUPPLY (UNIT 15).—This power supply contains four separate supplies providing output voltages of +250 volts, +150 volts, +105 volts, and +28 volts d.c.

(U) POWER SUPPLY (UNIT 16).—This power supply contains six individual supplies providing d.c. voltages of +2500 volts, +450 volts, +300 volts, +180 volts, +120 volts, -150 volts, -2395 volts, and -2500 volts.

(U) POWER SUPPLY (UNIT 31).—Unit 31 contains three individual supplies to provide d.c. voltages of +250 volts, klystron beam voltages of -325 volts, -1000 volts, or -1250 volts, and klystron reflector voltages of -865 volts, -1540 volts, or -1790 volts.

**Interconnecting  
Box (Unit 17)**

(U) The interconnecting box (unit 17) interconnects the various units of the ESM system.

(U) The unit consists primarily of terminal boards, relays, line filters, fuses, load indicators, and various wiring. The functions of the various relays used in the interconnecting box are as follows:

1. Supplies main power to all units except units 19 and 27.
2. Selects the proper power and control voltages for the nine RF tuners.

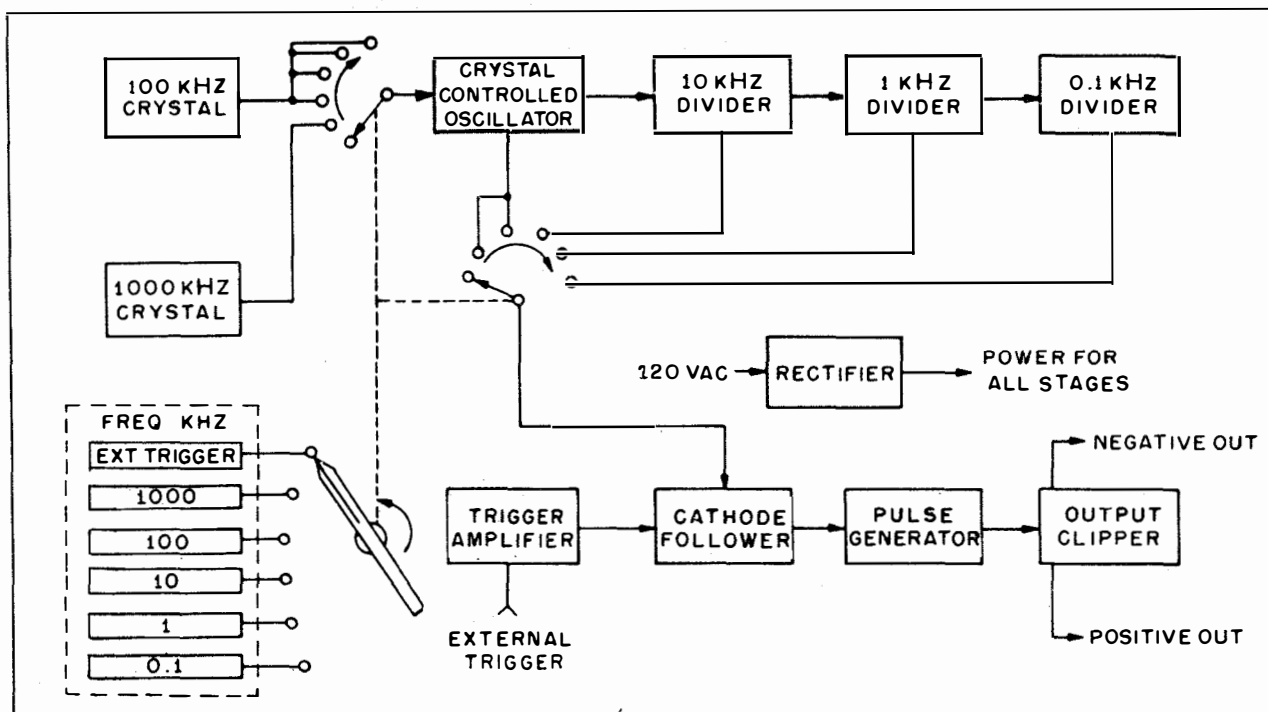
3. Selects the proper power and control voltages for units 10 and 11.

4. Applies control voltages to relays in units 18, 28, and 32 for selection of desired antenna and applies isolation-relay voltage to the DF control unit when required in submarine installations.

**Pulse Generator  
(Unit 19)**

(U) The pulse generator (unit 19) provides pulses to the azimuth indicator-pulse analyzer for accurate alignment of the analysis sweeps. These pulses may be synchronized internally at 1000 kHz, 100 kHz, 10 kHz, or 0.1 kHz, or they may be developed from external trigger pulses. The front panel FREQ KHZ switch determines the mode of operation.

(U) Figure 4-26 is a block diagram showing the signal flow through unit 19. The internal trigger pulse is developed by a crystal controlled oscillator. The position of the FREQ KHZ switch determines the repetition rate. The trigger pulse is taken from the crystal controlled oscillator or one of the frequency dividers, depending upon the position of the FREQ KHZ switch, and applied to the cathode follower. When the FREQ KHZ switch is in the 100 kHz or 1000 kHz position, the input to the cathode follower is taken directly from the crystal controlled oscillator. When the FREQ KHZ switch is in the 0.1 kHz, 1 kHz or 10 kHz position, the respective divider output is applied to the cathode follower. To obtain good frequency stability, the dividers are synchronized by the crystal controlled oscillator. The 100 kHz output of the crystal oscillator synchronizes the 10 kHz divider. The 10 kHz divider output then synchronizes the 1 kHz divider which, in turn, synchronizes the 0.1 kHz divider. The pulse generator stage receives the trigger from the cathode follower and presents it in pulse form to the output clipper which provides positive and negative output



67.87

Figure 4-26.—(U) Pulse generator (unit 19), block diagram (U).

pulses to the azimuth indicator-pulse analyzer. When the FREQ KHZ switch is in the EXT TRIG position an external trigger may be employed, in place of the internal trigger, to drive the pulse generator circuit.

#### Servo Test Set (Unit 27)

(U) The servo test set (unit 27) is stored in unit 19 for convenience. The set is used to align the high and low servo-potentiometers in the RF tuners. When connected to the tuner servo-potentiometer circuit, it forms a Wheatstone bridge. To ensure that all tuners will cover their complete frequency range while scanning, each tuner servo-potentiometer circuit must be aligned to exactly the same resistance ratio at the high and low limits of its range.

#### Electronic Equipment Maintenance Kit (Unit 30)

(U) The special tools, test cables, and accessory items required to troubleshoot the countermeasures set are supplied in the electronic equipment maintenance kit.

(U) Table 4-2 shows the operation of the narrowband countermeasures receiving set.

#### CONVERTER-TUNER CV-3292/WLR-1G (BAND 10)

(U) Converter-Tuner CV-3292/WLR-1G and Remote-Control C-9872/WLR-1G make up the SSC-10J receiving system. This receiving system, normally referred to as band 10, interfaces with the AN/WLR-1C receiving system and extends

Table 4-2.—(U) Operation of the Narrowband Countermeasures Receiving Set

## I. AZIMUTH INDICATOR-PULSE ANALYZER IP-480 (see fig. 4-27)

Pre-Operational Checks

Photo-Normal	NORMAL
DF-Calibrate	NORMAL
Battle Short	OFF
Audio Gain	Fully counterclockwise
Phone	Plugged in
Dimmer	Clockwise

NOTE: DO NOT vary SYNC LEVEL during prechecks.

Control Functions

Power ON/OFF	Switches power on and off.
Audio Gain	Controls level of audio output signal.
Dimmer	Controls illumination of front panel.
Vertical Sweep Stop (Top/Bottom)	Positions sweep on acquisition scope at top or bottom of the raster.
Battle Short	Interlocking shorting switch. Places a short across the high-voltage interlock when in the ON position.
DF (Cal/Norm/Off)	CAL — applies a DF calibration signal from DF antenna control. NORM — provides normal DF operation. NB OFF — provides momentary removal of CW indication from the DF display.
Photo/Normal	Clips intensification on pan display when in the PHOTO position.
Sync Level	Controls level of signal which will trigger analysis sweeps while in analysis operation only.
Osc Inject	Indicates oscillator injection level at the mixer crystal of the RF tuner. Should read anything other than zero.



Table 4-2.—(U) Operation of the Narrowband Countermeasures Receiving Set—Continued (U)

## II. CONTROL-STORER C-2697 (see fig. 4-28)

Pre-Operational Checks

Function Selector	VIDEO
Band Selector	BAND 1
SCAN	(select storage)
Release Buttons	All depressed
FM Bandwidth (MC)	1.2 MHz
Dimmer	Clockwise
Fixed OSC	OFF
Sector Scan Limits	LOW—1. Counterclockwise to stops 2. Clockwise 1/4 turn HIGH—1. Clockwise to stops 2. Counterclockwise 1/4 turn
Bandwidth (Narrow/ Wide)	WIDE
Gain	Fully counterclockwise
Antenna Selector	OMNI— Bands 1 through 6 D/F— Bands 7 through 9 (AS-570, AS-899). Antenna selector in position "C"

Control Functions

Dimmer	Controls illumination of front panel.
Band Selector	Permits selection of any one of nine frequency bands.
Scan	Pushing button places equipment in search operation and enables GAIN control regardless of FUNCTION SELECTOR setting.
Storage Channels (10 buttons)	Depressing SELECT button places equipment in analysis operation. BAND SELECTOR and BAND light is illuminated, indicating presence of stored information.
Release (10 buttons)	Depressing RELEASE button frees the BAND indicator and turns off BAND indicator light.
FM Bandwidth (MC)	Permits a choice of selectivity on PM reception.

**Table 4-2.—(U) Operation of the Narrowband Countermeasures Receiving Set—Continued (U)**

**II. CONTROL-STORER C-2697 — Continued**

Control Functions — Continued

FIXED OSC	Switches on fixed oscillator. Used as an aid in accurately tuning the signal to the center of both wide and narrow pass bands.
Bandwidth (NARROW/WIDE)	Selects either narrow or wideband video. In NARROW position, equipment has increased selectivity.
Gain	Controls gain of IF stages in mixer amplifiers and RF tuners when FUNCTION SELECTOR switch is in VIDEO or AM MGC position. Controls video output level of RF-89 when in either the FM MFC or FM AFC position. Controls gain of mixer amplifiers and RF tuners on SCAN regardless of FUNCTION SELECTOR setting.
Sector Scan Limits (LOW and HIGH)	Selects low- and high-frequency scanning limits.
Antenna Selector (OMNI/SPECIAL/DF)	Selects type of antenna to be employed: OMNI—Search antenna, selected automatically; Bayonet, Cone, Wye. SPECIAL—Submarines, selected automatically; Stub, Door Knob. DF — AS-571, AS-616, AS-570, AS-605, AS-899. Submarines, AS-626 and AS-944.
Manual Tune	Manually positions storage potentiometer when the respective SELECT button is depressed. Storage potentiometer tunes RF tuners electrically.
Function Selector	FM—Selects FM video signal and operates AGC. In the AFC position, AFC is applied in FM BANDWIDTH positions 1.2, .23, or .05. VIDEO—Enables GAIN control; disables AGC. Enables audio stretch to AUDIO OUT jack. AM—MGC enables GAIN control, disables AGC. AGC enables AGC, disables GAIN control.

Table 4-2.—(U) Operation of the Narrowband Countermeasures Receiving Set—Continued (U)

## IV. SETTING UP THE SCOPE

- |                   |   |
|-------------------|---|
| 1. Power ON       | Azimuth indicator and antenna control units.  |
| 2. Band Selector  | Desired band.   |
| 3. Select Antenna | Select appropriate antenna for band selected.   |
| 4. Scan Button    | Depressed.  |
| 5. Gain Control   | Increase until slight random noise is visible on the scan scope. (If no scan appears, readjust sector scan limits.) |
| 6. Phones         | Place on head.  |
| 7. Audio Gain     | Adjust for slight noise level.  |
| 8. Storage Button | Ride with finger on storage button.   |

## III. ANTENNA CONTROL UNIT (see fig. 4-29)

Control Settings

Antenna Speed	Counterclockwise
Polarization	Horizontal
True/Relative	REL
Automatic/Manual	MAN
Antenna Selector	OFF

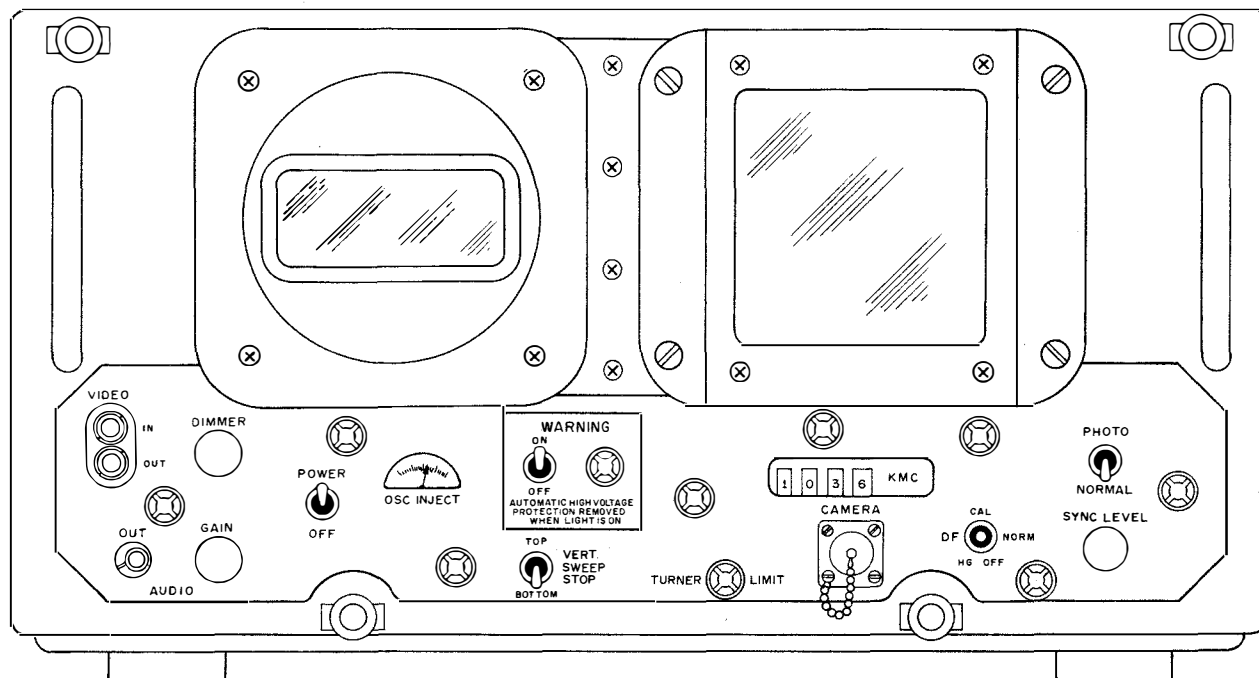
<u>Bands</u>	<u>Position</u>	<u>Antenna</u>	<u>Freq. Range</u>
1-2-3	None	None	None
4	A	AS-571	300-600 MHz
5-6	B	AS-616	550-2400 MHz
7-8-9	C	AS-570	2300-11,000 MHz

189.10

the overall system's frequency range to 20 GHz, band 10, encompassing the 10-GHz to 20-GHz frequency range. Figure 4-30 is a functional block diagram of the system interface. Video from Frequency Converter CV-742 is fed to Azimuth Indicator-Pulse Analyzer

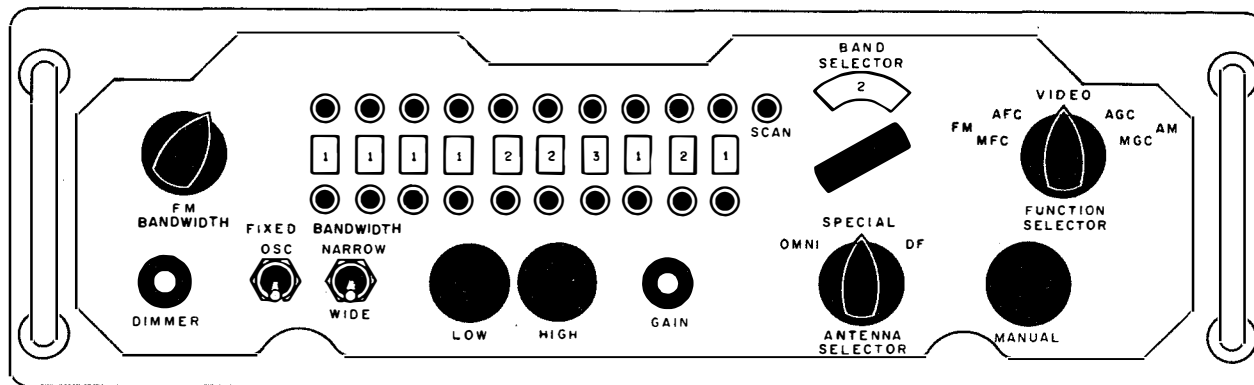
IP-480C/WLR-1C for operator analysis. Remote-Control C-9872/WLR-1G provides a direct frequency readout. The system has a limited stand-alone capability in that frequency readout could be obtained in the event that the IP-480C/WLR-1C is inoperative.

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Figure 4-27.—(U) IP-480 control locations (U).



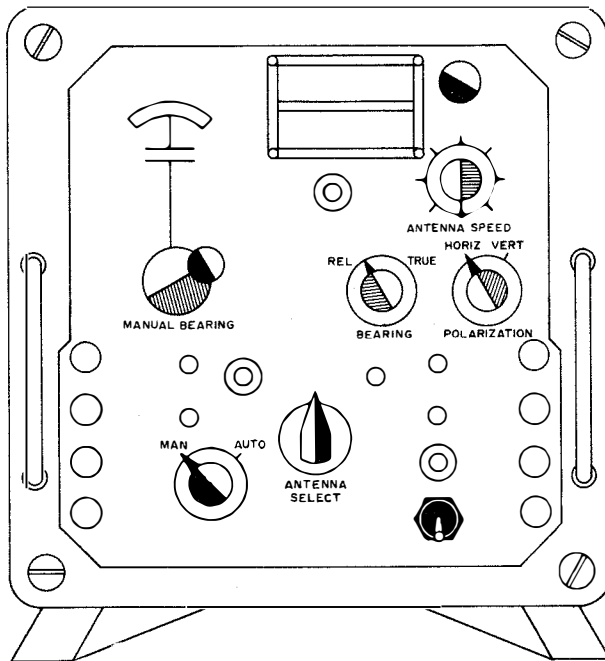
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Figure 4-28.—(U) Control Storer C-2697 control locations (U).

(U) The Converter-Tuner CV-3292/WLR-1G is a mast-mounted unit at the base of the antenna and contains the necessary circuitry to perform the down-conversion of the received RF frequencies (10-20 GHz) to an intermediate

frequency (IF) of 160 MHz. The unit contains a power supply and is electrically tied to Remote Control C-9872/WLR-1G which is mounted adjacent to the AN/WLR-1C receiver control units.

**CONFIDENTIAL**



189.13

Figure 4-29.—(U) Antenna control C-3118 control locations (U).

### COUNTERMEASURES RECEIVING SET AN/WLR-8(V)

(U) The AN/WLR-8(V) is a tactical receiver system configured to meet surface and subsurface requirements for electronic warfare surveillance. The system analyzes, processes, and displays RF signals intercepted via an antenna system in the 0.25-GHz to 18-GHz frequency range. Figure 4-31 shows the relationship of the five units which make up the AN/WLR-8(V) receiver system. Figure 4-32 shows a composite pictorial view of the system.

(U) The Control-Monitor Group OK-243/WLR-8(V), figure 4-33, is configured to provide an operator control position for the analysis and display of intercepted electromagnetic signals. Two receiver assemblies are installed within this group. Teletypewriter

AN/UGR-9 is positioned adjacent to the control-monitor group and is utilized to print out the processed signal data.

(U) The Amplifier-Converter Group OG-126/WLR-8(V) contains the majority of the receivers associated with the system and is remotely controlled by signals from the OK-243/WLR-8(V).

(U) An additional Receiver Assembly AM-110/WLR-8(V) and an Antenna Switching Unit SA-401/WLR-8(V) complete the countermeasures receiving set.

### Operational Modes

(U) Frequency coverage of bands 4 and 5 is provided by a single radio receiver assembly per band, R104 and R105, respectively (see table 4-3.) Frequency coverage of bands 6 through 10 is provided by the use of two assemblies per band, a radio-frequency amplifier unit/assembly and an electronic frequency converter assembly. Each receiver can be operated independently of any other receiver, and all receivers can be operated simultaneously. There are four operational modes in which a receiver or combination of receivers can be utilized. The four primary modes of operation are BAND SCAN, LIMIT SCAN, ANALYZE, and SET SCAN LOCK.

(U) BAND SCAN.—The BAND SCAN mode is primarily an activity display mode in which a frequency band is scanned at selected scan rates, and the resultant video output is visible to an operator on an activity display. The video activity output of seven frequency bands can be displayed simultaneously or one may be selected for DOC (direct operator control).

(U) LIMIT SCAN.—The LIMIT SCAN mode provides the capability of selecting a frequency segment of a frequency band for scanning, and expanding this frequency segment over the entire activity display trace. The operator selects the upper and lower limits of the frequency

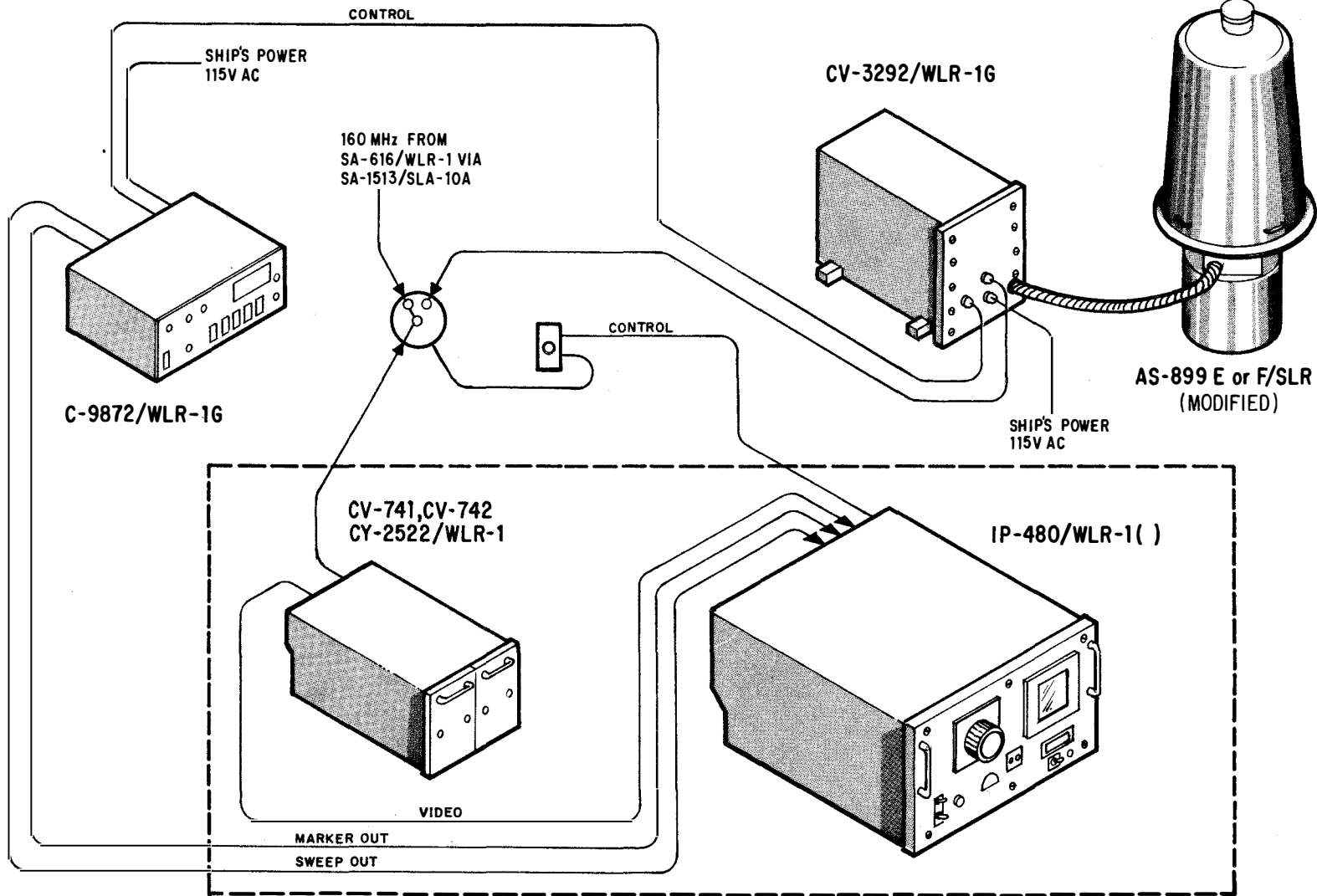


Figure 4-30.—(U) Band 10 Tuner CV-3292/WLR-1G, functional diagram (U).

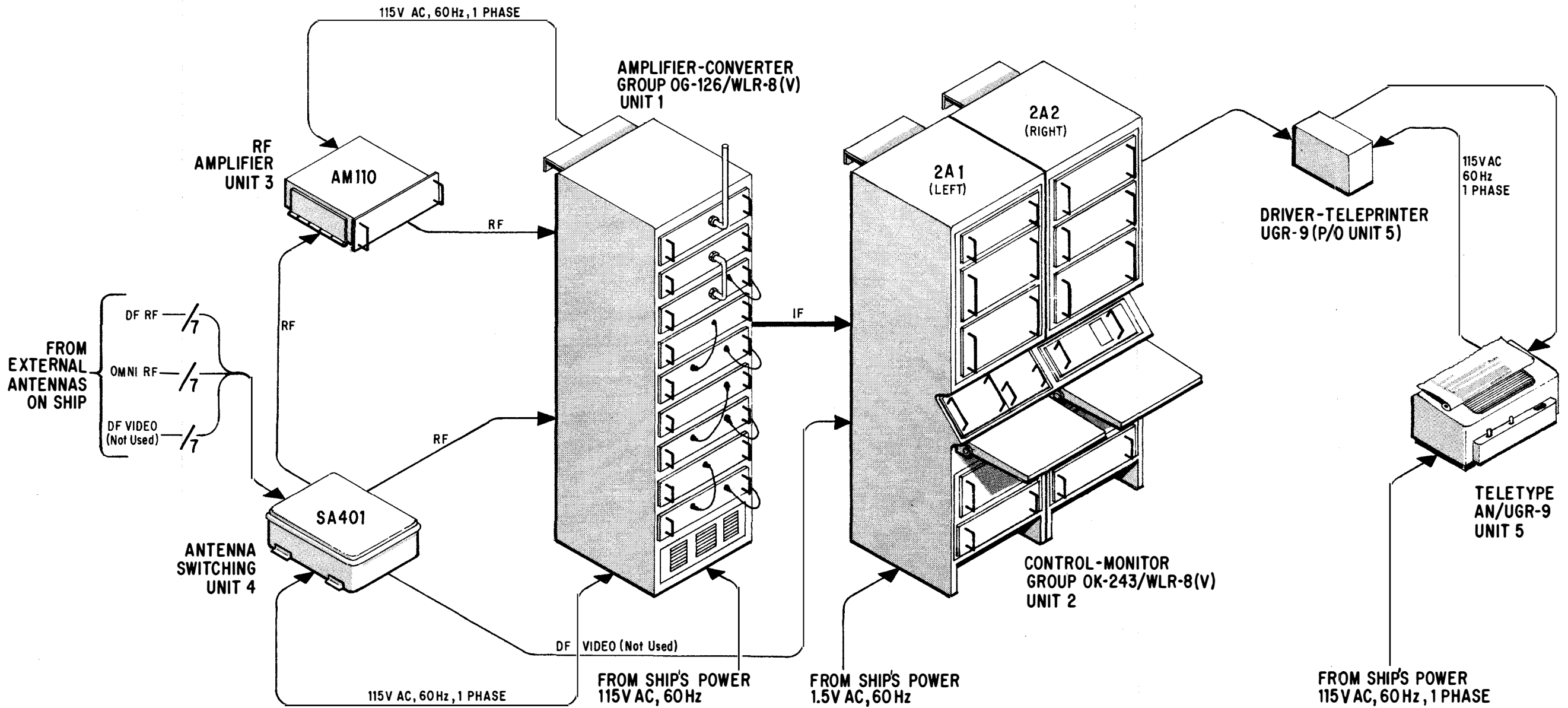


Figure 4-31.—(U) Countermeasures Receiving Set AN/WLR-8(V) relationship of units (U).





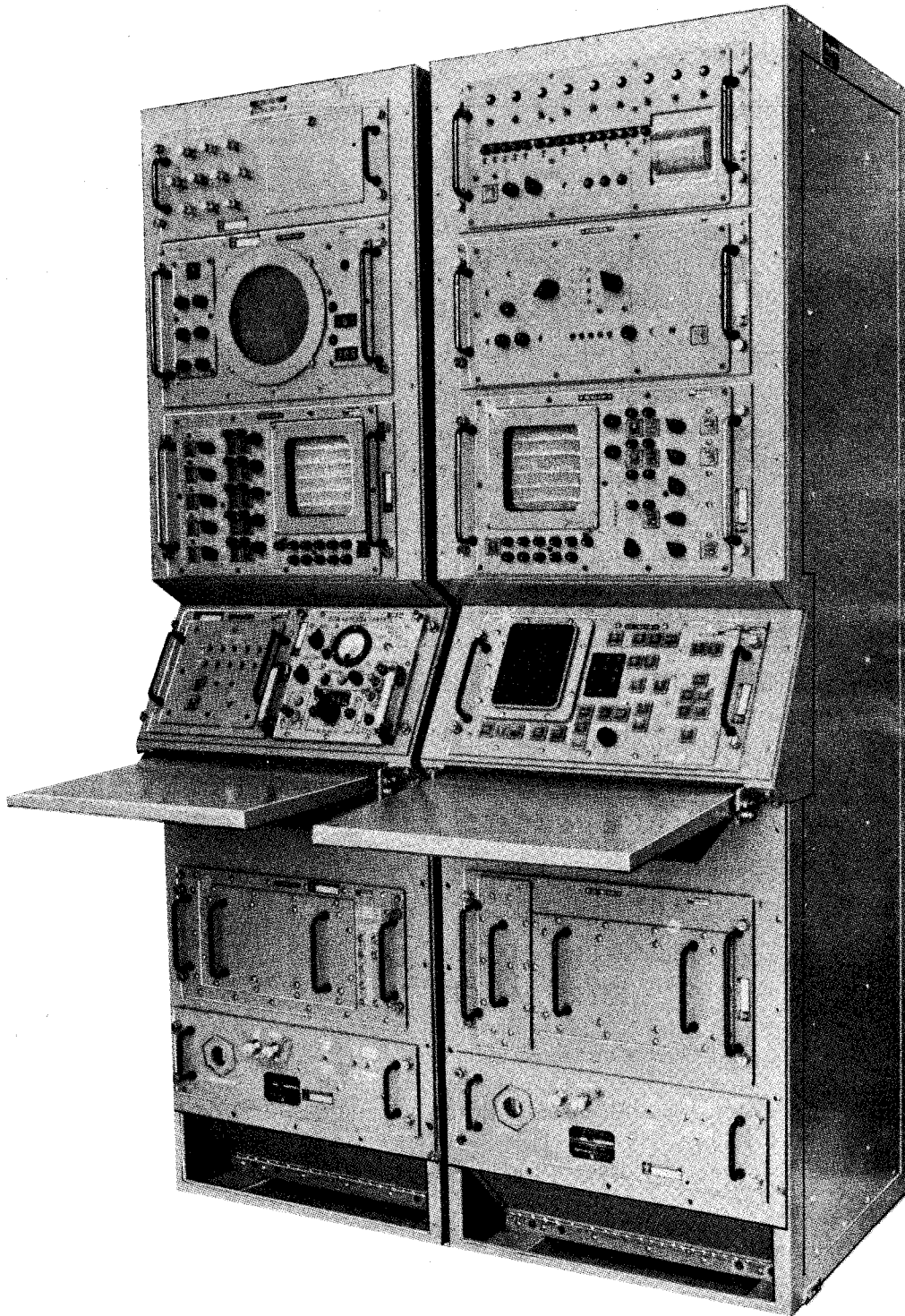


Figure 4-33.—(C) Configuration of the control monitor group (C).

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Table 4-3.--(U) Receiver Frequency Coverage (U).

BAND	FREQUENCY	COMMON NAME/DESIGNATOR	UNIT/ASSEMBLY DESIGNATION
4		R-104	2A1A7
5		R-105	2A2A6
6		AM-106	1A9
		CV-106	1A8
7		AM-107	1A7
		CV-107	1A6
8		AM-108	1A5
		CV-108	1A4
9		AM-109	1A3
		CV-109	1A2
10		AM-110	3
		CV-110	1A1

1. System Frequency Range: 0.25 GHz to 18.0 GHz in the following frequency bands:

Band 4:	0.25 GHz to 0.5 GHz
Band 5:	0.5 GHz to 1.0 GHz
Band 6:	1.0 GHz to 2.0 GHz
Band 7:	2.0 GHz to 4.0 GHz
Band 8:	4.0 GHz to 8.0 GHz
Band 9:	8.0 GHz to 12.0 GHz
Band 10:	12.0 GHz to 18.0 GHz

2. System Receiver Modes of Operation (in each band);

BAND SCAN Mode:	Receiver is swept-tuned at 0.5, 2, 8, or 32 sps (selectable)
LIMIT SCAN Mode:	Receiver is swept-tuned over a selected segment (upper and lower limits selectable)
ANALYZE Mode:	Receiver is in a fixed-tuned mode of operation
SCAN LOCK Mode:	Receiver is swept-tuned in BAND SCAN mode, with capability for automatic signal intercept, lock-on, signal parameters analysis and print-out of intercept

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segment to be scanned and then initiates the LIMIT SCAN mode.

(U) ANALYZE.—The ANALYZE mode is a fixed tuned mode at a frequency selected directly by the operator or from frequencies stored in the ordered frequency memory portion of the processor. Three analysis traces are available for displaying the signal parameters, and the signal azimuth can be determined on a DF display.

(U) SET SCAN LOCK.—The SET SCAN LOCK mode provides an operator with the capability of automatic band scanning, signal intercept, and parameter analysis. From one to all of the frequency bands can be selected for SET SCAN LOCK. The frequency bands are scanned sequentially from the highest to the lowest. The following sequence of operations occurs:

1. The highest frequency receiver (of the receivers selected) is placed in the SET SCAN LOCK mode first.
2. When a signal intercept occurs, the tuner stops scanning and fix-tunes at the signal intercept frequency.
3. Selected parameters of the signal intercept are automatically measured and temporarily stored.
4. The receiver continues scanning from frequency of last intercept and will stop scanning again on the next intercept.
5. The measured parameters are recorded on the teletype.
6. When the entire frequency band has been scanned, the next highest band of those receivers chosen is placed in the SET SCAN LOCK mode and the process is repeated.

#### System Operation

(U) The seven receivers (bands 4 through 10) are placed individually in one of the four operational modes defined above and controlled by the Receiver Control C-301 at the

control-monitor group console. In addition to controlling the four operational modes of the receivers, the receiver control also contains capabilities for the insertion of an external local oscillator, RF attenuation, and RF amplification. To enhance receiver operation, 16 cells of the memory in the Receiver Control Processor MX-201 are available for frequency storage and retrieval. The Receiver Control C-301 permits the operator to store, recall for analysis, and erase 16 selected frequencies for any of the seven receivers; these 16 stored frequencies can also be selected for blanking from the Activity and Analysis Indicators IP-301 and IP-302, respectively, upon operator discretion. The Receiver Control C-301 contains a CRT alphanumeric display which provides receiver status, ordered frequency memory status, measured parameters, and a test pattern as an alphanumeric readout. The receiver status format displays the operational status (frequency, mode, upper and lower sector limits, etc.) of the receiver under DOC and the availability status of other receivers. The ordered frequency memory status displays the number of cells (of the 16 total) that contain stored frequencies and indicates what these frequencies are and the receiver with which they are associated. The signal file processor readout format displays the receiver frequency, measured receiver parameters, and the bands selected for SCAN LOCK. The C-301 test pattern displays alternating columns of dollar signs (\$) and fours (4).

(U) While actual operator control of the receivers is accomplished at the Receiver Control C-301(P)/WLR-8(V), the digital command signals required for tuning each receiver are produced in the Receiver Control Processor MX-201. The receiver control processor contains the processing circuitry, memory, and associated input/output circuitry that produces the operator command functions actuated at the Receiver Control C-301. In addition, it routes the IF output of the receiver under DOC to the Control-Processor C-302 which switches in amplifier-demodulation parameters (IF bandwidth, detection mode, AFC on/off, etc.). The Receiver Control Processor MX-201 also generates and routes the necessary sweep and

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cursor command signals to the Activity and Analysis Indicators IP-301 and IP-302, respectively, via the Video Switching Unit SA-402.

(U) The video output of the receivers is monitored on the Activity Indicator IP-301 and the Analysis Indicator IP-302, both of which are five trace CRT displays. Overall signal activity of the seven receivers (bands 6 through 10) are displayed on the five traces of the IP-301, and bands 4 and 5 are displayed on the top two traces of the IP-302. Intercepted signals are displayed as vertical "spikes" on the horizontal axis which represents the frequency spectrum of the receiver band covered. The bottom three traces on the IP-302 are used for signal analysis of the receiver under DOC; trace 3 displays the signal's pulse width, trace 4 displays the signal's pulse repetition frequency (PRF), and trace 5 presents a panoramic view of the IF passband of the receiver under DOC. These bottom three traces enable the operator to determine the parameters of the signal from the receiver under DOC. If DF is required, this is accomplished utilizing Antenna Control C-7847 and Antenna Switching Control C-308 and observing the presentation on the DF Indicator IP-303. The DF Indicator IP-303 is a J-sweep display in which the signal is seen as strobed lines that radiate from the center of the CRT and vary in length in proportion to signal strength.

(U) Direction-finding can be performed in two modes, TRUE (relative to gyro input) or REL (relative to the ship's heading), as selected at the Antenna Control. TRUE and REL lights on the IP-303 indicate which mode is in use. The TRUE or REL bearing of the signal can be determined by reading the bearing graticule of the CRT. A more accurate bearing readout can be obtained by positioning the cursor on the signal, using the CURSOR control on the antenna control, and observing either the TRUE or REL three-digit readout on the IP-303.

(U) The Control-Indicator C-304 is the central prime power distribution and fault indicator point for the AN/WLR-8(V) units/assemblies. The Control Indicator C-304

contains the capability to test the ship's primary power input for under- and over-voltage conditions prior to application of power to the AN/WLR-8(V)2 units/assemblies. In addition, a capability is provided so that power supply and functional faults in any AN/WLR-8(V)2 units/assemblies will light a fault indicator on the Control Indicator C-304 which localizes the malfunction to the unit level. A lamp-test capability is also available at the Control Indicator C-304.

**COUNTERMEASURES  
RECEIVING SET  
AN/WLR-11A**

(U) The AN/WLR-11A is an instantaneous frequency measurement and analysis receiving system designed to cover the frequency range from 7 to 18 GHz in two bands. In addition, it provides an acquisition capability for the AN/WLR-1C band tuner. The frequency-sensing element in the IFM (Instantaneous Frequency Measuring) receiver is a stripline discriminator which is an inherently wide-open device. This means that the full RF frequency band is monitored on an instantaneous basis rather than by conventional scanning.

(U) The discriminator output consists of video signals that are a function of both input signal amplitude and instantaneous frequency. To obtain a frequency measurement independent of signal level, the outputs are subtracted and applied to the horizontal and vertical plates of a CRT display. This results in the appearance of the signal as a dot (in the case of a CW or pulsed signal having constant frequency and amplitude). The radial distance of the dot from the center of the scope is proportional to input power; the angular displacement is linearly proportional to the instantaneous frequency of the signal. A display advantage of IFM over superheterodyne stems from the basic difference between measuring instantaneous and spectral frequencies. Radar systems having some form of frequency agility (e.g., chirp, simultaneous signals, or frequency jump) are very difficult to acquire. In many EW situations, IFM becomes the only practical

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means of receiving and displaying transmissions of this type.

(U) The AN/WLR-11A receiver system combines a broadband, high-probability-of-intercept IFM channel in parallel with a tunable TRF narrowband channel. The resulting capability is 100% intercept probability on a single pulse through the wideband channel. The system components are designed for shipboard installations that provide 115-volt a.c., single-phase, 60-Hz power.

(U) The AN/WLR-11A IFM receiving system, as supplied, consists of two control/display units, a digital pulse train sorter/analyzer, and one RF unit, and is designed to operate with an RF preamp/antenna unit. The functional relationship of these units is illustrated in figure 4-34.

#### IFM RF Unit (R-1814/WLR)

(U) The RF unit mainframe (figure 4-35) is an electrically passive enclosure for the three

plug-in modules, two IFM receiver modules, and a power supply/switching module. The enclosure contains only interfacing cables, connectors, and RFI line filters. If the installation requires another mounting scheme (i.e., rack mounting), the modules can be removed from the enclosure and mounted in an optional rack-mount kit.

(U) The low-band receiver hardware is located in a removable module designed to plug directly into the RF unit. This takes the low-band RF from an externally mounted preamplifier (usually located near the antenna) and amplifies, limits, detects, and produces the video outputs processed by the control/display unit. The receiver module may be considered as two receivers in one. The wideband IFM receiver instantaneously displays the frequency of each signal received throughout the entire low-band spectrum and a parallel TRF receiver signals within the 25-MHz passband of the voltage-tuned filter. The control/display unit employs the X, Y, and Z video outputs from this receiver so that signal frequency determines the rotation angle, and relative signal strength

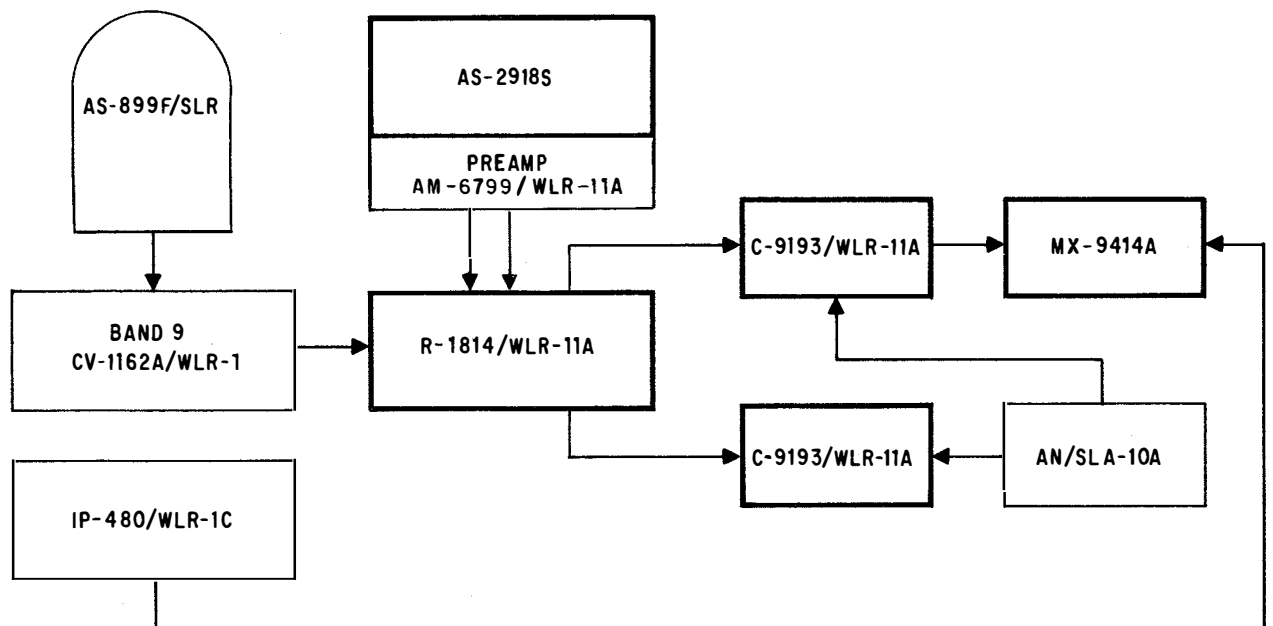
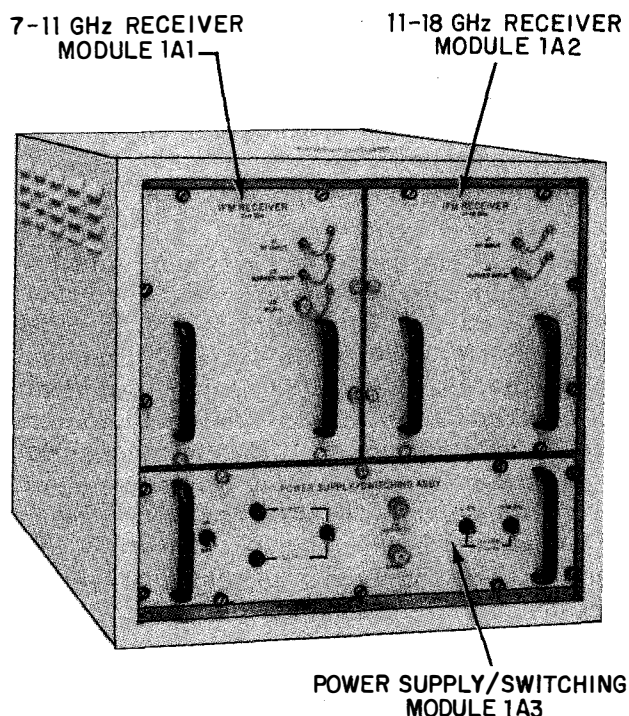


Figure 4-34.—(U) Receiving Set AN/WLR-11A, functional diagram (U).

253.26

**CONFIDENTIAL**

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Figure 4-35.—(U) Radio Frequency Unit, R-1814/WLR-11, Unit 1 (U).

determines the distance the display dot is deflected from the CRT screen center.

(U) IFM RECEIVERS.—The IFM receivers are designed to supply an operator with visual and audio indications of radars operating in the low and high bands. A radar signal is displayed on a CRT polar indicator where the distance from the center of the screen is proportional to the relative power of the signal, and the angular displacement indicates the operating frequency. The RF components, low-level video amplifiers, and cable drivers are located remotely in the RF unit. The control/display units are in direct view of the operator and contain the CRT display angle gate for sorting signals by frequency and controls for the RF unit.

(U) The functions of the low-band (7-11 GHz) and high-band (11-18 GHz) receiver modules are essentially the same. Because the

low-band receiver module contains some additional features, a system description of signals received in the lower frequency range is presented. The signal enters the low-band receiver module after preamplification. The preamps can be bypassed by a switch on the RF unit and/or control/display units.

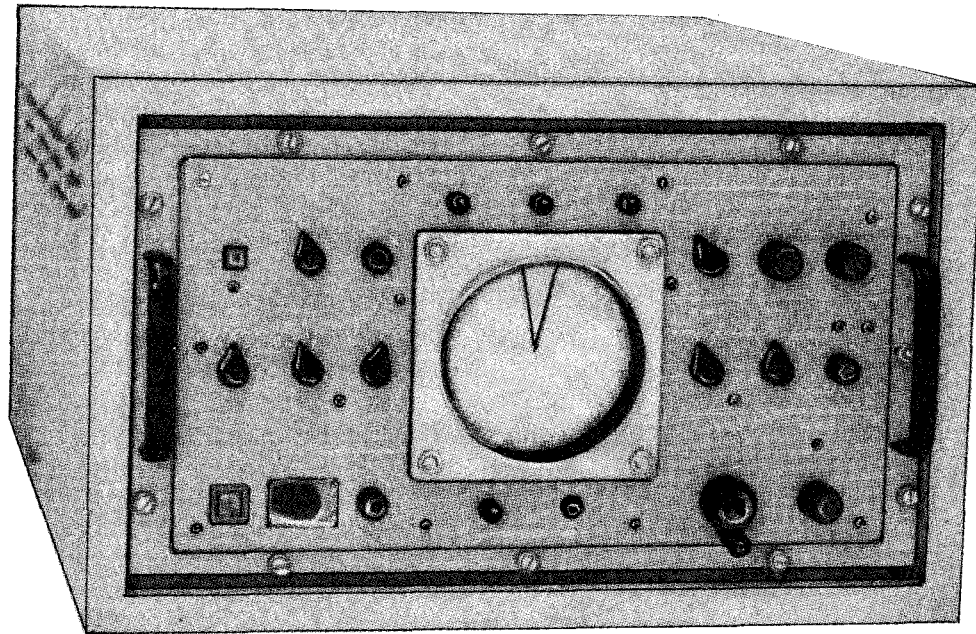
(U) Each receiver module provides an X, Y, and wide-open video output through the power supply/switching module to the control/display unit; when in the expand mode, these same outputs are provided for signals within the 8.5- to 9.6-GHz range. When the TRF MARK mode is selected, a pulsed RF marker is generated in the module and produces a marking strobe on the display at the BANDPASS center frequency. If the AN/WLR-1C MARK mode is selected, a pulsed 400-MHz signal is supplied to the band 9 tuner of the AN/WLR-1C, thus generating an RF pulse at the AN/WLR-1C frequency which is applied to the MARKER input. Both of these marker signals plus the video outputs are presented to the control/display unit for generation of the TRF and AN/WLR-1C marker strobes. Each receiver module also generates a logic level output to the control/display unit through the power supply/switching module for CW signals received. This output activates the CW indicator on the control/display unit.

(U) POWER SUPPLY/SWITCHING MODULE.—The power supply/switching module provides outputs from the receiver modules to both control/display units simultaneously and also determines system priority. Because both units cannot control certain receiver functions, the priority circuits reject an attempt by control/display unit No. 2 to control the same receiver module being controlled by control/display unit No. 1.

#### Control/Display Units (C-9193/WLR)

(U) The control/display units (figure 4-36) supply control signals to the receiver modules through the power supply/switching module. These signals exercise control over the receiver functions as determined by the priority circuits. The control/display units also furnish the system

**CONFIDENTIAL**



189.111

Figure 4-36.—(U) Control/Display Unit, C-9193/WLR-11, Units 2 and 3 (U).

outputs for processed auxiliary, X, Y, Z, video, and audio. The video processing in these units consists of:

1. Generation of Z-axis intensity modulation on the video (wide open).
2. Angle gating through a sin/cos comparator circuit that switches video to the output only for signals within a gated angular sector.
3. Generation of an audio output for the video signals or gated video signals.

The control/display unit also contains the CRT display circuits for the X-, Y-, and Z-axis video corresponding to signals received at the RF unit. The screen is calibrated in frequency for the three ranges: 7-11 GHz, 11-18 GHz, and 8.5-9.6 GHz when in the expand mode.

(U) The AN/WLR-1C marker strobe indicates on the AN/WLR-11A display the frequency to which the AN/WLR-1C (band 9 only) is tuned. As the AN/WLR-1C frequency is tuned, the mark strobe (a bright radial line) rotates on the IFM polar display. When the mark

is superimposed on a signal, the AN/WLR-1C is tuned to that signal with no set-on error. The AN/WLR-1C MARK is then set to OFF, and signal measurements (pulse width, PRF, DF, and scan rate) can be made using the IP-480C/WLR-1 Pulse Analyzer.

### WIDEBAND RECEIVERS

(U) Wideband or direct detection receivers simultaneously intercept all signals within the full range of the receiver frequency coverage and within the intercept limits of their intercept antenna. The use of channelized crystal video receivers will permit higher sensitivities to be obtained and will permit detection to be defined to more specific areas in the band. A different version of the wide-open receiver that is proving to be quite valuable is the Instantaneous Frequency Measuring (IFM) receiver system. This system not only provides both wide and narrowband reception capabilities, but permits instantaneous read-out and storage of the frequency parameters. These receivers can



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provide an audio or video warning of signal activity within their frequency range.

(U) Wideband receivers have a high signal detection probability over a broad portion of the spectrum. They frequently are used in conjunction with narrowband receivers to provide increased signal detection probability over a broad frequency range while the narrowband receiver provides effective signal analysis. Other advantages of this type of receiver include simplicity, light weight, and compactness.

(U) Wide-open receivers are relatively ineffective in environments with a high signal density since they have a poor signal

discrimination capability. Care must be exercised in the operation of wide-open receivers in the presence of high intensity radiations. If they are not blanked during own ship's high powered emissions, they are susceptible to receiver overloading and consequent crystal failure.

**AN/WLR-3**

(C) The wideband countermeasures receiving set AN/WLR-3, a representative equipment, is designed to detect and amplify pulsed type signals within the 2300-11,000 MHz frequency range. A functional block diagram of the receiver is shown in figure 4-37.

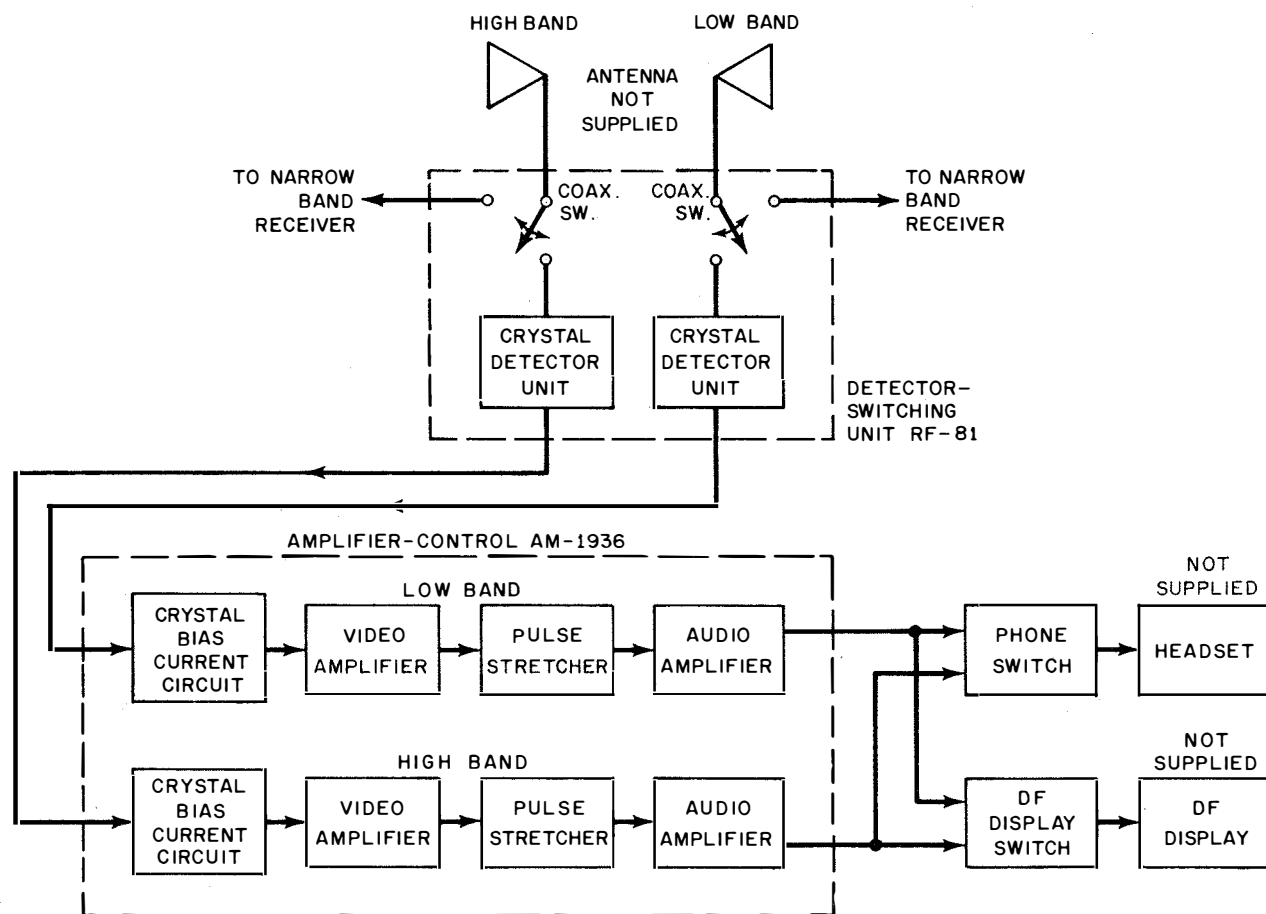


Figure 4-37.—(U) Functional block diagram of a wide-band receiver (U).

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(C) A pulsed signal is intercepted by either the low-band (2300-5200 MHz) or high-band (4800-11,000 MHz) antenna. Each antenna is connected to a detector-switching unit RF-81 where the received signal is either switched to the narrowband receiver for normal operation or switched to the wideband receiver. When switched to the wideband receiver, the signal is detected by one of the two coupler detectors (depending on whether the signal is in the high band or low band) located in the detector switching unit RF-81, and fed into one of two video channels located in the amplifier-control AM-1936. Here the signal is amplified, made audible, further amplified and delivered to a set of headphones for audio presentation. In addition, the output is connected to a panel jack for connection to the DF display of the narrowband receiver (IP-480).

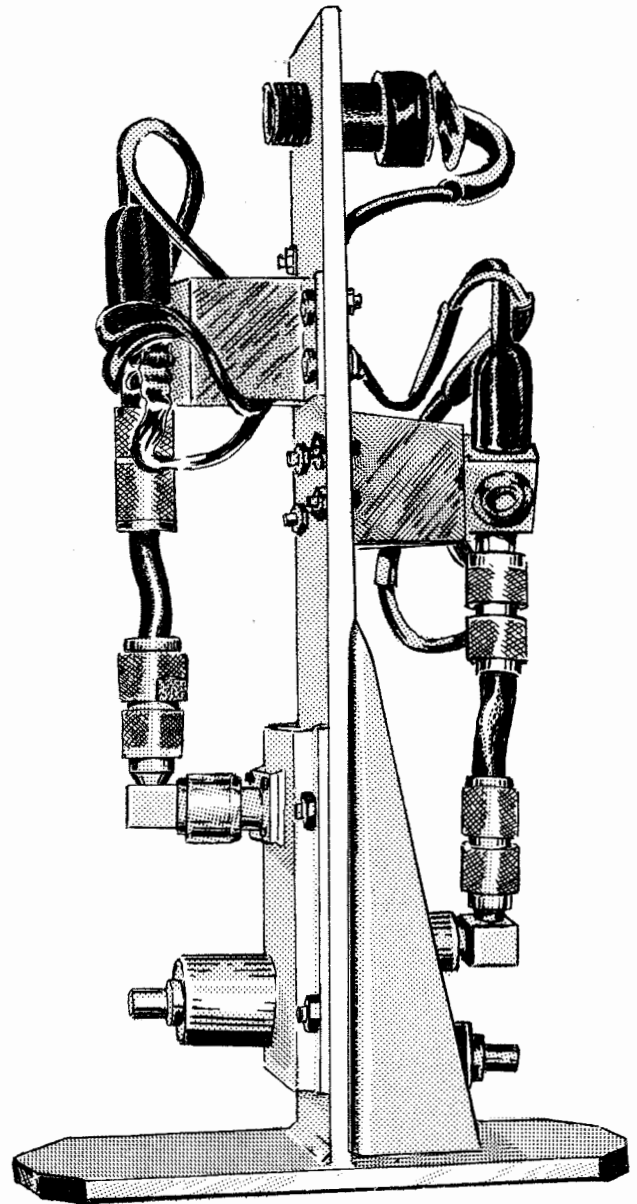
#### Description of Units

(C) The detector switching unit RF-81 (see figure 4-38) consists of two crystal video detecting arrangements together with two solenoid-operated coaxial switches to permit use with other receiving equipment.

(C) The amplifier control AM-1936 (see figure 4-39) consists of two identical video amplifier channels identified as high band and low band, in addition to a power supply. Each video amplifier channel consists of a video amplifier, pulse stretching circuit, and an audio amplifier.

(C) The front panel contains all the operating controls in addition to the phone jack J 107 and DF output connector J 105. The panel is illuminated by means of red filters and controlled by dimmer control R 144.

(C) The power supply operates from a 115-volt a.c. primary power source which is comprised of a high-voltage fullwave rectifier circuit with associated filters for supplying the 260-volt d.c. potential, plus two separate filament windings, one for the rectifier tube in the high-voltage supply and one for the



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Figure 4-38.—(U) Detector switching unit RF-81 (U).

filaments of the two video amplifier channel tubes.

(C) In addition, a fourth winding is used to supply a fullwave bridge-type selenium rectifier circuit with associated filters to obtain a 27-volt

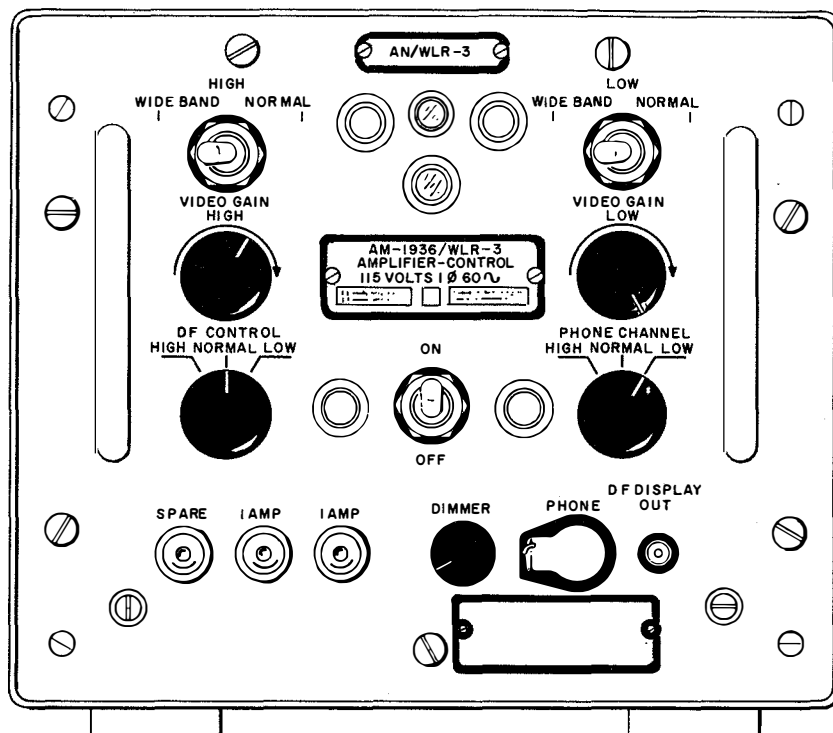
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Figure 4-39.—(C) Amplifier control AM-1936 (C).

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d.c. output. This voltage is used to operate the solenoid-operated coaxial switches in the detector-switching unit.

### Operation

(C) Operation of the equipment is controlled by switching operations performed at the amplifier-control AM-1936. (See figure 4-39.)

(C) **LOW WIDE BAND NORMAL.**—The low-channel switch has two extreme positions. The **WIDE BAND** position operates the proper coaxial switch located in the detector-switching unit RF-81 to connect the low-band antenna to the receiver set. The **NORMAL** position operates the coaxial switch to provide connections of the antenna to the narrowband receiver.

(C) **HIGH WIDE BAND NORMAL.**—The high-channel toggle switch operates the coaxial

switch and performs the same function for the high-channel as the switch described for the low-channel. In the **WIDE BAND** position, the high-channel antenna is connected to the wideband receiving set and the **NORMAL** position connects the antenna to the narrowband receiver.

(C) **VIDEO GAIN LOW.**—The video gain low control regulates the amount of signal delivered to the low-channel amplifier. This control should normally be set to maximum and reduced for strong signals.

(C) **PHONE CHANNEL SWITCH.**—The phone channel switch is a three-position rotary switch (**HIGH**, **BOTH**, **LOW**). The **HIGH** and the **LOW** positions connect the audio signal of the high-channel and low-channel amplifiers, respectively, to the phone jack. The **BOTH**

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position connects signals from both amplifiers to the jack.

(C) DF CONTROL SWITCH.—The DF control switch is a three-position rotary switch (HIGH, NORMAL, LOW). The HIGH and LOW positions connect the audio signal of the high-channel and low-channel amplifiers, respectively, to an external DF display, a part of the narrowband receiver. Although the NORMAL position of the switch has an electrical connection, it is an open position, denoting that the receiver is in normal operation.

(C) ON-OFF.—The ON-OFF toggle switch controls the primary power source and switches the equipment on or off.

(C) PRE-OPERATIONAL CHECKS.—Before turning on the power to the amplifier control AM-1936 be sure that the following switches are set in the positions indicated. If they are not so set, there is danger of injuring the equipment.

<u>SWITCHES</u>	<u>SETTINGS</u>
HIGH WIDEBAND NORMAL	WIDEBAND
LOW WIDEBAND NORMAL	WIDEBAND
VIDEO GAIN HIGH	MAXIMUM CLOCKWISE
VIDEO GAIN LOW	MAXIMUM CLOCKWISE
DF CONTROL	NORMAL
ON OFF	OFF

(C) To place the equipment in operation, turn the ON-OFF switch to ON. Adjust the VIDEO GAIN control until a comfortable level of background noise is heard in the headset. The presence of background noise is an indication that the equipment is operating. When strong signals are detected keep the audio level at a low

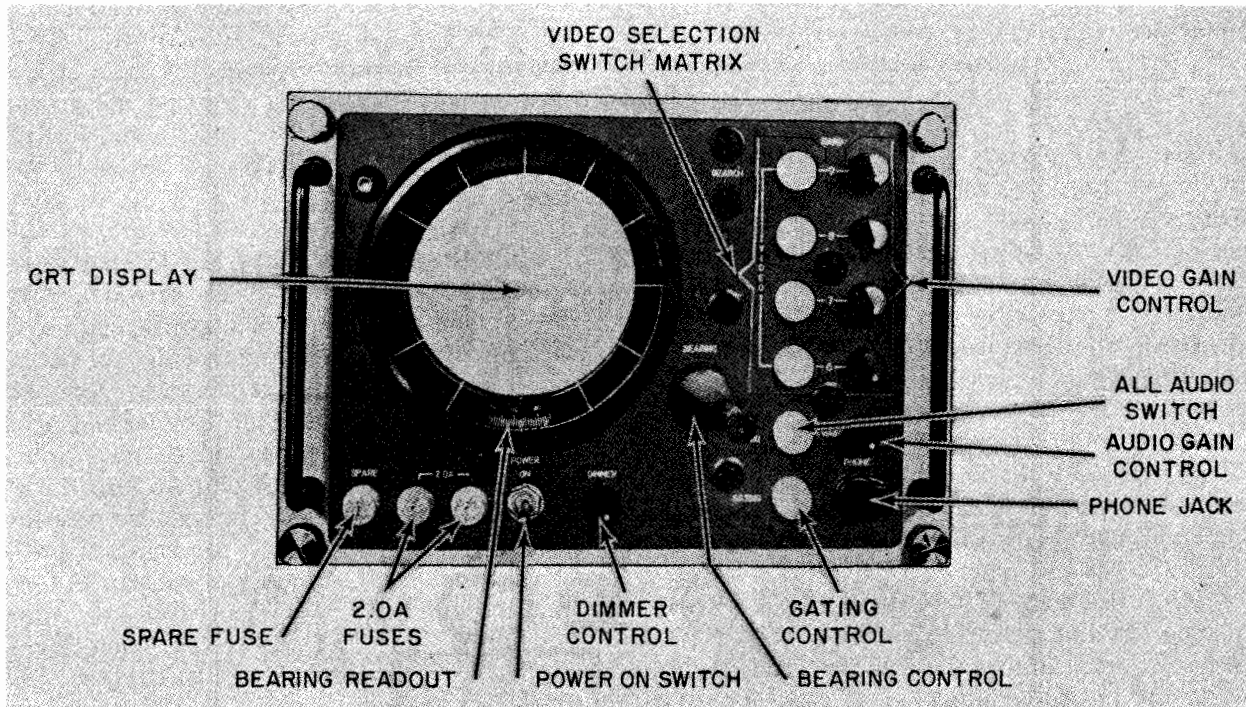
setting to prevent crosstalk between channels. To stop the equipment, turn off the ON-OFF switch.

#### WIDEBAND COUNTER- MEASURES RECEIVING SET AM-4255

(C) Amplifier control AM-4255 (figure 4-40) is an electronic unit which provides a visual display and an audio signal which relate to both the concurrent bearing and intelligence of one or more RF signals being received by a shipboard direction-finding antenna. The visual display consists of a PPI-type video trace on the calibrated face of a CRT, located on the front panel of the AM-4255. The angular position of the CRT trace is slaved to the azimuth position of the direction-finding antenna; hence, bearing (relative or true) is presented by the angular position of the CRT trace. The audio signal is applied to a headset (phone) jack located on the unit's front panel.

(C) The AM-4255 functions in conjunction with other countermeasures DF equipment such as the AS-899 antenna, control indicator C-3118, amplifier assembly AM-4891, Mk 7 Mod (O) synchro amplifier, and a special receiver. RF signals received by the antenna are detected in the AM-4891 and supplied as video signals to the AM-4255 for CRT display and audio output. Synchro data, relating to true or relative antenna bearing, is supplied via the C-3118 control indicator to the AM-4255 for controlling the angular position of the CRT trace. When true bearing synchro data is to be supplied to the AM-4255, the relative bearing data supplied the C-3118 from the antenna is converted to true bearing data by the Mk 7 Mod (O) synchro amplifier. The third input signal to the AM-4255 is the gating signal supplied by a special receiver. This gating signal allows the AM-4255 to present only selected signals from the AM-4891 amplifier assembly.

(C) The DF system in figure 4-41 operates over the 1 GHz to 10.75 GHz spectrum. This frequency spectrum is divided by the equipment into four bands, designed as bands 6 (1.00 to 2.60 GHz), 7 (2.30 to 4.45 GHz), 8 (4.30 to 7.35 GHz), and 9 (7.05 to 10.75 GHz). To permit the separate processing of each of these

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Figure 4-40.—(U) Amplifier control AM-4255, controls and indicators (U).

bands, the AM-4255 contains four identical and independent channels. By means of the front panel controls, the input bands may be individually monitored, collectively monitored, or monitored in any desired combination. The types of monitoring are as follows: (1) one or more bands may be selected for simultaneous audio and video presentation, (2) all bands may be selected for simultaneous audio and video presentation, or (3) all bands may be presented as audio while only selected bands are presented as video.

#### Operating Controls and Indicators

(C) Various controls and indicators and their functions are shown below.

Control or Indicator	Function
POWER ON switch	Controls the application of 115 vac, single-phase 60-Hz power to the AM-4255.

#### Control or Indicator

#### Function

CRT	Displays the true or relative bearing signals.
VIDEO BAND selection switch matrix	Selects for monitoring any combination of one or more band signals; both audio and video signals are monitored for each switch selected.
VIDEO gain controls	Individually controls gain of the four video amplifiers.
ALL AUDIO switch	Allows an audio output of all bands through the headset.
AUDIO GAIN control	Controls the gain of the audio output.
GATING switch	Allows selected signals to be monitored when they are gated by a special receiver.

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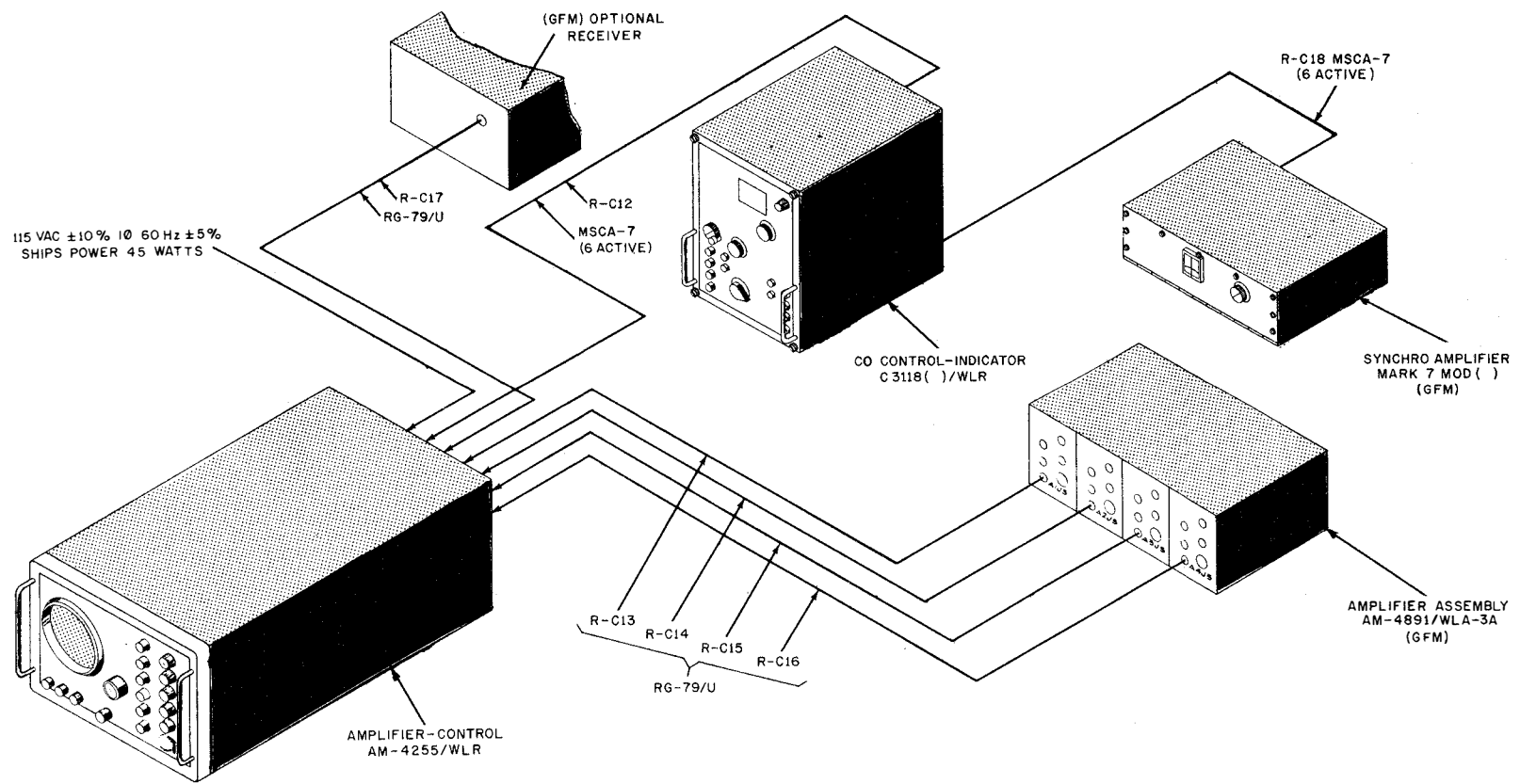


Figure 4-41.—(U) Amplifier control AM-4255, with associated equipment (U).

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<u>Control or Indicator</u>	<u>Function</u>
PHONE jack	Receptacle for male plug 600-ohm headset.
BEARING control	Simultaneously positions the bearing indicator and rotates the cursor on the CRT face.
DIMMER control	Controls the illumination of the edge and switch lights.

**Sequence of Operation**

(C) In order to operate the AM-4255, the associated equipment must first be set up. Perform the following steps in the sequence of their presentation:

1. Set up preamplifier front panel controls as follows:

- A. Set the Power Switch to ON.
- B. Set all DIR-AMPL switches to AMPL.

2. Set up the control-indicator controls as follows:

- A. Set the Power Switch to ON.
- B. Set the Antenna Selector to C.
- C. Set the HORZ-VERT switch to either position.
- D. Set the TRUE-REL switch to REL.
- E. Select Automatic Control mode.
- F. Set the SPEED control for approximately 200 rpm.

3. Set up the narrowband receiver by setting its ANTENNA SELECTOR to DF.

4. Operate the AM-4255 as follows:

- A. Plug in headset at the phone jack.
- B. Set the POWER ON switch to ON.
- C. Turn all video and audio gain controls fully clockwise.

D. Refer to the bands described above, and activate the VIDEO BAND switches that correspond to the frequency or frequencies to be represented on the CRT and at the phone jack.

(NOTE: When none of the video band switches are activated (none lit), the search mode is automatically selected. In this mode, the SEARCH indicator lights and all video and audio bands are represented at the CRT and phone jack. The results are identical to those obtained when all four video band switches are activated.)

E. If the gating mode is desired, actuate the GATING switch (pushbutton lit). In this mode, only selected signals are displayed.

F. Rotate DIMMER control for desired panel illumination.

G. If in the search mode the frequency band of a particular displayed signal is desired to be known, successively actuate and deactuate the video band switches while watching the CRT. The signal in question will only be displayed when the video band switch associated with the signal frequency has been actuated.

(NOTE: Due to an overlap in the frequency bands, a signal in an overlap region will be displayed by the actuation of two video band switches.)

H. If the signal in question extends off the CRT screen, rotate the associated VIDEO gain control counterclockwise until the entire signal is displayed.

I. Rotate the bearing crank until the cursor is positioned to bisect the displayed signal, then read the signal bearing on the calibrated scale in the notch at the bottom of the CRT bezel.

J. If it is desired to listen to all bands simultaneously, actuate the ALL AUDIO switch.

### **WIDEBAND COUNTER- MEASURES RECEIVING SET SLR-12**

(C) The wideband countermeasures receiving set SLR-12 provides for intercepting and locating the direction of pulse signals in the frequency range of 11 to 16 GHz. It may be used with external equipment to analyze the characteristics of the intercepted signals, such as pulse width and repetition rate. The system, which is intended for shipboard use, consists of

three units: a mast-mounted antenna assembly, servoamplifier, and control-indicator unit. The latter two are installed below decks. Direction finding (DF) information is displayed on a CRT in a polar-type presentation. The DF display may be either true or relative.

(C) There are three control modes available for the antenna. It operates in spin mode, with rotational speeds of from 20 to 300 rpm in either a clockwise or counterclockwise direction. It may operate in auto-stop mode, which is similar to the spin mode but the antenna rotates

more slowly and stops automatically when a signal is received; or the antenna also may operate in a manual mode, wherein it follows the rotation of a handcrank on the control-indicator unit.

(C) The system is a crystal video set which, due to its wide band characteristics, facilitates the rapid detection of signals.

**Description of Units**

(C) Figure 4-42 illustrates the three component units of the receiving set.

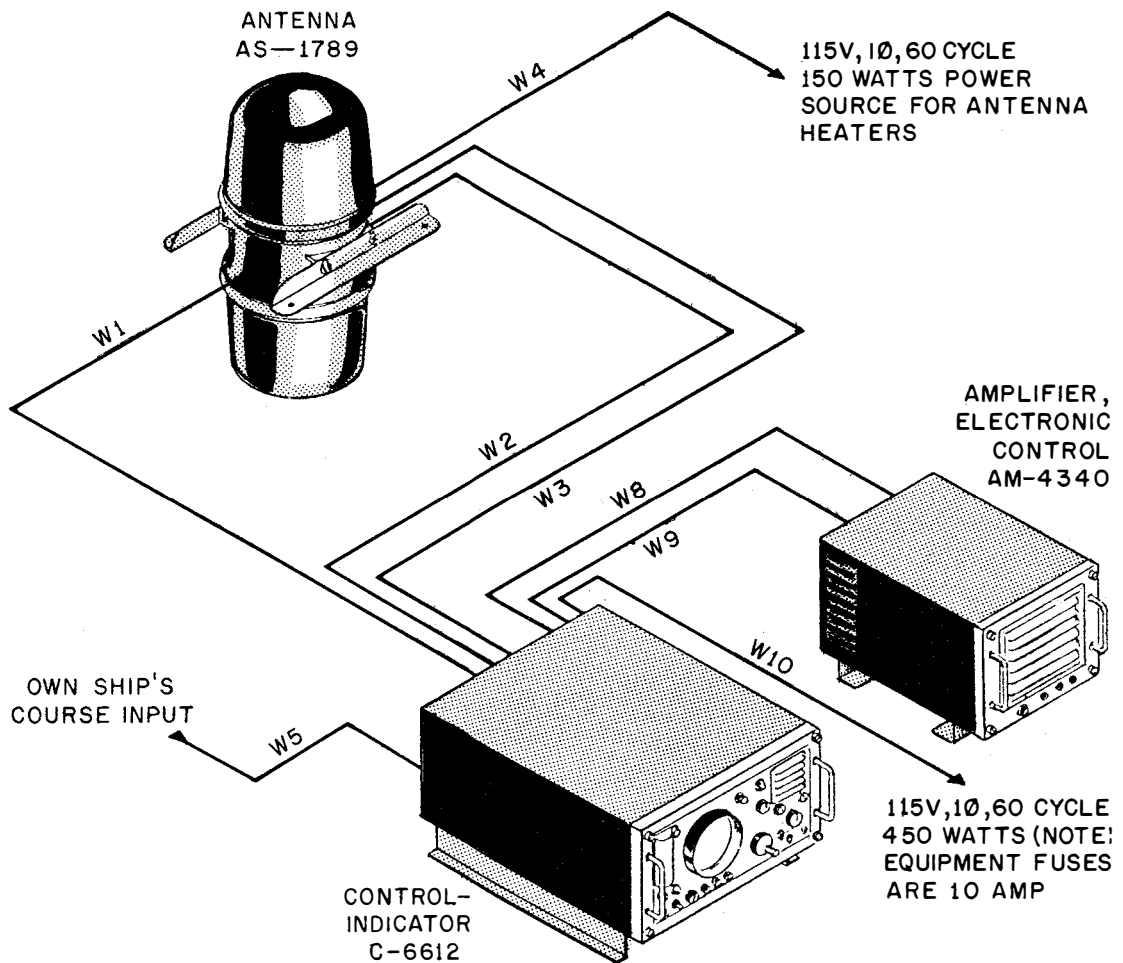


Figure 4-42.—(C) Receiving set, countermeasures AN/SLR-12, relationship of units (C).

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(C) CONTROL-INDICATOR C-6612.—The front panel of control-indicator unit C-6612 contains all the controls used by the operator in selecting the operating mode for the DF antenna, for properly presenting the display on the CRT, and for determining the bearing of the intercepted signal. Video pulse signals for analysis by external equipment are obtained from this unit.

(C) AMPLIFIER, ELECTRONIC CONTROL AM-4340.—The electronic control amplifier AM-4340 has no operating controls. In it is developed the power to drive the antenna servomotor.

(C) ANTENNA AS-1789.—The antenna assembly is mast-mounted and includes the rotatable DF antenna with right and left circularly polarized RF outputs, crystal video

receiver circuitry following the two RF outputs, antenna drive system including synchros for position transmission to the control-indicator unit, and test source used to check system performance.

### Operating Controls and Indicators

(C) Various operating controls and indicators and their functions are shown below; for their locations see figure 4-43.

<u>Controls and Indicators</u>	<u>Function</u>
POWER ON switch	Controls the primary power to all units except heater power to the antenna.

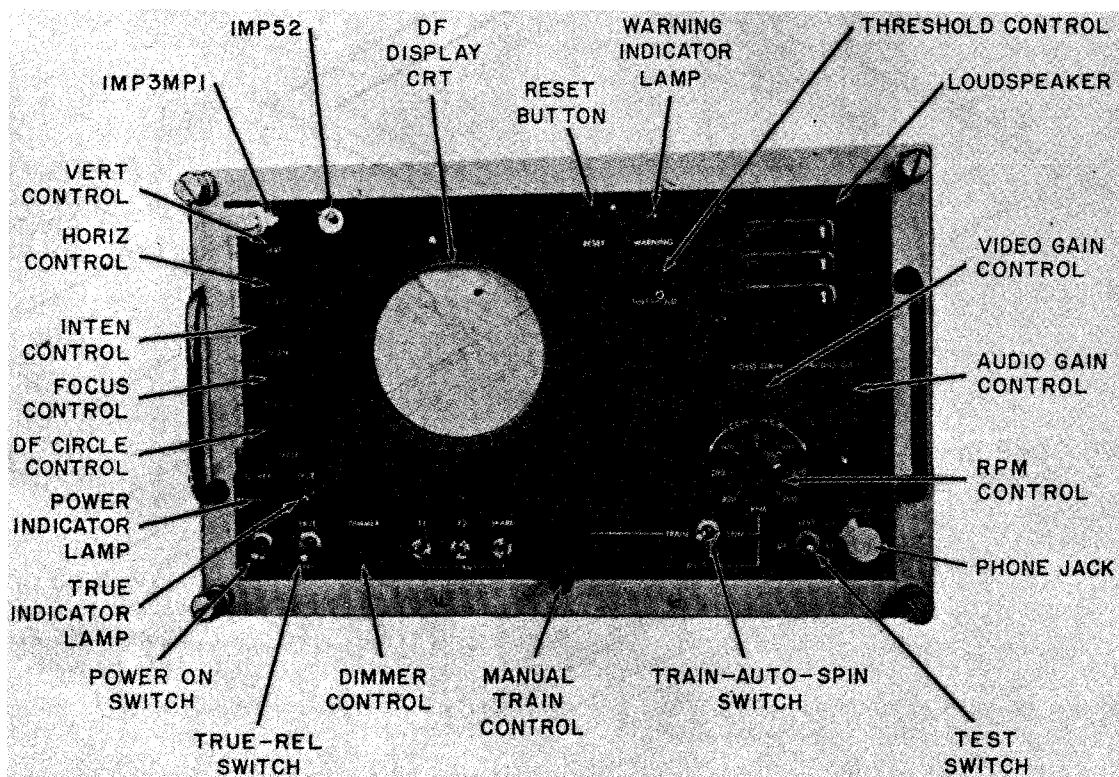


Figure 4-43.—(C) Control-indicator, location of controls (C).

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<u>Controls and Indicators</u>	<u>Function</u>	<u>Controls and Indicators</u>	<u>Function</u>
POWER indicator lamp	Lights when the power switch is ON and all interlocks are closed.	Manual TRAIN control	In manual train control, a hand crank may be used to position antenna or track a moving signal source.
DIMMER control	Adjusts intensity of illumination of front panel of the control-indicator.	VIDEO GAIN control	Adjusts the amplitude or trace length of the received signal shown on the DF display CRT.
WARNING indicator lamp	Indicates that a signal is being received by the set.	AUDIO GAIN control	Adjusts amplitude of the audio intercepted pulse rate signal heard either through the internal loud-speaker or through the external earphones.
RESET button	When depressed, momentarily extinguishes the WARNING light.	PHONE jack	Earphones may be plugged into jack to listen to audio intercepted pulse rate information; when phones are plugged into jack, internal speakers are disconnected.
THRESH-OLD control	May be adjusted to select the level of input signal that will cause WARNING indicator to light.	TRUE-REL switch	Selects true or relative bearing to be displayed.
INTEN control	Adjusts the intensity or brightness of display on CRT.	TRUE indicator lamp	Lights only when in the TRUE position and true bearing information is being fed into the system.
FOCUS control	Adjusts to attain proper focus of display on CRT.	TEST switch	This switch is a three-position, spring-loaded toggle switch, and must be held in either the RF or DF position. In the center position no contact is made. When in the RF position, a pulsed RF signal of known frequency, pulse rate, pulse width, amplitude, and azimuth is applied to the antenna for test purposes. When in the DF position, a pulsed video signal of known pulse rate, pulse width, and amplitude, but independent of antenna bearing, is applied to the video portion of the system. The purpose is primarily for DF CIRCLE alignment, but troubleshooting information concerning the RF section of the system may be obtained when used in conjunction with the RF position of the switch.
VERT centering control	Adjusts vertical centering of the CRT display.		
HORIZ centering control	Adjusts horizontal centering of the CRT display.		
DF display CRT	Displays the antenna beam pattern for each intercepted signal. DF information obtained by manually setting cursor on CRT to bisect displayed lobe to indicate azimuth of selected signal.		
DF CIRCLE control	Adjusts vertical sensitivity to equal horizontal sensitivity of CRT.		
TRAIN-AUTO-SPIN switch	Selects operation mode of antenna.		
RPM control	May be adjusted to govern rotational speed of antenna.		

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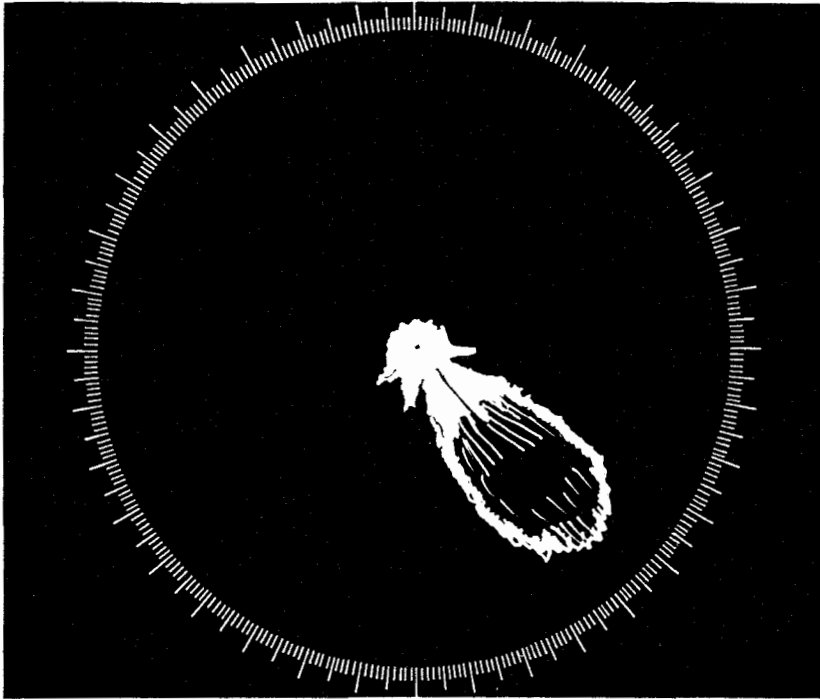


Figure 4-44.—(C) Typical display with antenna in spin mode (C).

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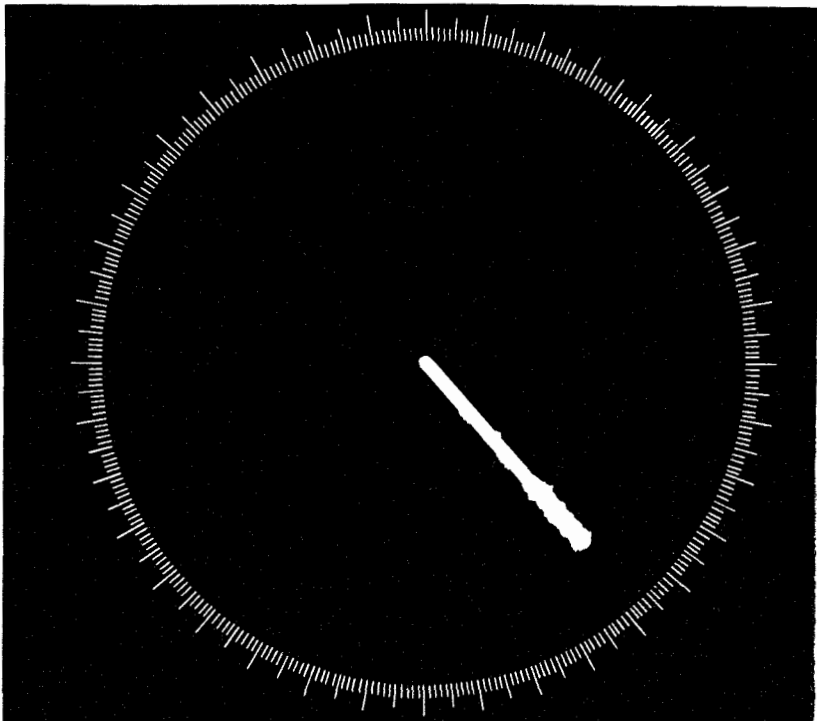


Figure 4-45.—(C) Typical display with antenna in train mode (C).

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**Equipment Operation**

(C) To operate the equipment select the desired mode of antenna operation, (TRAIN, AUTO, or SPIN). If TRAIN is chosen the antenna will follow the motion of the manual TRAIN handcrank. If SPIN is chosen the antenna will spin in a direction and at a rate determined by the RPM control which is adjustable from 20 to 300 rpm. If AUTO is chosen the antenna will spin in a direction determined by the RPM control, at a rate equal to 1/10 of the indicated spin speed, and will stop automatically when a signal is intercepted.

(C) The WARNING indicator lights when a signal is received by the system. Observing the CRT, adjust the VIDEO GAIN control for adequate pattern size of the received signal. Adjust the AUDIO GAIN control to make the audibility of the received pulses satisfactory to the operator.

(C) Direction finding can be performed with the antenna in either the SPIN or TRAIN mode. When the SPIN mode is selected, turn the manual TRAIN handcrank until the cursor bisects the signal pattern on the CRT. The cursor will indicate the bearing of the signal source on the azimuth dial around the CRT.

(NOTE: Care must be taken that the cursor bisects the main antenna lobe and not a minor lobe that will give a false bearing. The main lobe is the loop of maximum amplitude.)

When the TRAIN mode is selected, turn the manual TRAIN crank to produce the largest signal size on the CRT. Read the signal source bearing on the dial indicated by the cursor arrow. Bearings obtained are referenced either to true north or to the ship's heading, depending on whether the TRUE-REL switch is in the TRUE or REL position.

(NOTE: If the TRUE indicator lamp is not lighted, bearings obtained will be relative to the

ship's heading regardless of the position of the TRUE-REL switch.)

(C) For ease in locating a received signal on the CRT, the SPIN antenna mode is suggested. If external equipment is used with the system to analyze pulse width and repetition rate, the TRAIN mode should be used as it removes variables due to the antenna pattern characteristics. The AUTO mode should be used during periods when there are long time intervals in which no signals are received. In this mode of operation the warning lamp lights upon the receipt of a signal and the antenna stops rotating. When a signal is received, the operator may then switch to either the SPIN or TRAIN mode of operation, whichever is warranted by the existing conditions. The AUTO mode relieves the operator of tedious, continuous monitoring of the equipment during periods when few signals are received.

(C) Push the RESET button to make the warning light ready for another received signal. If the original signal is still capable of being intercepted, the warning light will not stay out when the RESET button is pushed.

(C) To secure the equipment, throw the POWER ON switch on the control-indicator to the OFF position. For emergency shut-down, throw the ship's power disconnect switch to OFF.

**Indicator Presentations**

(C) True or relative bearings of received signals are presented on the control-indicator front panel dial around the DF polar display CRT. Figure 4-44 shows a typical CRT presentation, including proper cursor setting for an intercepted signal with the antenna in the SPIN mode. Figure 4-45 displays the presentation to be expected with the antenna in the TRAIN mode. Figure 4-46 illustrates the results to be obtained in DF TEST when the CRT presentation controls, INTEN, FOCUS, VERT, HORIZ, and DF CIRCLE are properly adjusted. Figure 4-47 shows the results of improper adjustment of the DF CIRCLE.

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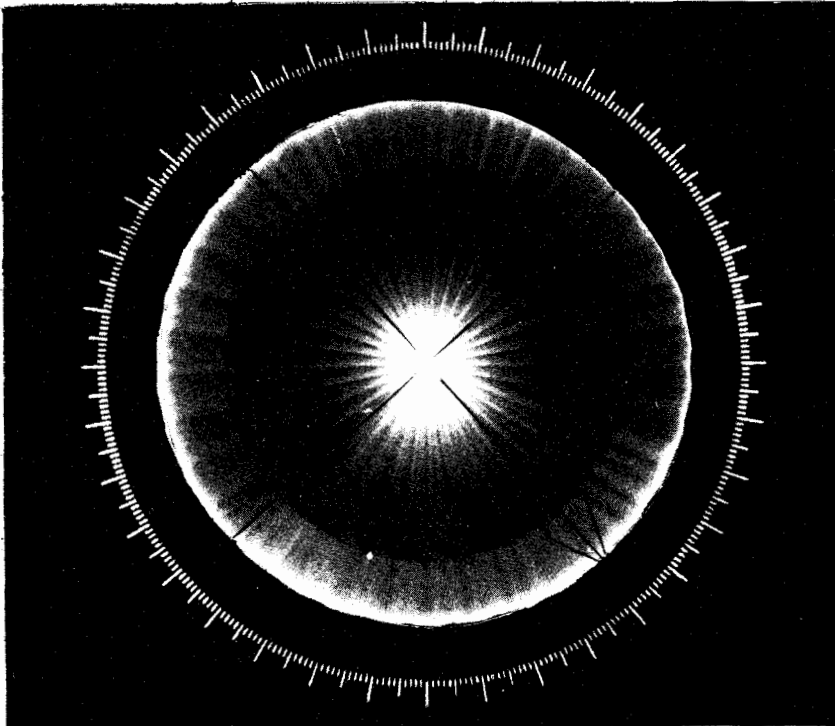


Figure 4-46.—(C) Proper DF circle adjustment (C).

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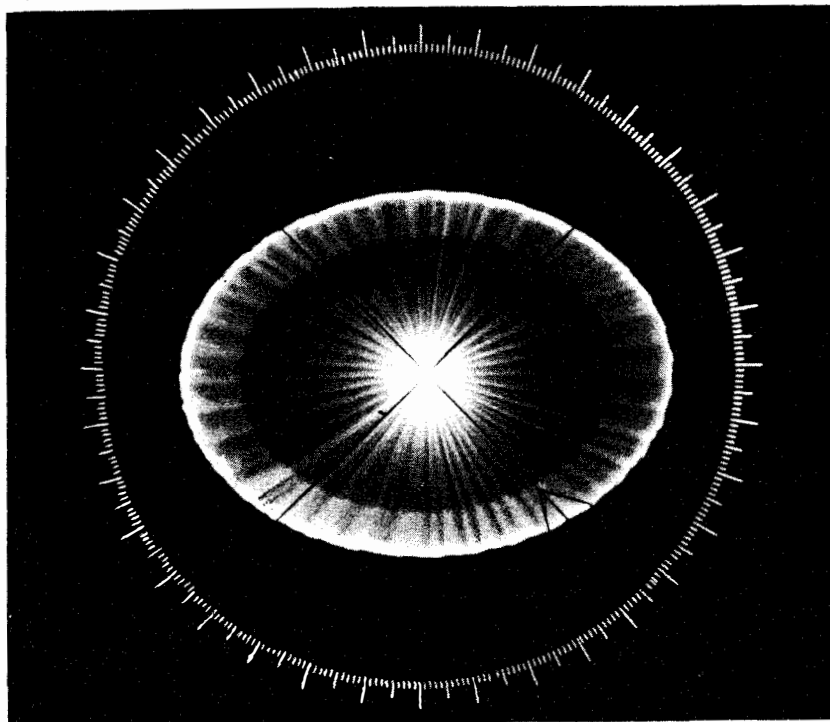


Figure 4-47.—(C) Improper DF circle adjustment (C).

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## CHAPTER 5

## ESM ANTENNAS AND CONTROL UNIT

The antenna assembly is an essential unit of any ESM installation. Most ESM antennas are constructed so that they cover a wide band of frequencies and possess different polarization characteristics.

Because enemy signals may appear over a very wide range of frequencies, the antennas used with ESM systems must necessarily be broad in frequency response. To ensure this response several different antennas are used.

Your ship may or may not have the types of antennas described in this chapter, however, most ships will have some of them in their ESM system.

## ANTENNAS

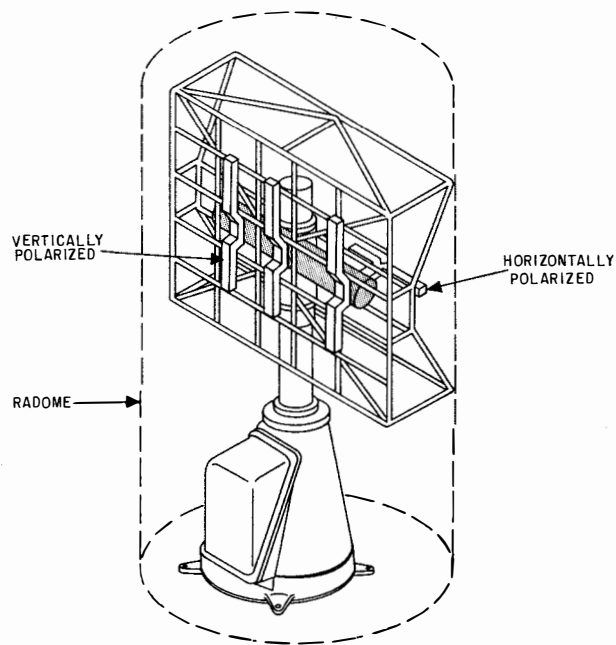
The following is a discussion of antennas that are used with ESM equipment. A brief description of some of their operating characteristics, capabilities, and frequency limitations is included for each type discussed.

## AS-571

The AS-571 Antenna shown in figure 5-1 is a directional, dual antenna assembly designed to receive both horizontally and vertically polarized signals in the frequency range of 300 to 600 MHz corresponding to band 4 of the narrowband receiver. The antenna is controlled by a C-3118 or C-1609A control-indicator and can be rotated clockwise at rates up to 250 rpm or it can be manually trained in either direction to any bearing.

The antenna consists of two principal antenna arrays (one horizontally and one vertically polarized) and one coaxial switch. The horizontally polarized array is back-to-back to the vertically polarized array. Either the vertical or horizontal arrays may be selected to receive signals. Switching between the horizontally and vertically polarized arrays is accomplished by the coaxial switch. Control of the switch, and thus polarization, is determined by the setting of the POLARIZATION switch on control-indicator C-3118 or C-1609A.

The entire antenna assembly is enclosed in a protective radome.



62.81(189)

Figure 5-1.—Antenna AS-571.

**UNCLASSIFIED****AS-616A**

Antenna AS-616A (figure 5-2) is a directional, multiple antenna assembly designed to receive both horizontally and vertically polarized signals in the frequency range of 500 to 2400 MHz corresponding to bands 5 and 6 of the narrowband receiver. The antenna is controlled by antenna control-indicator C-3118 or C-1609A and can be rotated clockwise at rates up to 250 rpm or it can be trained manually in either direction to any bearing.

The antenna consists of four principal antenna units (one horizontally polarized and one vertically polarized unit for each of the two channels), two coaxial switches, and six coaxial transformers. The horizontally polarized units are back-to-back to the vertically polarized units and combine to form two major RF channels. The low frequency channel covers from 500 to 1100 MHz and the high frequency channel covers from 1000 to 2400 MHz. Each channel is connected to a single coaxial transmission line.

Switching between the horizontally and vertically polarized units is accomplished by

the coaxial switches. Control of the switches, and thus polarization, is determined by the setting of the POLARIZATION switch on control-indicator C-3118 or C-1609A. The coaxial transformers provide impedance matching between the numerous antenna elements and the single coaxial output transmission line of each channel.

The entire antenna assembly is enclosed in a protective radome.

**AS-899 Series**

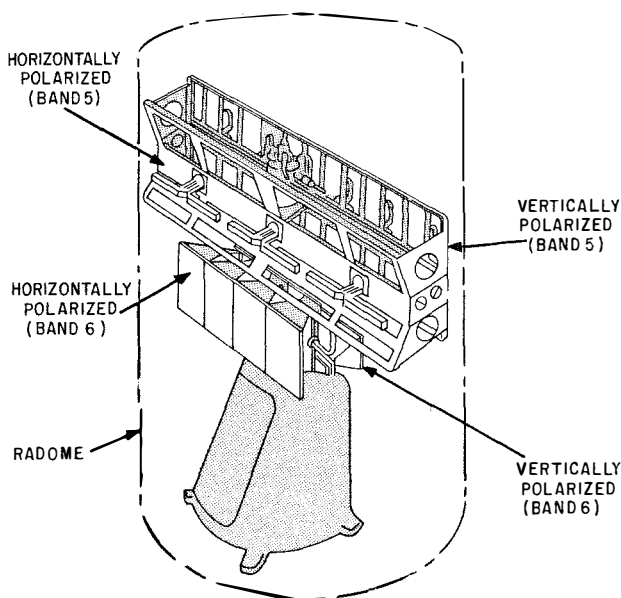
Antenna AS-899A is identical to AS-899 except for minor differences in the drive mechanism and for its four video crystal detectors (the AS-899 has one) which divide the frequency range into four overlapping bands. Amplifying information on these differences can be found in the appropriate technical manuals. Antenna AS-899 (figure 5-3) is a circularly-polarized, high-gain DF antenna covering the frequency range of 1000 to 12,000 MHz in four channels. This covers bands 6, 7, 8, and 9 of the narrowband receiver described in the preceding chapter. In addition to the RF outputs from the antenna provided for transmission to the narrowband receiver, there is also a video output from each channel which is used by the first wideband receiver described.

The antenna uses four bi-circularly polarized coaxial horns that cover the frequency range. The horns are mounted concentrically in two pairs; one assembly for bands 6 and 7 and the other assembly for bands 8 and 9.

The two lower-frequency horns point upward from the pedestal; the two high-frequency horns point downward from the top of the fiberglass radome. Both horn assemblies are stationary and are on the same vertical axis.

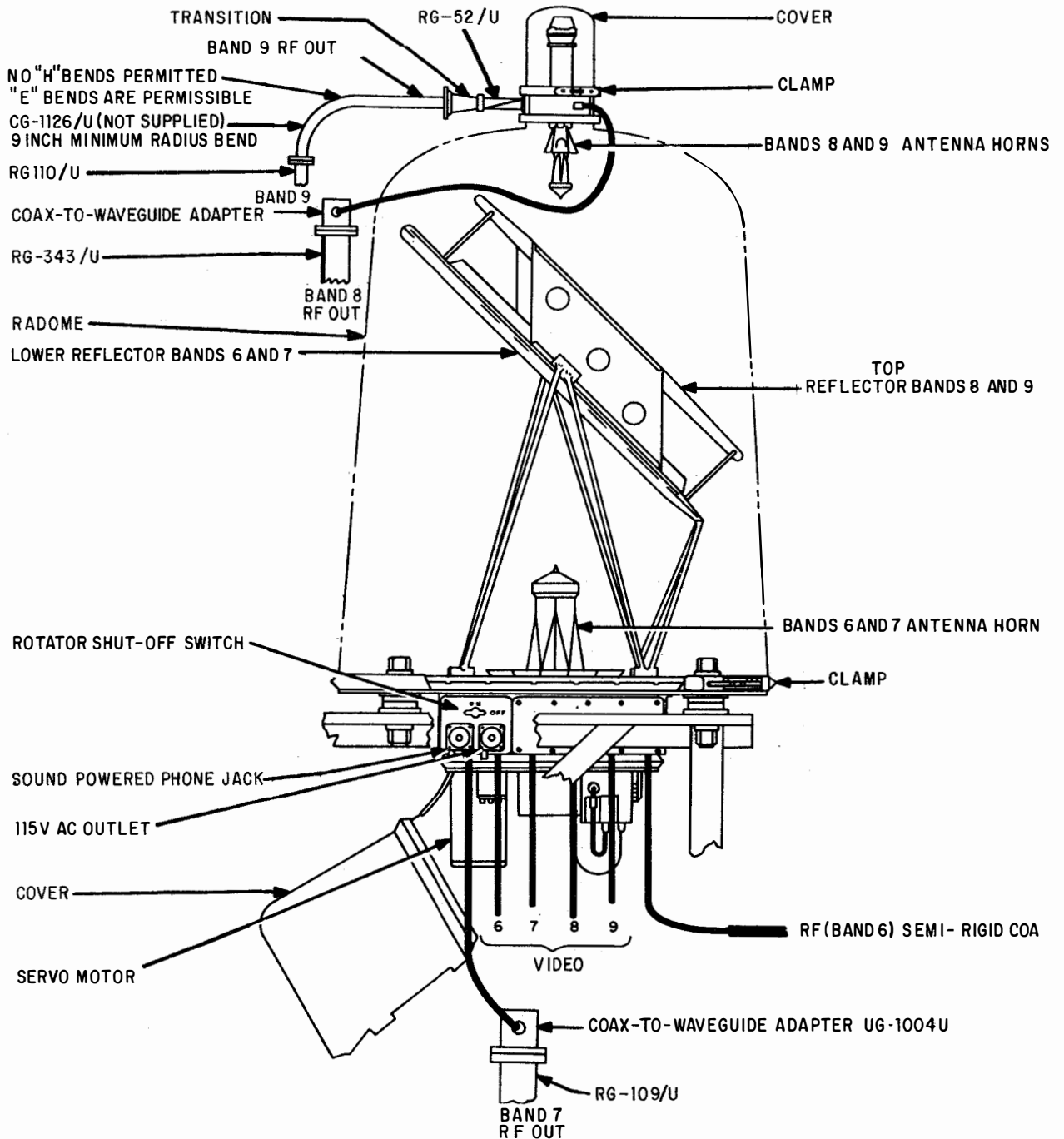
Each of the four horns has two RF outputs. One RF output from each horn feeds the narrowband receiver; the other set of RF outputs is applied to four internal crystal detector units which deliver a video output from each channel to the wideband receiver.

Back-to-back 360° rotating reflectors are mounted between the horn assemblies at a 45° angle with the axis going through the focal points of the horns. The 45° tilt allows



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Figure 5-2.—Antenna AS-616A.



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Figure 5-3.—Antenna assembly AS-899 and AS-899A.

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reception of vertically and horizontally polarized signals and the concentric shape permits reception of circularly polarized signals.

The rotation of the back-to-back reflectors is controlled by antenna control-indicator C-3118 or C-1609A and may be rotated clockwise at any rate from zero to 300 rpm or manually trained in either direction to any bearing. Because the two reflectors are mounted back-to-back, you have to make a 180° bearing correction when shifting operations from bands 6 or 7 to bands 8 or 9 and vice versa, in order to get an accurate signal bearing determination. On antenna control-indicator C-3118 or C-1609A this shift is accomplished by means of the POLARIZATION switch.

Antenna assembly AS-899F/SLR is a direction-finding antenna designed to receive RF signals in the frequency range of 1 to 20 GHz. Figure 5-4 illustrates the functional position of the antenna assembly in relation to associated controls, analysis, and early warning equipment. The signal analysis set is the countermeasures receiving set AN/WLR-1C. The associated control equipment consists of control-indicator C-3118/SLR and magnetic control amplifier AM-1017B/SLR. The four functional sections of antenna assembly AS-899F/SLR are RF, drive, heater, and synchro.

### RF Assembly

The RF section of the antenna consists of a shaped-beam reflector, broadband spiral antenna, and associated cables and connectors. The shaped-beam reflector is especially designed to provide coverage over a minimum of 20° in elevation, independent of frequency. The energy received by this reflector is focused on a broad-band spiral feed covering the frequency range from 1 to 20 GHz. (The spiral antenna is fixed while the reflector assembly rotates.) This energy is fed to a multiplexer which provides outputs for bands 6, 7, 8, 9, and 10 of countermeasures receiving set AN/WLR-1C. The received energy is then routed to output connectors via semi-rigid coaxial cables. Coaxial output connectors are provided for each band, except for bands 9 and 10, which are waveguide outputs.

### Drive Assembly

Power to orient or spin reflectors of the antenna for signal tracking or search functions is provided by a 100-watt two-phase servomotor. A.C. power for the servomotor is normally supplied by the magnetic control amplifier and controlled by the control-indicator. The reference phase of the servomotor is connected directly to the 115-volt a.c. ship power lines; the control phase is supplied with voltage of the proper magnitude and phase for the servomotor speed and velocity desired through the action of the control-indicator and the magnetic control amplifier. Refer to applicable technical manuals for the detailed theory of operation of the servomotor power control circuitry in the control-indicator and magnetic control amplifier.

### Heater Assembly

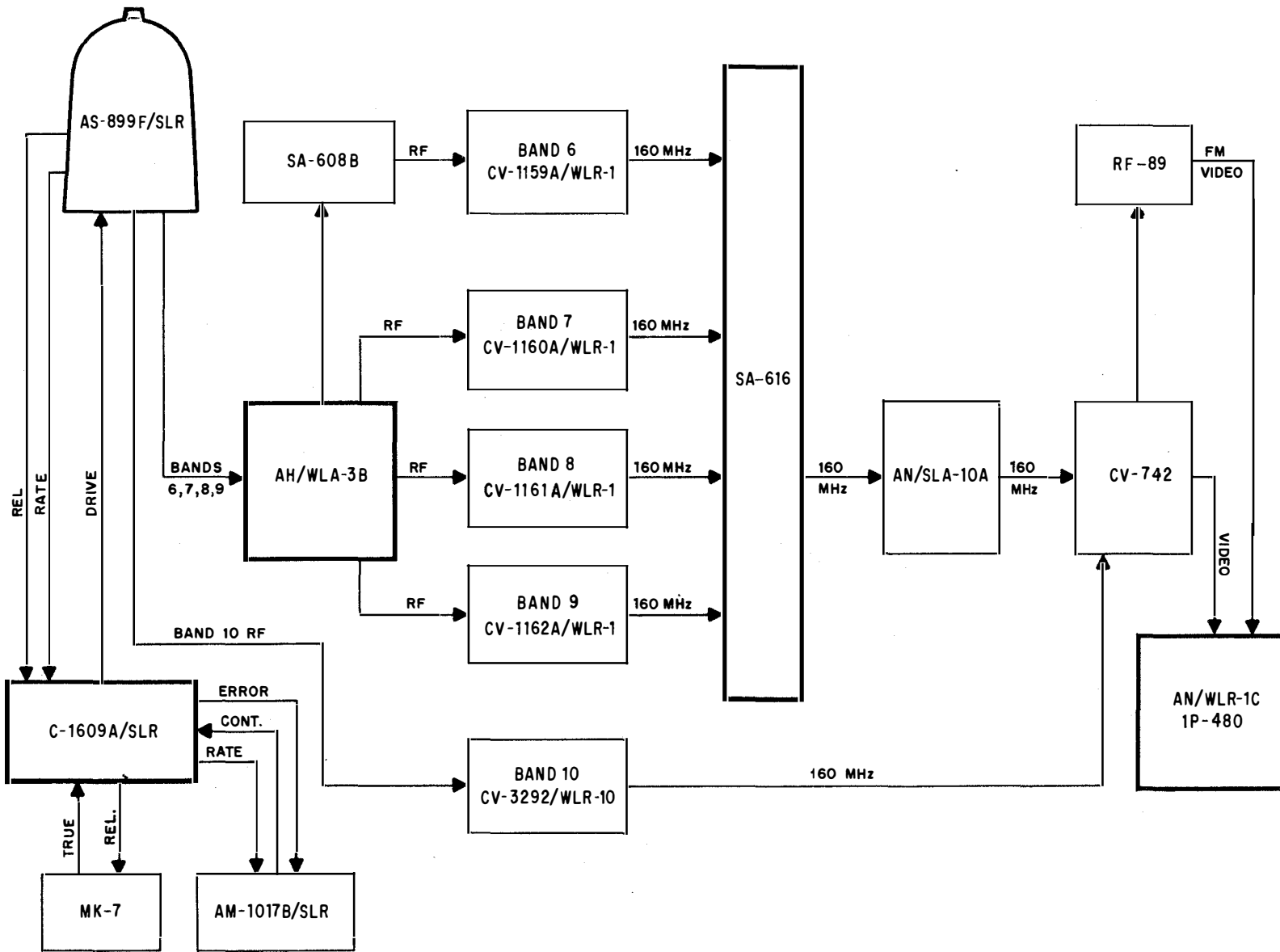
Two 150-watt space heater elements are installed in the antenna. Both are mounted on the bottom of the reflector housing base. A thermostatic control switch is installed in the bottom of the reflector housing base to apply power to the heaters when ambient temperature drops below 43° C (110° F). These heaters maintain a uniform temperature in the interiors of the pedestal and top cap which helps to prevent condensation and keeps the lubricants and components at the proper operating temperature.

### Synchro Assembly

Antenna bearing data are developed by a synchro transmitter and are directed to the control-indicator and signal analyzer set. The synchro transmitter rotor is supplied by a 115-volt a.c. reference phase of primary power and is geared to the reflector assembly. The stator windings of this synchro develop voltages representative of reflector position. In control-indicator C-3118/SLR these voltages are combined to yield bearing information. Circuits in the control-indicator also take care of the bearing reversal between the upper and lower bands of the antenna assembly due to the back-to-back reflector mounting arrangement.

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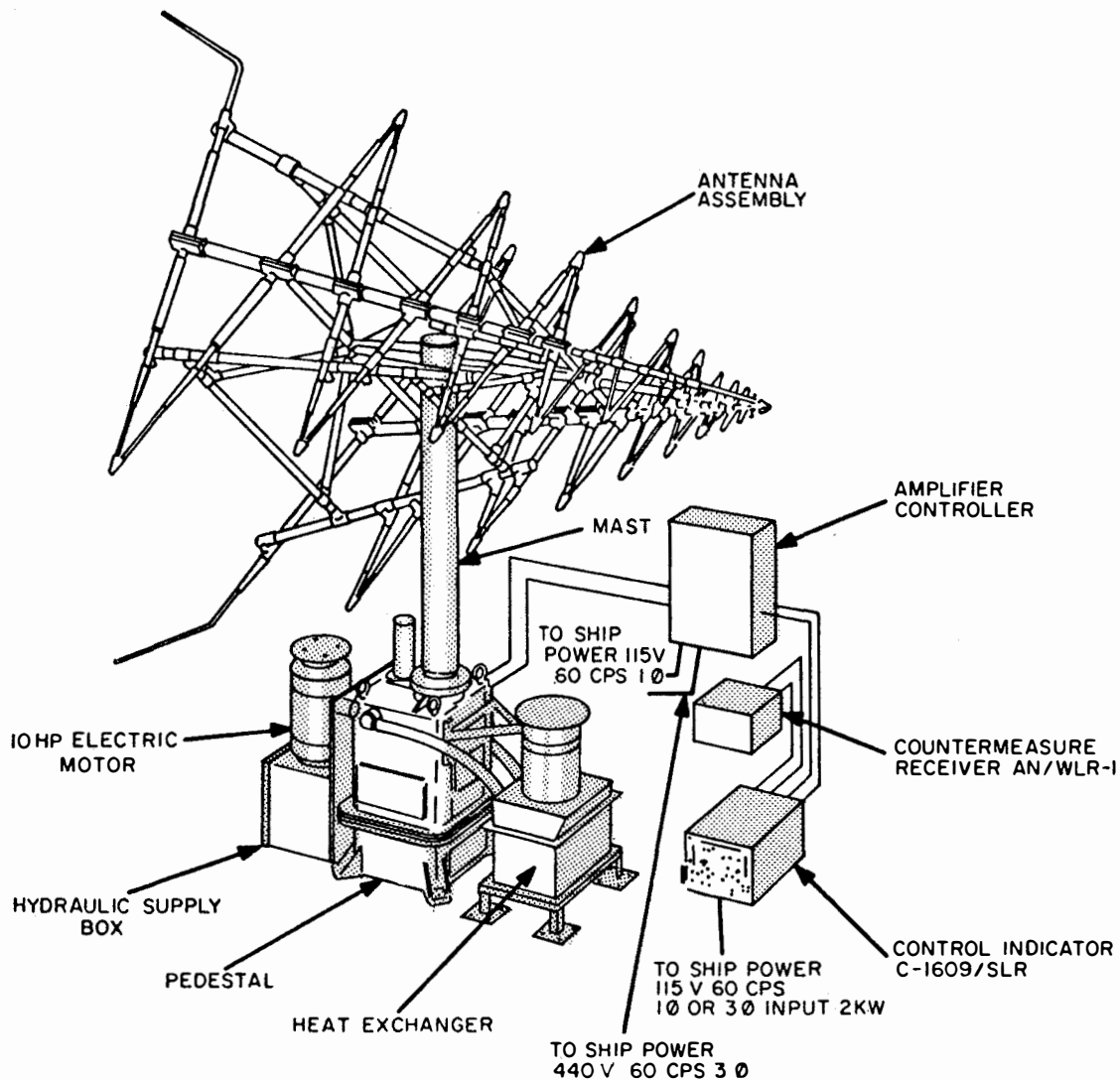
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Figure 5-4.—Antenna AS-899F/SLR Functional Diagram.

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Figure 5-5.—Antenna AS-1096 (log periodic).

With the reflector assembly in one position, signals received by the upper horns must come from a direction diametrically opposite those received by the lower horns. A switch in the control-indicator C-3118/SLR, operating in conjunction with the band switch on the countermeasures receiving set, reverses polarity of voltages to the antenna rotor synchro when the set is operating on the two upper bands. This 180° electrical error compensates for the 180° mechanical error, resulting in correct bearing presentation for all bands.

### AS-1096

Antenna AS-1096 (figure 5-5) is a 360° rotatable log-periodic broadband directional antenna. The antenna receives RF signals of either horizontal or vertical polarization in the frequency range of 50 to 1100 MHz (bands 1 through 5).

This antenna is part of a limited number of installations and is used to extend the ESM system direction finding capability of intercepted signals down to band 1.

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Rotation of the antenna is controlled by control-indicator C-3118 and may be rotated at rates from just above zero to 150 rpm or manually trained to any bearing.

**AS-1173, AS-1174,  
AS-1175**

Antennas AS-1173, AS-1174, and AS-1175 are cone-shaped helical, omnidirectional receiving antennas intended for use in future ESM installations (figure 5-6) to provide

improved omnidirectional coverage through the entire receiving range of the AN/WLR-1.

All three antennas are capable of receiving either horizontally or vertically polarized signals.

The frequency range of the AS-1173 is 50 to 300 MHz (bands 1 through 3 of the WLR-1). The AS-1174 can receive frequencies in the range of 300 to 7350 MHz (bands 4 through 8 of the WLR-1) and the AS-1175 can receive frequencies from 7000 to 11,000 MHz covering band 9 of the WLR-1.

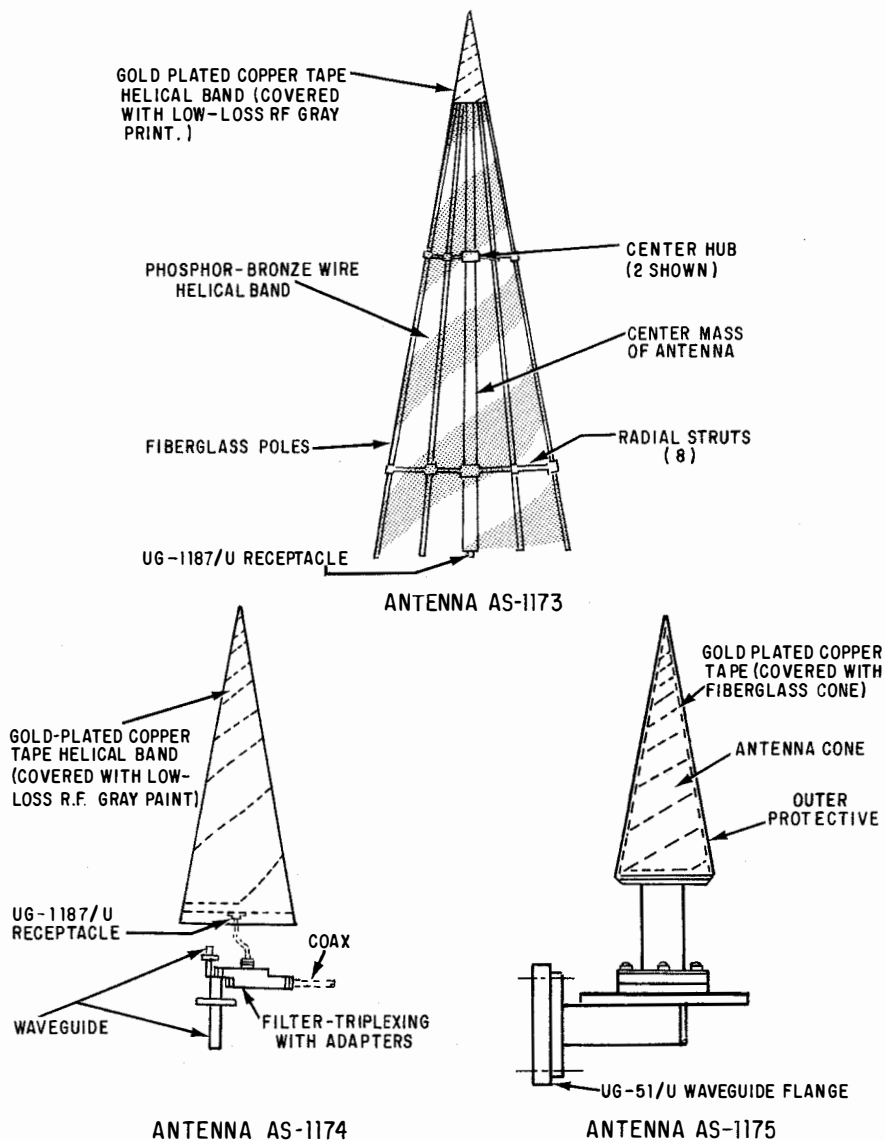


Figure 5-6.—Helical omnidirectional antennas.

**UNCLASSIFIED****AS-2918/S**

The AS-2918/S is a fixed omnidirectional antenna designed to receive RF signals within the frequency range of the AN/WLR-11A (7 to 18 GHz). The output of the antenna is fed directly into preamplifier AM-6799/WLR-11. The signals are split into low-band (7 to 11 GHz) and high-band (11 to 18 GHz) signals and fed directly into the low- or high-band limiters. From the limiter, the RF signals are fed directly into the tunnel diode amplifiers via a series of switches. Preamplifiers provide gain to overcome transmission line losses to the receiver and for noise limiting.

**NT-66131**

The antenna Navy type assembly NT-66131 (figure 5-7), often referred to as the "derby," is

a ground plane attached to the antenna base. The antenna provides frequency coverage from 300 to 2600 MHz and is equally sensitive to horizontally and vertically polarized signals when properly installed as described below. The antenna radiation pattern has a high front-to-back ratio with a null point at the back. The antennas, therefore, are installed in pairs at a 45° angle to the horizontal plane and a 90° angle to each other in azimuth so that their overlapping patterns provide 360° omnidirectional coverage.

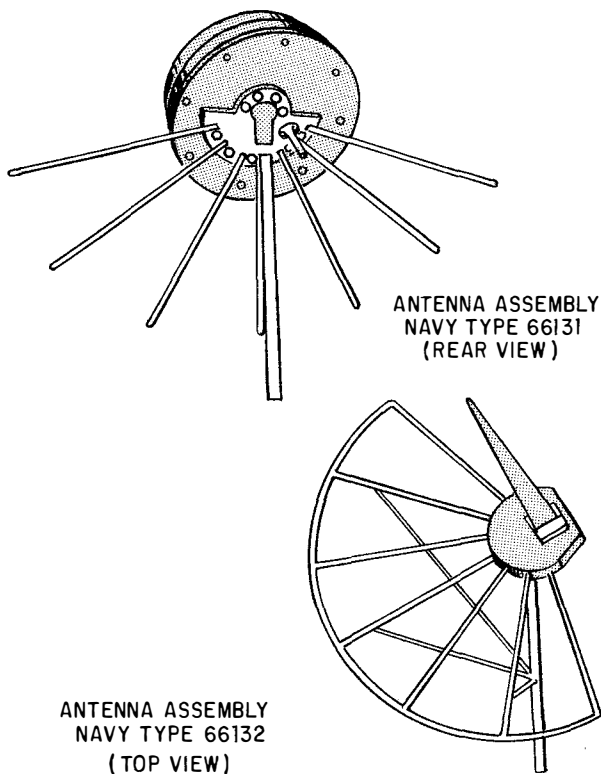
Most NT-66131 antenna installations have the transmission lines paralleled on the mast by a tee connector with a single coaxial transmission line coming into the ESM equipment room. Some installations have two separate coaxial transmission lines feeding into the ESM equipment room.

**NT-66132**

Antenna Navy type NT-66132 (figure 5-7) assembly, often referred to as a "sword," comprises a fixed-stub antenna and a fan-shaped ground plane attached to the antenna base. The antenna is installed at a 45° angle to the horizontal plane so that it is equally sensitive to the reception of horizontally and vertically polarized signals. The antenna provides for frequency coverage from 40 to 300 MHz. The radiation pattern has a sharp null point at the back of the antenna. The antennas, therefore, are installed in pairs at a 90° angle to each other in azimuth so that their overlapping patterns provide 360° omnidirectional coverage. The coaxial transmission lines are installed in the same manner as for the NT-66131.

**ANTENNA CONTROL UNIT**

Figure 5-8 shows a block diagram of a typical antenna control system, consisting of a control-indicator (C-3118), a magnetic control amplifier (AM-1017), and a synchro amplifier Mk 7. A synchro transformer resolver supplies bearing data to an azimuth indicator-pulse analyzer (IP-480). One control system may control up to three antennas, one at a time. All antennas may turn automatically or manually.



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Figure 5-7.—Antenna Navy type 66131 and 66132.

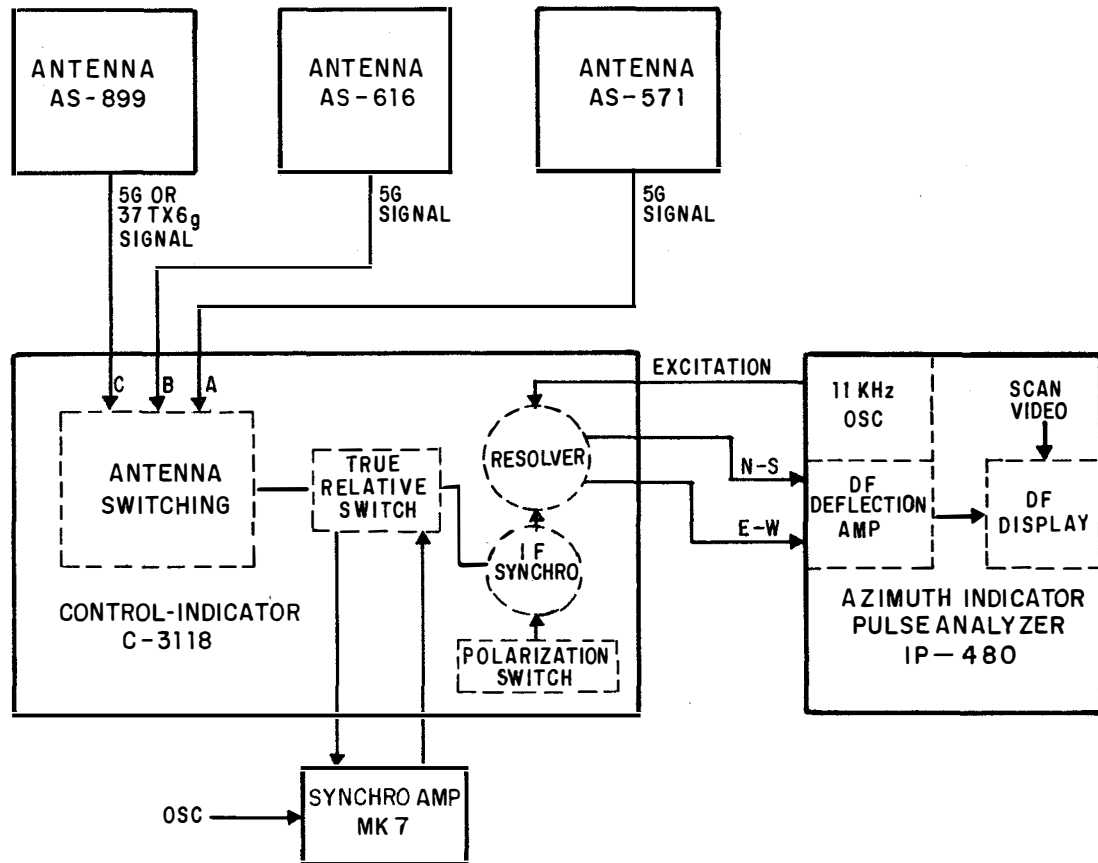


Figure 5-8.—Antenna control, functional block diagram.

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In automatic, the antenna rotates clockwise at speeds up to 250 rpm depending on the setting of the speed control potentiometer. A continuous error signal supplied through the magnetic control amplifier to the antenna servomotor causes the antenna to rotate.

In manual, the antenna rotates in either direction in response to a signal generated by a synchro control transformer turned or positioned by a handcrank. The magnetic control amplifier amplifies this signal and sends it to the synchro drive motor, which actually moves the antenna.

The POLARIZATION switch performs three functions. First, it controls the antenna coaxial switches which select either vertical or horizontal polarization for the plane-polarized

antennas (AS-616 and AS-571). Second, the POLARIZATION switch reverses the excitation voltage on a 1CT (manual synchro) synchro transmitter in the antenna positioning circuit, causing the antenna to rotate 180°, thus orienting the selected array with the bearing reference. Third, it reverses the polarity to the IF synchro to correct the position of the spot on the DF trace. To obtain the proper bearing, antennas AS-899, AS-616, and AS-571, must also have the POLARIZATION switch on a particular setting, depending on the reflector in use.

Figure 5-8 shows the functional relationship of the control-indicator and synchro amplifier Mk 7 for determining TRUE DF bearing indications on the countermeasures receiving set.

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The position of the antenna is shown on the DF trace of the analysis CRT indicator of azimuth indicator-pulse analyzer IP-480. Positioning is accomplished by a 5G synchro generator (37TX6g in antenna AS-899) geared to the antenna drive. The 5G synchro output is the relative bearing of the antenna.

In RELATIVE BEARING operation, the 5G synchro order from the antenna is received by the 1F synchro receiver in the control-indicator. The 1F synchro receiver mechanically positions the rotor of a resolver. The resolver has two stator windings mechanically displaced by  $90^\circ$ . The mechanical position of the rotor translates the angular position of the antenna into E-W and

N-S components (proportional to the sine and cosine of the antenna position). These components are applied to the DF trace deflection system.

In TRUE BEARING operation, synchro amplifier Mk 7 introduces an own-ship's course signal from the ship's gyro system into the antenna servo system. This adds to the relative bearing data of the antenna an angle equal to the true heading of the ship.

The POLARIZATION switch reverses the 117-VAC excitation voltage to the synchro receiver to make the  $180^\circ$  antenna-position correction when reception is changed from one back-to-back antenna reflector to another.

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## CHAPTER 6

# BLANKERS AND PREAMPLIFIERS

(U) Detection and analysis of electronic emissions by onboard ESM equipment is inhibited by many factors, some of which are: frequency of emission, altitude and range of platform, propagation, own ship's electronic systems interference, and strength of intercepted signal.

(C) By proper utilization of the Blanker-Video Mixer Group AN/SLA-10 or 10A and the Amplifier Group AN/WLA-3A or 3B, the operator greatly enhances his capability to detect and analyze electronic emissions.

(U) These equipments will be discussed in detail in the remainder of this chapter.

### **BLANKER-VIDEO MIXER GROUP (U)**

(U) Because of the transmitting power of radars and the close proximity of local radar antennas to ESM antennas, the radar transmission of frequencies within the frequency band of the ESM receiver can completely blank out the video display of distant or weak signals. The blanker-video mixer group, usually referred to as the video blanker, prevents this blanking by cutting off or blanking out the receiver's reception during the transmission time of local radars.

(U) Two installations are currently in use in the fleet; the AN/SLA-10 and the AN/SLA-10A. The AN/SLA-10 is in use on board some ships and will soon be replaced by the newer AN/SLA-10A as a ship undergoes overhaul,

providing the new AN/SLA-10As are available. Since there are still AN/SLA-10s in use, both versions will be explained in this chapter.

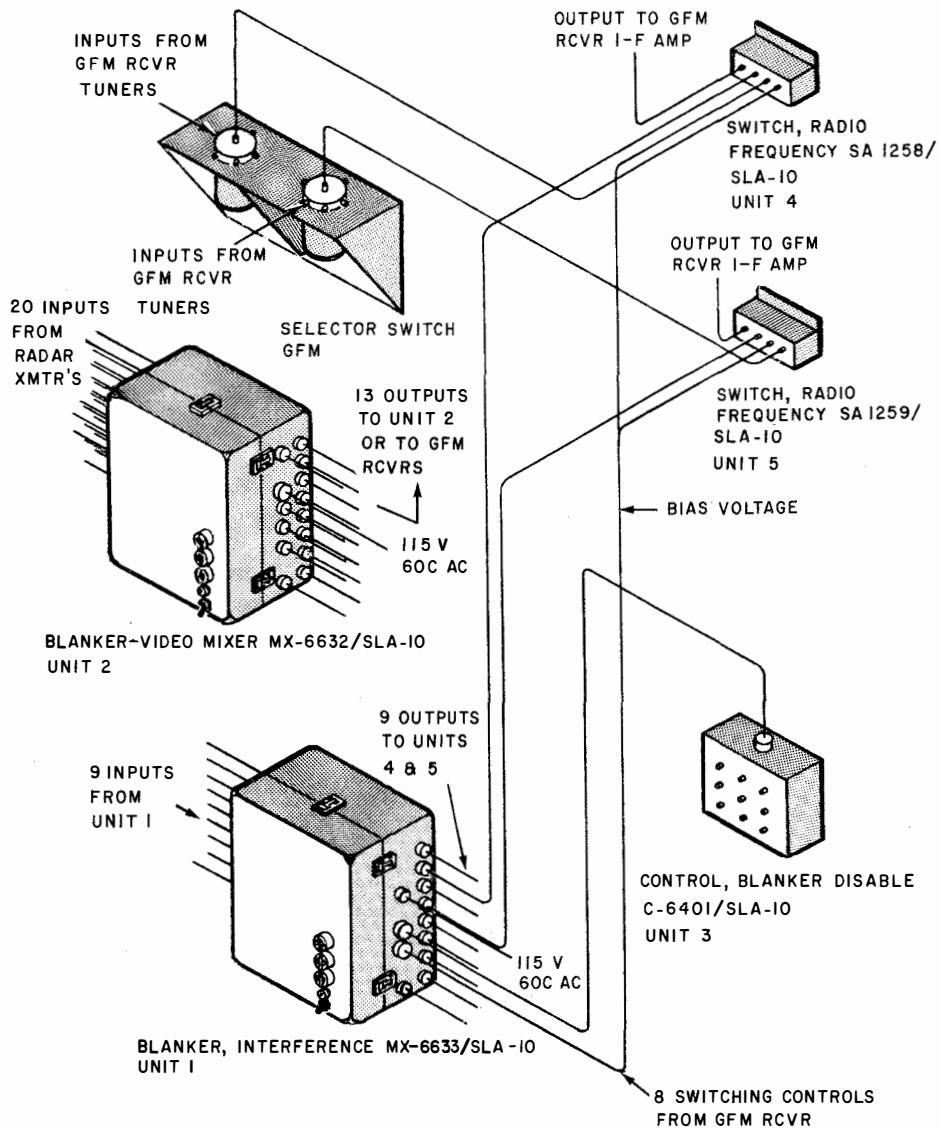
### **AN/SLA-10**

(U) A typical AN/SLA-10 installation consists of five major components: (See figure 6-1.)

1. Blanker-video mixer (master blanker)
2. Blanker, interference (auxiliary)
3. Control, blanker-disable (disable control)
4. Switch, radio frequency (60 MHz)
5. Switch, radio frequency (160 MHz)

(U) The blanker group is used in conjunction with selected receiving sets to prevent receiver interference from local radar transmitters operating on a frequency within the band to which the receiver is tuned. This condition interferes with the display of the distant radars on the same frequency as our own ship's radars.

(U) When the blanker group is operating, each of the local radar transmitters, which might cause receiver interference, provides an input to the master blanker which then generates blanking pulses. The blanking pulses are mixed, as determined by the installation program (explained under operating procedures), and the master blanker outputs are used as inputs to the interference blanker or to disable other local equipment. Inputs to the interference blanker generate blanking pulses which are switched by

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189.112

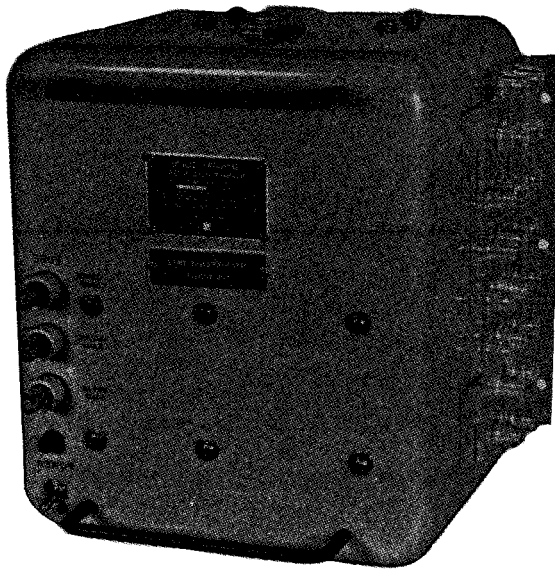
Figure 6-1.--(U) Blanker-Video Mixer Group AN/SLA-10. Relationship of Units (U).

the control voltage from the receiver, so that only the transmitter whose frequencies are within the band on which the receiver is operating will cause interference blanking outputs.

(U) Outputs from the interference blanker control the 60 and 160 MHz switches which are cable connected to the receiver circuitry. This procedure effectively disables the receiver for the duration of the pulse. The operator may

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189.31

Figure 6-2.—(U) Blanker-Video Mixer MX-6632/SLA-10 (U).

prevent generation of selected interference blanking pulses by depressing the appropriate disable control switch. This facility is provided so the operator can be sure that the selected local transmitter is, in fact, operating.

**Blanker-Video Mixer  
MX-6632/SLA-10  
(Master Blanker)**

(U) The master blanker (see figure 6-2) is contained in a drip-proof aluminum case designed for bulkhead mounting. Three fuses in extractor-post-type indicating holders, a power switch, and a power indicator are mounted on the hinged front cover. The left side of the case contains the mounts for 20 input signal connectors, while the 13 signal output and 1 power input connectors are on the right side of the case. Louvered openings on each side of the cover near the top and on the bottom of the case and cover provide ventilation.

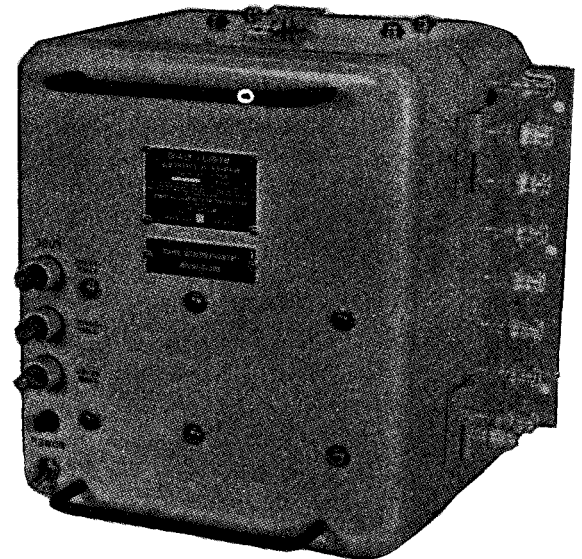
(U) All master blanker electronic circuits are contained on 21 printed circuit assemblies of four different types.

**Blanker, Interference  
MX-6633/SLA-10  
(Auxiliary Blanker)**

(U) Construction of the blanker, interference (auxiliary blanker) is similar to the master blanker, with the same parts mounted on the cover. There are nine signal input connectors on the left side, there are nine outputs, one power input and two control input connectors on the right side. Internal arrangement is the same, except that there are 16 printed circuit assemblies of four types. See figure 6-3 for the blanker, interference assemblies.

**Control, Blanker-  
Disable C-6401/SLA-10  
(Disable Control)**

(U) The control, blanker disable (see figure 6-4), is a small aluminum, drip-proof enclosure designed for mounting on a bulkhead or equipment rack. It contains nine spring-loaded



189.32

Figure 6-3.—(U) Blanker, interference MX-6633/SLA-10 (U).

**CONFIDENTIAL**

189.33

Figure 6-4.—(U) Control, blanker disable C-6401/SLA-10 (U).

pushbutton switches mounted on the cover and one connector for the control outputs which is mounted on the top.

Switch, Radio Frequency  
SA-1258/SLA-10 and  
Switch, Radio Frequency  
SA-1259/SLA-10

(U) The two switches, radio frequency 60 and 160 MHz, are identical in construction, each contains one printed circuit assembly and four

connectors, one each for signal input, signal output, blanking pulse input, and power input. (See figure 6-5.)

### Operating Procedures

(U) The blanker-video mixer group requires the preparation of a program chart upon initial installation. This programming chart will be different for each individual shipboard installation; therefore, no standard programming chart can be established prior to installation. Once the installation is completed the operator can determine from the programming chart the function of each spring-loaded pushbutton on the control, blanker disable (disable control). Activation of these switches will disable the blanker and, if a local radar transmitter fires and is on the same frequency as the receiver, the transmitter pulse will appear on the acquisition display of the ESM receiver. In the same situation, when the switch is not depressed, the radar transmitter pulse will be blanked out and will not appear on the acquisition display.

(U) The disable control will usually be operated in conjunction with a receiver band selector switch. In this case, the operator will normally operate both switch controls; therefore, he should study the blanker installation program chart.

### AN/SLA-10A

(U) A typical AN/SLA-10A installation consists of four major components: (See figure 6-6.)

1. Blanker-video mixer (blanker)
2. Control, blanker-disable (disable control)
3. Radio frequency switch (60 MHz)
4. Radio frequency switch (160 MHz)

(U) The blanker operates in conjunction with local radar transmitters and

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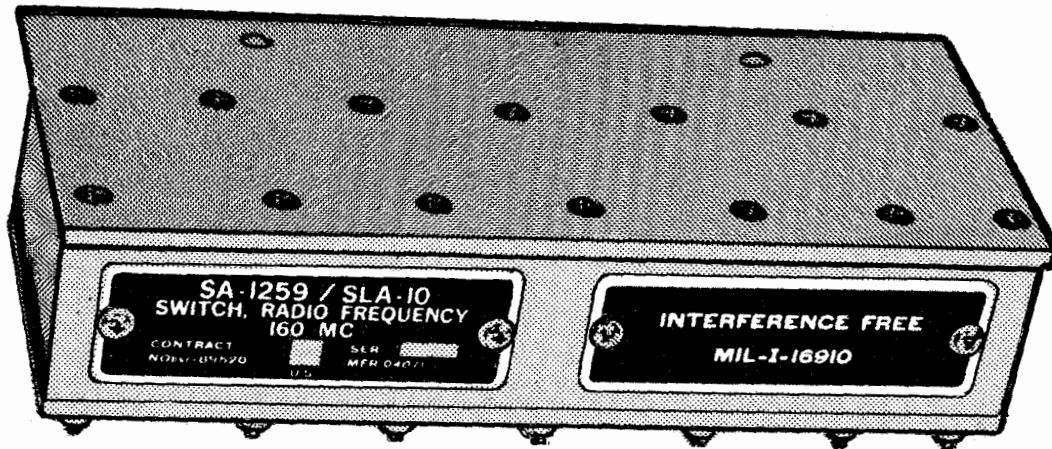


Figure 6-5.—(U) Switches, radio frequency SA-1258/SLA-10 and SA-1259/SLA-10.

189.34

countermeasures receiving sets to prevent receiver interference just as the AN/SLA-10 does.

(U) Except for the differences as pointed out in subsequent paragraphs, the overall operation and the operating procedures for the AN/SLA-10A are the same as those for the AN/SLA-10.

(U) The blanker group consists of four components. It receives up to 20 positive pulse inputs from local transmitters and generates 13 positive or negative output pulses with preselected delay and pulse width characteristics which disable selected receivers during transmission periods. Controls are provided for the operator to inhibit generation of selected blanking pulses.

#### Blanker-Video Mixer MX-7544/SLA-10A

(U) The blanker, figure 6-7, is contained in a drip-proof aluminum case designed for bulkhead

mounting. Six fuses in extractor-post-type indicating holders, two spare fuses in extractor-post-type holders, and a power indicator are mounted across the top front of the case. Eight test jacks for voltage monitoring are mounted down the front of the case adjacent to the hinged cover. The hinged cover is secured by thumbscrews and gives access to plug-in, printed circuit subassemblies. The top of the case contains the mounts for one control-line connector, one power connector, and 13 output connectors. The bottom of the case contains the mounts for 20 input connectors.

#### Blanking Disable Control C-7132/SLA-10A

(U) The control, figure 6-8, is a small aluminum, drip-proof enclosure designed for bulkhead mounting. Nine spring-loaded pushbutton switches are mounted on the case. Two control-line connectors are mounted on the top of the case. A cover fastened by screws to the case gives access to the case interior.

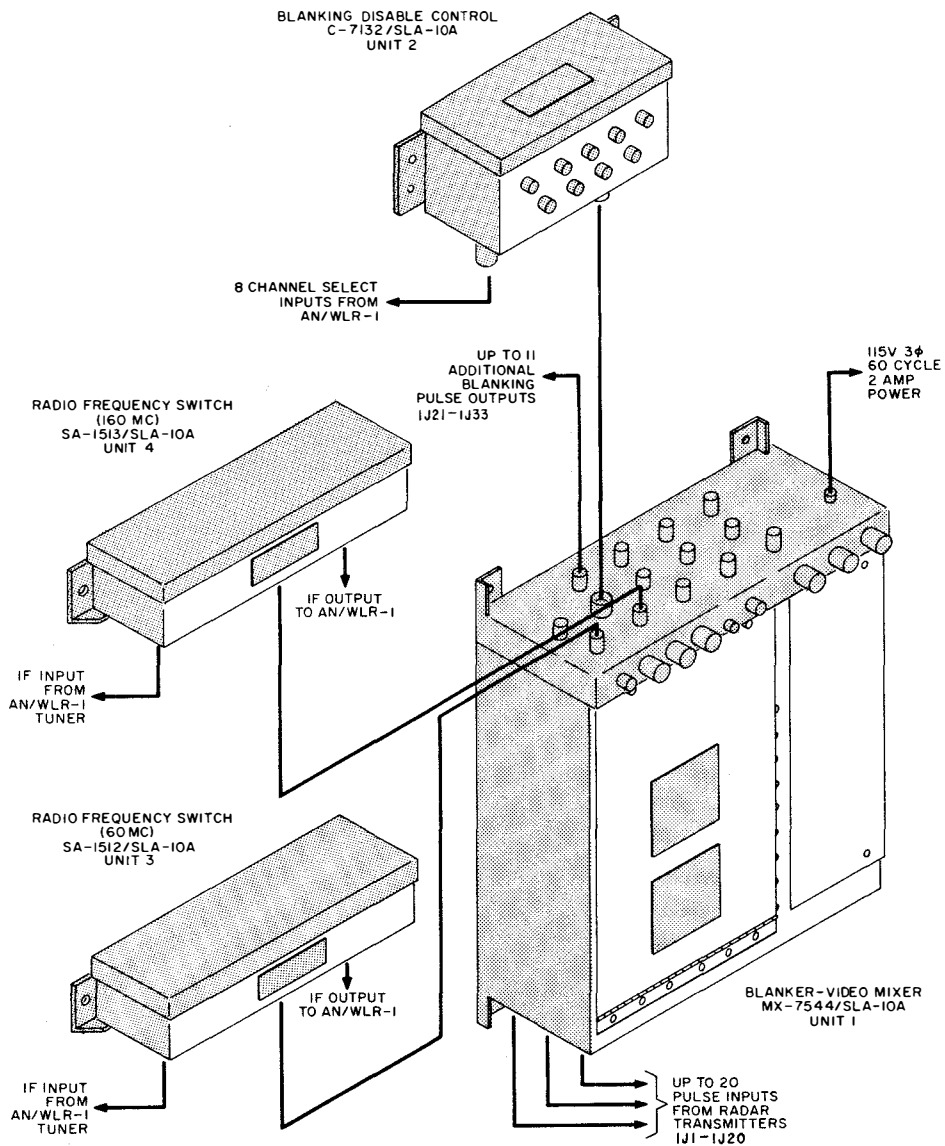
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Figure 6-6.—(U) Blanker-Video Mixer Group AN/SLA-10, Relationship of Units (U).

189.113

### Radio Frequency Switch SA-1512/SLA-10A and Radio Frequency Switch SA-1513/SLA-10A

(U) The two units, figure 6-9, are identical in basic construction, each being a drip-proof aluminum enclosure designed for bulkhead mounting. Three connectors are mounted on the

bottom of the case, one each for signal input, signal output, and blanking pulse input.

### Detailed Functional Description

(U) The following paragraphs describe the functional operation of the units of the AN/SLA-10A.

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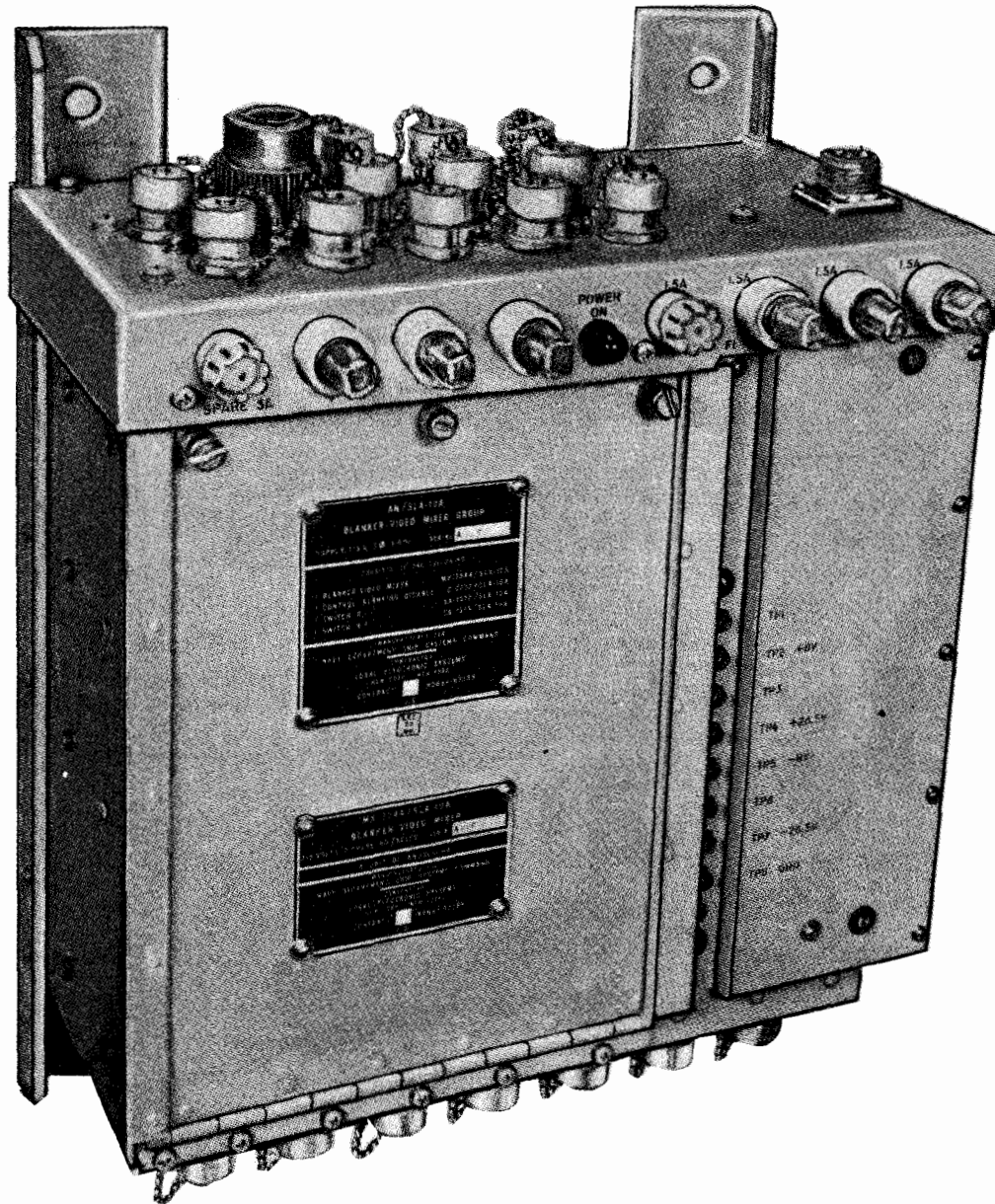
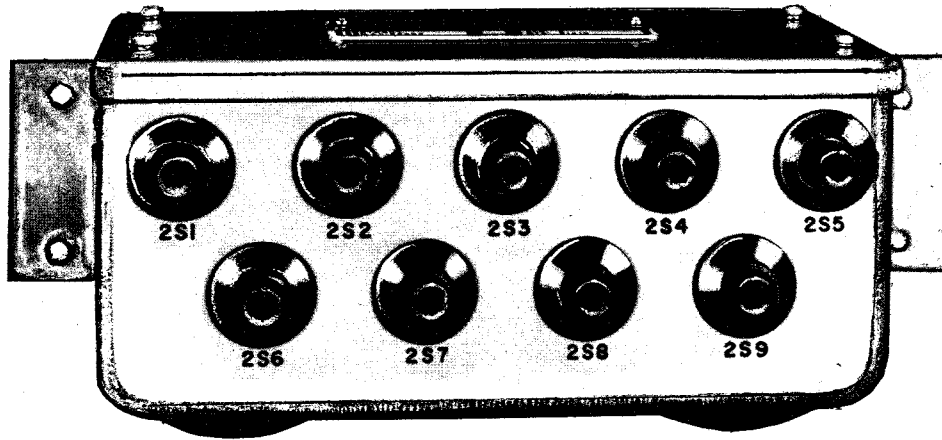


Figure 6-7.—(U) Blanker-Video Mixer MX-7544/SLA-10A (U).

189.114

**CONFIDENTIAL**

189.115

Figure 6-8.—(U) Blanking Disable Control C-7132/SLA-10A (U).

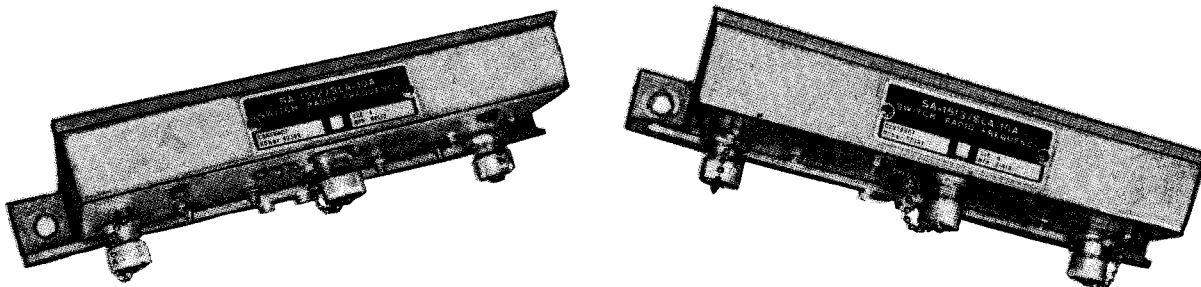
(U) **BLANKER-VIDEO MIXER.**—The signal inputs, figure 6-6, are positive pulses from up to 20 transmitters brought into the blanker group through blanker connectors 1J1 through 1J20. The inputs on 1J1 through 1J10 are from 5 to 50 volts in amplitude and from 0.25 to 20 microseconds wide. The other inputs on 1J11 through 1J20 are limited to 20 to 50 volts in amplitude and are from 0.25 to 20 microseconds wide.

(C) The signals on 1J1 through 1J10 will trigger blanker generation of undelayed or

variable delayed pulses with variable pulse width, both parameters being preselected. The signals on 1J11 through 1J20 are processed to provide undelayed pulses whose duration may be stretched to a preselected width.

(C) The maximum repetition rate is 10,000 pps; less than 0.1 microsecond rise time. Blanking duty cycle, 2 percent maximum.

(C) There are thirteen outputs to external equipment through 1J21 to 1J33 positive or negative (preselected); 20 to 50 volts amplitude; undelayed 0.3 to 100 microseconds after trigger;



189.116

Figure 6-9.—(U) Radio Frequency Switch SA-1512/SLA-10A and SA-1513/SLA-10A (U).

**CONFIDENTIAL**

0.5 to 230 microseconds wide; maximum repetition rate 10,000 pps; rise and fall times less than 0.1 microsecond; drop less than 5 percent in 20 microseconds pulse width. Duty cycle, 2 percent maximum. They may be applied directly to the affected receivers or to one or more radio frequency switches as required.

(U) **BLANKING DISABLE CONTROL.**—Each of the nine disable switches, figure 6-8, is connected through the intercomponent cabling to an interference blanker programmer assembly. When the pushbutton is depressed, the pulse inhibitor in the affected interference blanker programmer is activated to prevent generation of the blanking pulse. Normal operation is resumed when the pushbutton is released.

(U) **RADIO FREQUENCY SWITCH.**—Operation of the two switches, figure 6-9, is identical and only one will be described; differences between the components are the operating frequencies and parts values. The circuits are PIN (positive-intrinsic-negative) diode switches embedded in a bandpass filter. The switch, which is normally reversed bias, acts as a normal bandpass filter to pass the IF signal output. When a positive blanking pulse is applied to the switch it is forward biased and the RF is shunted through the diode and capacitor to ground. However, if the operator is able to cause the ESM display to trigger on the leading or trailing edge of a blanked interval, transients may be getting through. In such cases, the test of the blanking program will help locate the defect.

## PREAMPLIFIERS

(U) Over the years it has become evident that something had to be done about the signals intercepted by the ESM receivers that were too weak to be analyzed. Preamplifiers were developed for this purpose. There are several different models, but only one preamplifier will be covered in this text. To this end the AN/WLA-3B has been selected since fleetwide use is imminent.

## GENERAL DESCRIPTION

(U) Amplifier Group AN/WLA-3B, figure 6-10, is a four-band RF preamplifier with a frequency range of 1.0 GHz to 11.0 GHz that provides signal enhancement for use with ESM receiving sets, such as the AN/WLR-1 series or AM-4255. It accepts blanking inputs from blanker video mixer groups such as the AN/SLA-10A. The AN/WLA-3B provides for independent selection of amplified RF and video or direct RF from OMNI or DF antennas of four frequency bands to associated ESM equipment. An indicator lamp shows whether an omnidirectional or DF antenna has been selected for each band by the associated ESM receiver. These bands numbered 1 through 4 correspond with bands 6 through 9 of the AN/WLR-1.

## DESCRIPTION OF UNITS

(U) The preamplifier consists of two major units, figures 6-11 and 6-12, Units 1 and 2 pictorial, the control indicator and the amplifier assembly. The amplifier units, one for each band, are independently powered. All operating controls are located on the control indicator unit.

### Control Indicator (C-9993/WLA-3B Unit 1)

(U) The control indicator contains the operating controls for the preamplifier. It is housed in a drip-proof wraparound case with four tapped mounting feet.

(U) A three-position selector switch is provided, figure 6-13, for each of the four RF amplifiers to be individually switched in or out of the circuit. The third selector switch position provides for indicator lamp test. The indicator lamp above each selector switch shows whether a direct circuit (RF amplifier not used) or the amplifier is in use in each band and whether omnidirectional or DF antennas have been selected at the associated ESM receiver. A power switch controls the application of primary power to the equipment and an indicator lamp shows whether power is on. A dimmer control is provided to vary the intensity of all lamps except the "power on" lamp.



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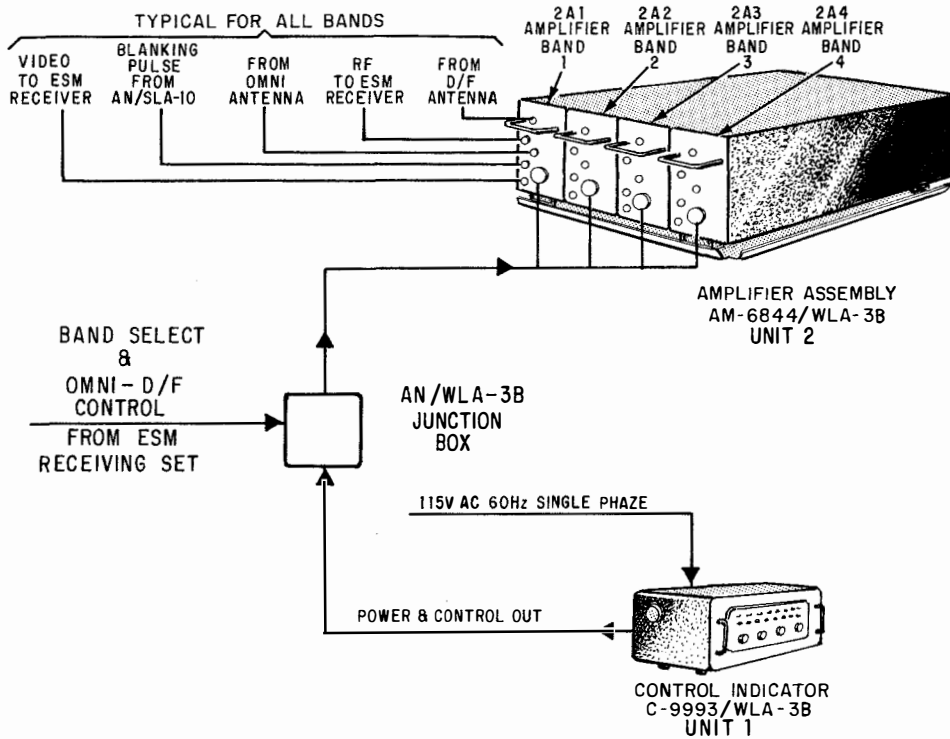


Figure 6-10.—(U) Relationship of Units (U).

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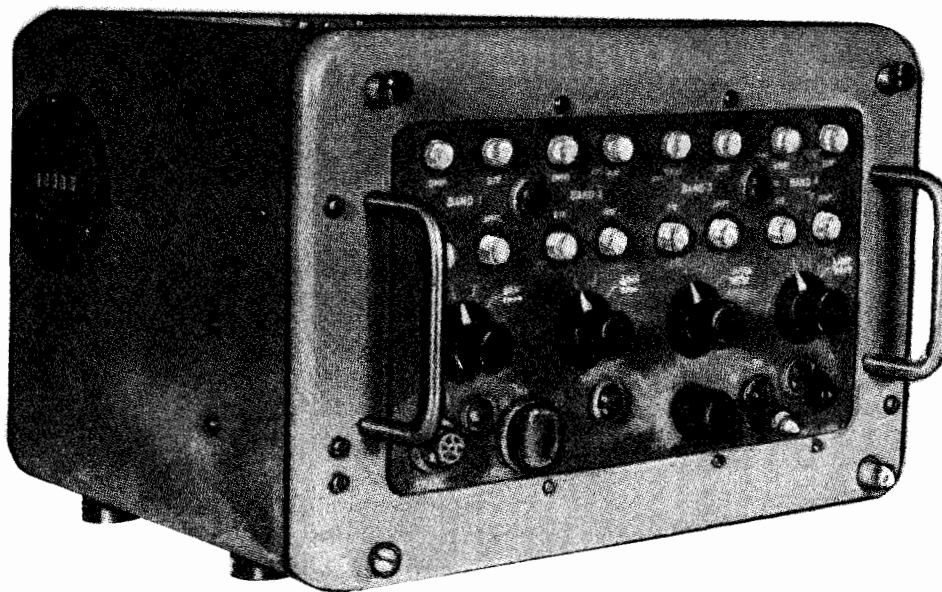


Figure 6-11.—(U) Control Indicator C-9993/WLA-3B, Unit 1 (U).

189.118

CONFIDENTIAL





Figure 6-12.—(U) Amplifier assembly AM-4891 (U).

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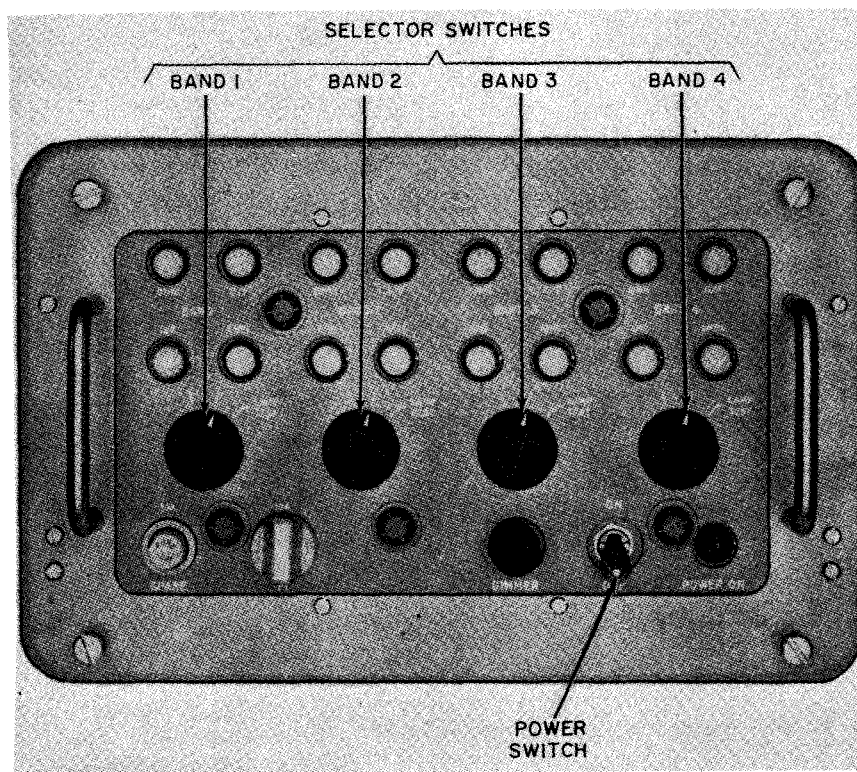


Figure 6-13.—(U) Control-indicator, operating controls and indicators (U).

189.37

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(U) The control indicator receives the primary power input for the equipment and routes it to each of the four RF amplifiers in the amplifier assembly. The indicator lamps indicate the status of the four bands, as selected by the four selector switches and the antenna selection control of the associated ESM receiver.

### Amplifier Assembly (AM-6844/WLA-3B Unit 2)

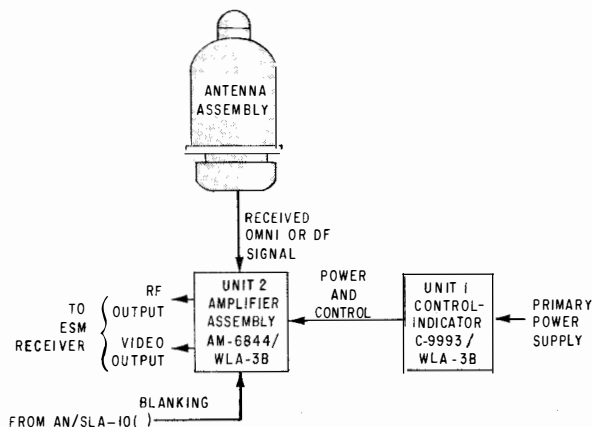
(U) The amplifier assembly (figure 6-12) consists of four RF amplifiers, bands 1 through 4, contained in a waterproof wraparound case. Each of the four amplifiers is mounted in a separate section of the case and can be separately withdrawn or removed for servicing. All connections for the individual amplifiers are made at the front panel connectors. Frequency operating ranges of the four amplifiers are:

<u>UNIT</u>	<u>BAND</u>	<u>FREQUENCY (GHZ)</u>
2A1	1	1.0- 2.6
2A2	2	2.0 - 4.5
2A3	3	4.0 - 8.0
2A4	4	7.0 - 11.0

(U) The RF amplifiers for bands 1 and 2 contain solid state amplifiers and bands 3 and 4 contain low noise traveling wave tube amplifiers (TWTAs) with integral power supplies. Also, each RF amplifier has a power divider and bandpass filter contained in an integrated package, a video detector, three coaxial relays, an RF limiter (used in bands 1 and 2 only), and provision for an input for a blanking pulse through a pin diode switch. Independent band selection of RF and video is controlled at the associated ESM receiver.

### OVERALL FUNCTIONAL DESCRIPTION

(U) The preamplifier receives its RF signal from an antenna, which is not part of the preamplifier. Functionally the names of the preamplifier units describe the major functions of the two units. Refer to figure 6-14.

**CONFIDENTIAL**

189.119

Figure 6-14.—(U) AN/WLA-3B Overall Block Diagram (U).

### Control Indicator

(U) The control indicator contains the +28 volt power supply assembly and provides the operating controls for primary power switching and operating mode selection as well as indicator lamp display of the selected operating mode.

### Amplifier Assembly

(U) The amplifier assembly consists of four RF amplifiers. Each of the four amplifiers is mounted in a separate section of the case and can be withdrawn or removed for servicing. All connections for the individual amplifiers are made through the front panel connectors. Bands 1 and 2 amplifiers contain solid state amplifiers while bands 3 and 4 use TWTAs. Also contained are a blanking pin diode switch, a power splitter and bandpass filter, a video detector, and three coaxial relays. Bands 1 and 2 also contain a limiter.

### DETAILED FUNCTIONAL DESCRIPTION

(U) The AN/WLA-3B preamplifier system consists of relay circuits to select either an omnidirectional or DF input, switch the amplifier in or out of circuit, and control circuits. All control functions are located at the control indicator, as shown in figure 6-13,

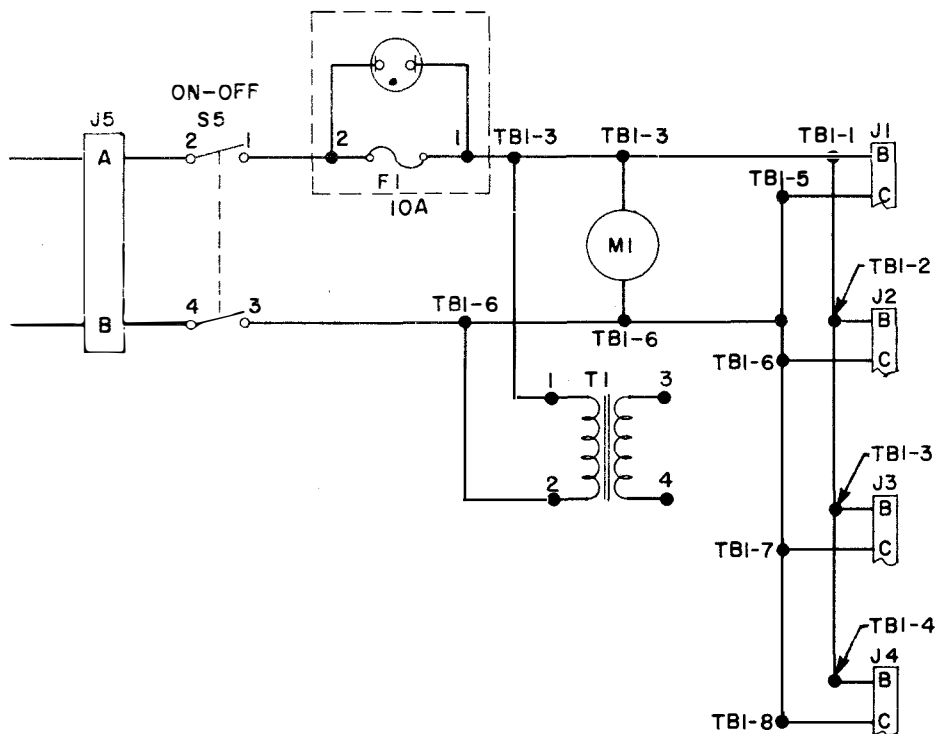


Figure 6-15.--(U) Power Distribution Wiring Diagram (U).

189.120

except for the selection of OMNI-DF which is made at the narrowband receiver.

(U) The signal input for the amplifier shown in figure 6-14 is either an omnidirectional or direction-finding signal from the antenna depending on the selection made at the narrowband receiver. The amplifier can be switched into the circuit for AMPL mode of operation or removed from the circuit for DIR mode of operation, the mode selection being made at the control indicator.

(U) The primary power input, figure 6-15, on (115VAC) to the control indicator is through connector 1J5 to the power switch 1S5, and the fuse 1F1, then branches to the four connectors 1J1, 1J2, 1J3, and 1J4, which serve the four amplifier drawers, and to the primary of 1T1 of the 28VDC power supply. An elapsed time meter, 1M1, shows the total system operating hours.

### +28VDC POWER SUPPLY

(U) The +28VDC power supply, figure 6-16, provides power for edge lights, indicator lights ON/OFF lamp and coaxial relays. The +28VDC supply is a conventional full wave supply in a bridge configuration. Filtering is accomplished using an LC network consisting of L-1 and C-1. Resistors R-1 and R-2 serve as a series voltage divider-bleeder network, to provide a discharge path to ground for C-1 when power is secured, and a fixed drain to aid supply regulation when power is ON.

### INDICATOR AND DIMMER CIRCUITS

(U) The panel illumination lamps and power ON/OFF lamps, figure 6-17, are supplied

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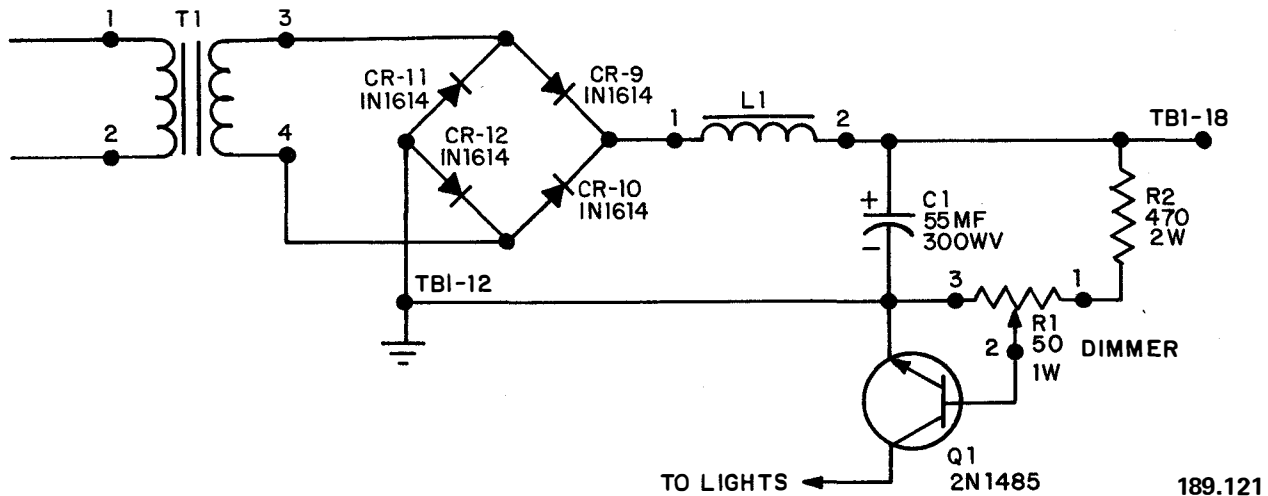


Figure 6-16.—(U) Power Supply Schematic Diagram (U).

directly from the collector of Q-1, and are unaffected by switching circuits. Power for DS-1 through DS-16 and DS-18 through DS-22 is controlled by Q-1; however, position of operators switches and resulting opening or

closing of relays in the amplifier unit determine which lamp or lamps will be in the current path for Q-1. R-1, a 50-ohm, 4-watt potentiometer, which serves as part of the series voltage divider-bleeder network (in the +28VDC power

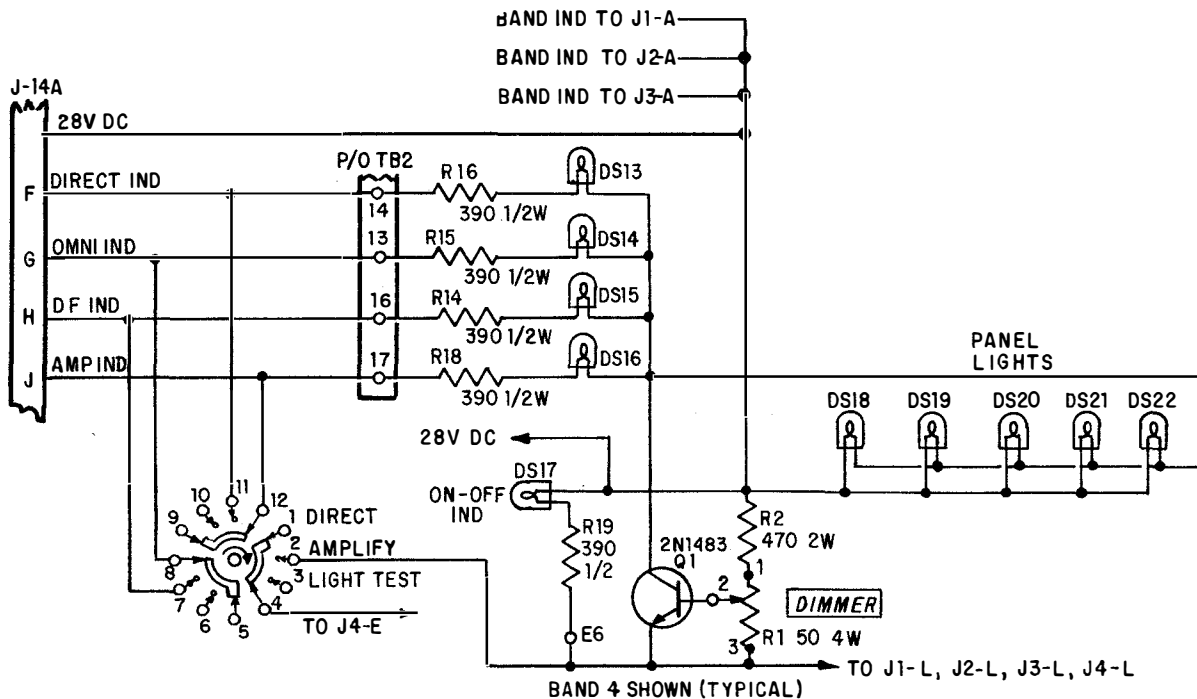


Figure 6-17.—(U) Indicator and Dimmer Circuits Schematic Diagram (U).

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supply) is used to set the Q-1 rate of conduction. By controlling conduction of Q-1, the intensity of all panel and indicator lamps may be set to the level desired.

### AMPLIFIER ASSEMBLY

(U) The signal input for the typical amplifier shown in figure 6-18 is either an omnidirectional or direction finding signal, dependent on the selection made at the associated ESM equipment. An amplifier can be switched into the circuit for the AMPL mode of operation or out of the circuit for the DIR mode of operation, the mode selection being made at the control indicator.

(U) Signal input selection and amplifier use is made by three coaxial relays, K1, K2, and K3. Relays K1 and K2 are controlled by the AMPL-DIR selector switch at the control indicator, and relay K3 is controlled by the (BAND) selection switch at the associated ESM equipment.

### AMPL MODE

(U) Relays K1 and K2 are energized. The signal input is applied to the amplifier and the amplified signal is applied to the power divider bandpass filter, Z1. The power divider splits the amplified signal, feeding one-half of the amplified signal through K1 to the RF output connector, J6. The other power divider output passes through a detector, CR1, to the video output connector, J5.

### DIR MODE

(U) Relays K1 and K2 are deenergized. In this mode the signal input is fed through relays K3, K2, and K1 to the RF output connector, J6. There is no video output in this mode of operation to video receivers such as the AM-4255.

### DF SELECT

(U) Antenna selection is made at the associated ESM equipment. When DF is selected, the DF input at the connector, J4, is applied through K3 to a power limiter (bands 1 and 2 only), through the limiter and a pin diode switch to K2. Relay K2 determines the mode of operation.

### OMNI SELECT

(U) Antenna selection is made at the associated ESM equipment. When OMNI is selected, the OMNI input at connector J5 is applied through K3 to a power limiter (bands 1 and 2 only), through the limiter and a pin diode switch to K2. Relay K2 determines the mode of operation.

### BLANKING

(U) A pin diode device is inserted in the input RF path and serves as a microwave switch. When triggered by an abrupt change in bias (signal input from the AN/SLA-10) the pin diode is forward biased, shunting the signal to ground, effectively blanking incoming signals. The AN/SLA-10() is programmed to provide a zero to +20VDC.

### ANTENNA SELECTION

(U) The AN/WLA-3B amplifier group is normally connected to the DF antenna. Switching to the OMNI antenna is accomplished by the operator at the ESM receiver through two operations; selecting a band to monitor, and selecting an antenna. The +28VDC used for band selection is available for OMNI-DF antenna switching. A diode has been installed in the 80-wire junction box for each band, to allow individual control voltage application to the relay of the band selected for proper antenna input to each of the four amplifiers.

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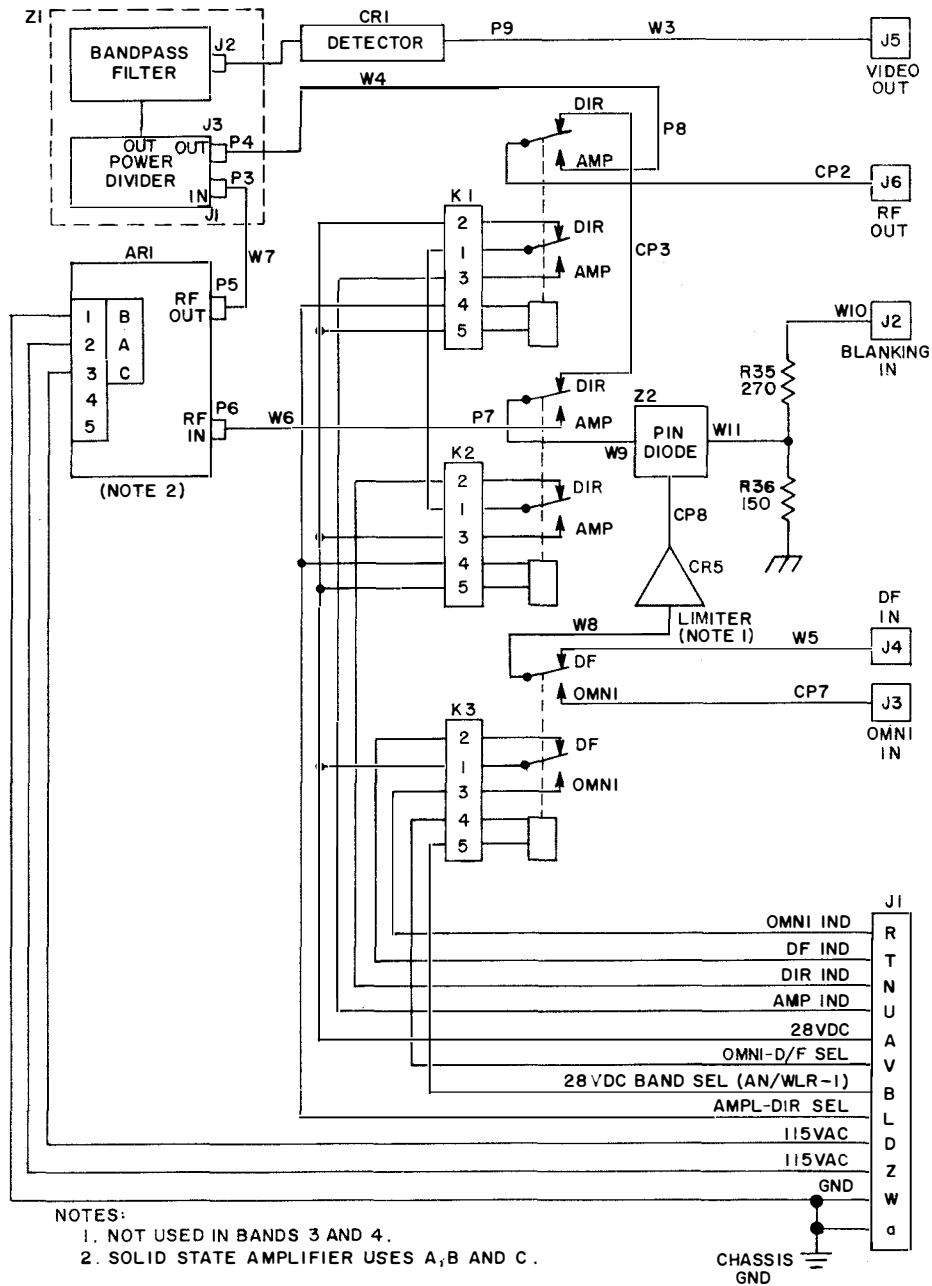


Figure 6-18.--(U) Amplifier Circuit Block Diagram (Typical) (U).

189.123

CONFIDENTIAL

## CHAPTER 7

## EW RECORDING DEVICES

Electronic warfare recording devices are as valuable to the ESM operator as they are to the analyst. They are used to record ESM and ECM information to be forwarded to the ELINT center for analysis. They are also excellent tools for training operators.

The EW recording devices covered in this chapter are magnetic tape recorders and cameras used to photograph the analysis scope.

#### RECORDER-REPRODUCER SET, AN/UNQ-7D

The AN/UNQ-7D Sound Recorder-Reproducer Set is a dual-track, magnetic tape recorder and reproducer which may be operated at any one of three tape speeds, 3.75, 7.5, or 15 ips (inches per second). Electrical signals falling within the normal audio frequency spectrum may be recorded on this equipment and this information either reproduced immediately or stored for an indefinite period of time. Recording and reproducing can be accomplished simultaneously, or the reproducing function can be performed subsequent to the recording process. Two information channels are provided: Channel A for voice and reference/tone and Channel B for recording data information. The equipment consists of three main components—an equipment cabinet, a tape transport, and a recorder-reproducer sound control.

#### CY6094/UNQ-7D CABINET, ELECTRICAL EQUIPMENT

This equipment consists of a cabinet assembly in which the tape transport and the

following electronic assemblies are mounted: A record amplifier, two reproduce power amplifiers, a bias and erase oscillator, two reproduce preamplifiers and a power supply. With the exception of parts of the power amplifiers and power supply, all of these assemblies are self-contained modular components which plug into rack mounted receptacles within the cabinet. These receptacle connectors form part of the mounting tray, thus providing inter-connection as well as mounting support for the electronic assemblies.

#### RD259/UNQ-7D RECORDER- REPRODUCER, SOUND (TAPE TRANSPORT)

The tape transport, mounted on slides within the cabinet, is used to transport the magnetic recording tape past the head assembly, which is mounted on the front of the transport between the supply reel and the take-up reel. Three tape speeds are selectable, 3.75, 7.5, and 15 ips plus fast forward and rewind speeds. The transport control assembly, a part of the recorder-reproducer, contains the electronic parts, relays, etc., that control the operation of the recorder-reproducer. A three-digit counter with reset knob provides an indication of tape usage. Local operation of the equipment is accomplished by the controls located on the front panel. These controls include the MODE SELECTOR switch and the TAPE SPEED selector switch. A bias defeat switch, located on the chassis of the transport control assembly, permits removal of the bias signal from Channel B for certain applications.

**UNCLASSIFIED****C4957/UNQ-7D CONTROL  
SOUND RECORDER-REPRODUCER**

This section is used to control the entire equipment operation, including the RECORD mode, once the tape threading is complete, system power is applied and the desired tape speed has been selected. The sound control permits the equipment to be placed in RECORD, REPRODUCE, FAST FORWARD, REWIND or STOP, from a remote location. Controls that govern system operation are located on the front panel of the sound control. There is also an AGC (automatic gain control) defeat switch, located inside the cabinet used to disable the AGC circuit in Channel B when necessary for certain applications.

The following electronic assemblies are mounted within the sound control cabinet: Record preamplifier, horizontal oscillator, vertical deflection, and display assembly. These assemblies are plug-in modules easily removed for servicing or replacement. A speaker is mounted inside the rear of the sound control to provide aural indication for either channel selected by a control switch located on the front panel. The chassis has a plug connector which mates with a matching receptacle inside the cabinet. This allows removal of the chassis from the cabinet and permits insertion of a service extender board during maintenance procedures. The sound control service extender board is stored inside the cabinet underneath the chassis assembly. A service extender board, also stored inside the chassis assembly, can be used to service the four plug-in modules.

**EQUIPMENT ACCESSORIES**

Each complete set of equipment is furnished with several accessories to assist in performing certain maintenance functions. These accessories and their function are as follows: An alignment tape from which previously recorded test data may be reproduced for the purpose of checking and/or alignment of the equipment electronics; a head demagnetizer for degaussing the head assembly and the tape guides with which the tape comes in contact; a tape splicer used in the repair of magnetic tape or when the tape is deliberately cut for the purpose of editing; and two empty 7-inch reels.

These accessories are stored in the maintenance kit container. Also included in the container are two extender service assemblies used to service the bias oscillator, power amplifiers, reproduce preamplifiers, and record amplifier modules; and a cable assembly extension to service the power regulator module.

**OPERATING CONTROLS  
AND INDICATORS**

Operating controls and indicators for the UNQ-7D are shown in figures 7-1 and 7-2. Their designations and purposes are listed in table 7-1. Additionally, two monitoring jacks (one for Channel A and one for Channel B) are located on the front panel of the amplifier assembly.

**OPERATION**

To operate the AN/UNQ-7D, first place a full reel of tape on the left-hand turntable and an empty reel on the right-hand take-up turntable. The reels should be the same size and both must have 2 1/4-inch hub diameter. Thread the tape as shown in figure 7-3. Then:

- Place the POWER switch to the ON position. The power light should come on and the capstan start to turn. Allow a 30-second warmup period before recording or reproducing.
- Select the tape speed desired by placing the TAPE SPEED switch in the appropriate position. For EW purposes, record at 15 ips.
- Set the amplitude on both channels. Place the CHANNEL SELECTOR switch on A, and while speaking into the microphone observe the vertical amplitude display on the face of the record level indicator. Adjust the RECORD LEVEL control until the signal peaks in the space between the upper and lower horizontal lines. Move the CHANNEL SELECTOR switch to B. With a signal coming into the channel, adjust the amplitude on Channel B as described for Channel A.
- Reverse the position of the CHANNEL SELECTOR switch and repeat the above procedure for the other channel.
- The equipment is now ready to record. To start the recording process, hold the



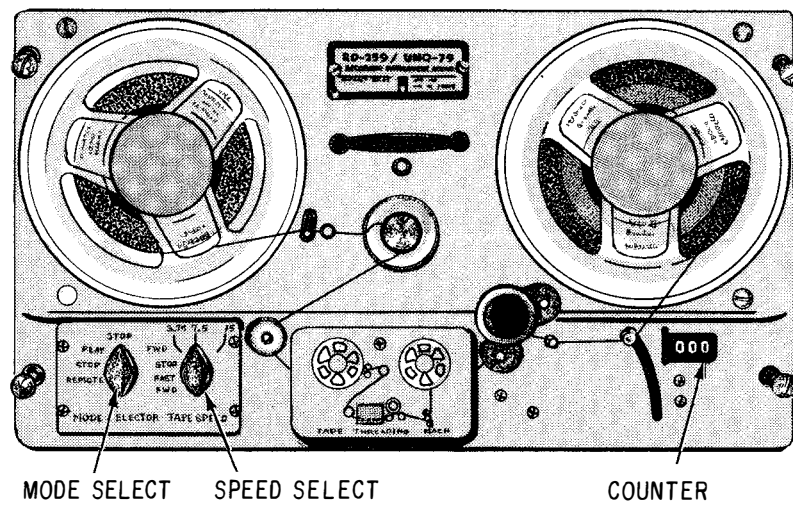


Figure 7-1.—Operating Controls, Recorder-Reproducer.

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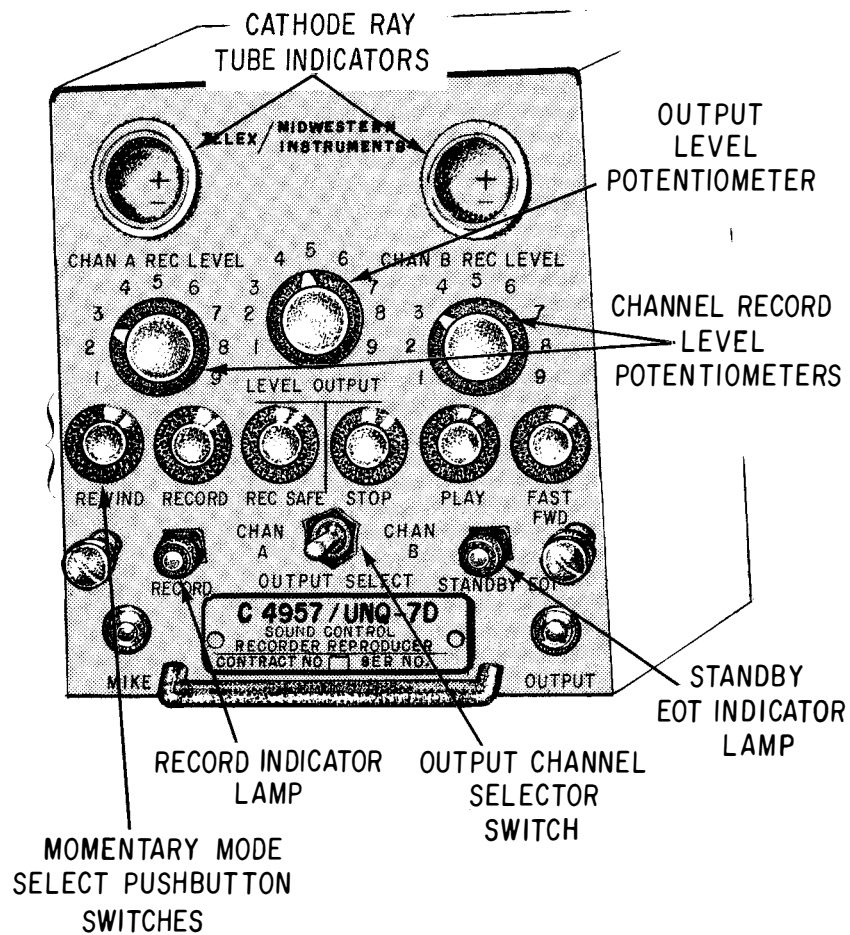
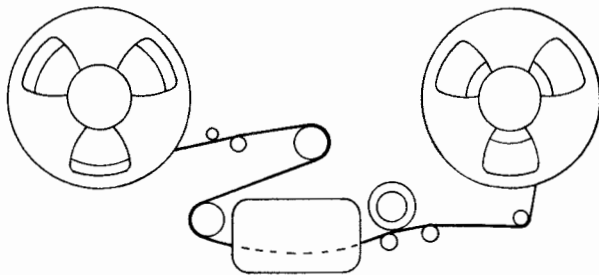


Figure 7-2.—Operating Controls, Sound Control.

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Table 7-1.—Operating Controls and Indicators

CONTROLS/INDICATORS	FUNCTION	NORMAL POSITION OR INDICATION
<b>Recorder-Reproducer Figure 7-1</b>		
Power Switch	Controls power to the Recorder-Reproducer.	"ON" or "OFF" as desired.
PWR Indicator Lamp	Indicates that power is applied to equipment.	Illuminates when PWR switch is "ON."
MODE SELECTOR	Selects desired mode of operation.	As desired.
TAPE SPEED	Selects 3.75, 7.5 or 15-inches per second tape speed.	As desired.
Tape Counter	Indicates number of feet of tape used.	Set to 000 when new reel of tape is installed.
<b>Sound Control Figure 7-2</b>		
CHAN A REC LEVEL	Controls the record level gain for Channel A.	See text
CHAN B REC LEVEL	Controls the record level gain for Channel B.	See text
LEVEL OUTPUT	Controls output gain of either the built-in speaker or the headset, whichever is used.	As desired.
REWIND Mode Switch	Used to rewind tape at high speed from the take-up onto the supply reel.	Depressed when in use.
RECORD Switch	Initiates the record mode of operation.	Depressed when in use.
REC SAFE	Used as a safety or interlock switch to be depressed at the same time the record switch is depressed, for record mode.	Depress with record switch.
STOP Switch	Used to stop tape movement.	Depressed when in use.
PLAY Switch	Used to playback recorded information.	Depressed when in use.
FAST FWD	Drives tape forward onto take-up reel at high speed.	Depressed when in use.
RECORD Light	Indicates equipment in record mode.	Illuminated when in record.
OUTPUT Select Switch	Selects Channel A or B as desired.	As desired.
STANDBY - E.O.T. Light	Indicates system in standby or end of tape is reached.	Illuminates steady when in standby and flashes when within 5-minutes at E.O.T.
Cathode Ray Tube, Indicators	Indicates the record level of both Channel A and Channel B.	Optimum level is indicated when vertical trace barely touches top and bottom reference marks.



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Figure 7-3.—Tape Threading Path.

RECORD SAFETY INTERLOCK to the left and place the RECORD switch in its 1 position. The tape should be set in motion and the RECORD INDICATOR (green) light should be illuminated. Reset the RECORD LEVEL controls if necessary.

Recording can be stopped at any time by pushing the STOP button, which places the equipment in the standby condition. Under normal operating conditions the tape drive stops automatically at the end of a reel or if the tape breaks. When you use this recorder for ESM recordings, tape speed should be set for 15 ips. This speed provides a recording frequency range of 50-20,000 Hz. The 7.5 ips speed provides a recording frequency range of 50-10,000 Hz and may be used in an emergency if there is a trouble in the recorder precluding the use of the 15 ips speed. The use of the 3.75 ips speed provides a recording frequency range of only 50-5000 Hz. This frequency range is undesirable and inefficient for ESM work. As a rule of thumb you should remember that the faster the tape speed, the better the frequency response and the recording quality. Special care should be taken with the audio and IF gains when recording ESM intercept signals. Often the signal is overdriven which distorts the recorded signal, making it difficult to obtain beam-width estimates and scan rates.

#### Recording from the Remote Position

The remote control assembly provides the ESM operator with facilities for placing the

equipment in the RECORD mode from the remote position. The previously mentioned operation steps should be followed. The switches on the remote control assembly will then control operation of the set.

An understanding of the indicating lights on the remote control assembly is necessary for proper operation. The STANDBY light only indicates that power is applied and that tape is threaded properly. It does not indicate that the proper tape speed has been selected nor that the recording levels have been adjusted. Neither the STANDBY nor RECORD light will illuminate if the power is not applied, the tape is not properly threaded, or if the equipment is being used to reproduce a previously recorded tape.

The RECORD light indicates that the equipment is in the RECORD mode either at the remote control unit or on the equipment itself.

The STANDBY-E.O.T. (end of tape) light is an amber full dimmer type light located below the PLAY mode switch. This light is illuminated any time the STOP mode switch has been depressed, thus placing the system in standby. The light will blink on and off any time the E.O.T. switch has been actuated. The E.O.T. switch is actuated approximately 5 minutes before the end-of-tape is reached when operating at 7.5 ips.

#### Reproducing Operation

To reproduce a tape:

- Thread the tape as before.
- Place POWER switch in the ON position, allowing a 30-second warmup period.
- Select the proper tape speed.
- Push the PLAY button.
- Adjust the LEVEL OUTPUT control for desired level.
- To stop reproduction, push the STOP button.

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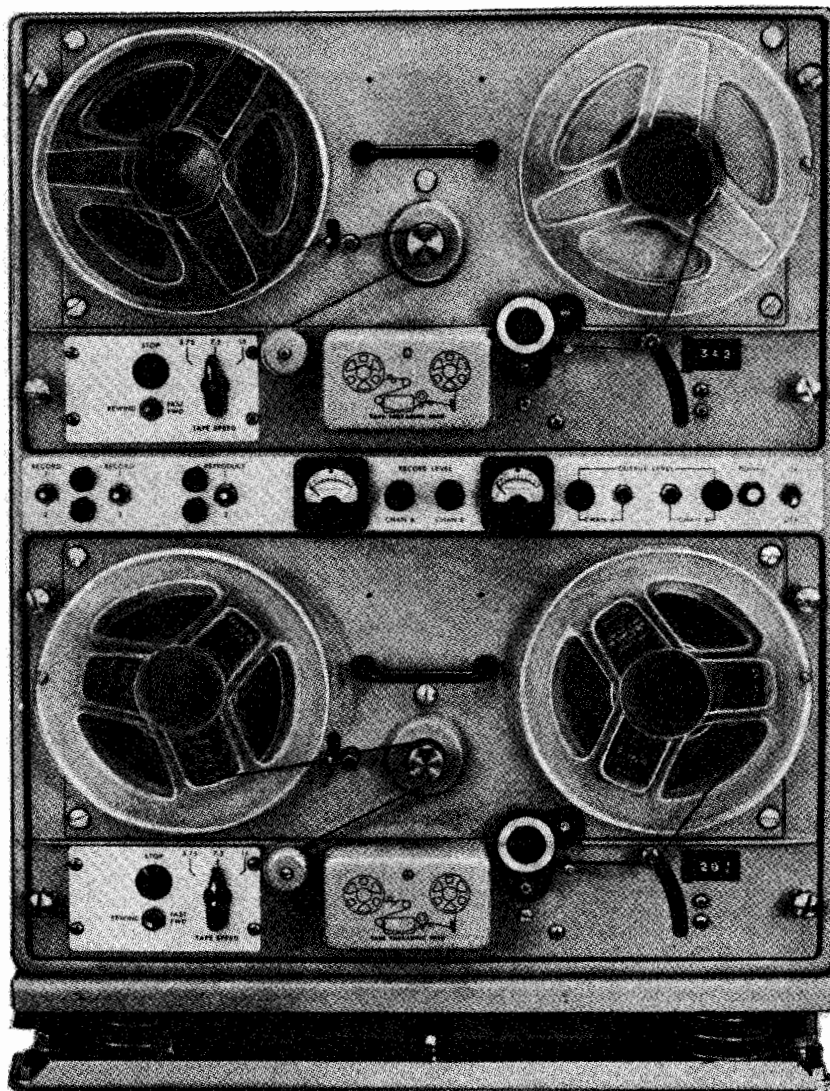


Figure 7-4.—Operating Controls, Recorder-Reproducer.

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### Rewinding and Forward Operation

Tape that is threaded and not already in motion, can be moved at about 300 ips in either the forward (FAST-FWD) or reverse (REWIND)

direction by placing the switch in the desired position.

Models (mods) -7A, -7B, -7C, -7D and -7E of the basic set UNQ-7 are installed on some ships for the purpose of recording EW information.

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### RECORDER-REPRODUCER AN/UNQ-7E

The AN/UNQ-7E (see figures 7-4 and 7-5) is a relatively new magnetic tape recorder used on surface ships. It consists of two dual track recorder-reproducers which can operate at 3.75, 7.5, and 15 ips. Recording and reproducing can be accomplished simultaneously on the same transport. One transport can record while the other reproduces pre-recorded data. The two information channels that are provided on each transport are the same as explained earlier in the chapter.

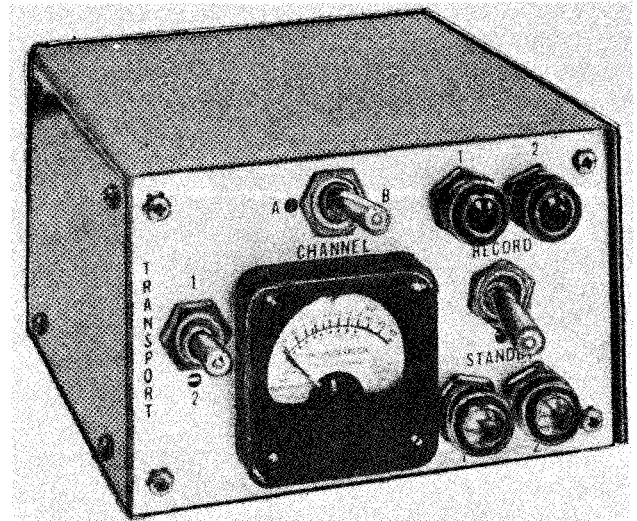
The primary advantage of the AN/UNQ-7E is the two tape transports. Due to equipment design, recording can be accomplished on only one transport at a time. The second transport however, can be in the ready or standby position with tape threaded and can be activated by the flip of a switch. This design greatly reduces or eliminates an intercepted signal not being recorded because a single transport has run out of tape and not been reloaded.

#### AN/UNQ-7E CABINET, ELECTRICAL EQUIPMENT

This unit (figure 7-4) consists of a cabinet assembly in which two tape transports and the following electronic assemblies are installed: a Channel A and B record preamplifier, a Channel A and B record amplifier, two reproduce preamplifiers, a Channel A and B reproduce amplifier, a bias and erase oscillator and a power supply. The record preamplifier incorporates a manually operated AGC defeat switch for disabling the Channel B AGC circuit during certain recording applications. All of these assemblies, with the exception of parts of the power supply and the power amplifiers, are self-contained modular components which plug into rack-mounted receptacles within the cabinet.

#### CONTROLS AND INDICATORS ON EQUIPMENT CABINET

All functions of the recorder-reproducer set, with the exception of the Channel B bias defeat



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Figure 7-5.—Remote Control Unit.

and AGC defeat, can be controlled from the front of the equipment cabinet. A two-position toggle switch is used to turn the a.c. power OFF and ON. All other function control switches on the front of the unit are three-position, center OFF, momentary contact toggle switches. One tape transport can record while the other reproduces pre-recorded data, and one can record or reproduce while the other is in either the FAST FORWARD or REWIND mode of operation. The controls also facilitate any combination of simultaneous FAST FORWARD and REWIND operation of the two tape transports. A three-position, rotary speed selection switch, a momentary, push-action STOP button, and a FAST FORWARD-REWIND toggle switch are located just below the supply reel on each transport. The following jacks, level controls, and indicators are also located on the front of the cabinet: Channel A and B RECORD LEVEL VU meters and RECORD LEVEL controls, Channel A and B output jacks and OUTPUT LEVEL controls, RECORD and REPRODUCE indicator lights for Tape Transports 1 and 2, and a POWER ON indicator light. All five indicator lights have mechanical dimmer mechanisms.

**UNCLASSIFIED****TAPE TRANSPORTS**

Two identical tape transports (1 and 2) are mounted on slides, one above the other in the electrical equipment cabinet, and are used to transport magnetic recording tape past the head assemblies which are mounted on the front of each transport between the supply and take-up reels. These units can be operated at speeds of 3.75, 7.5, and 15 ips for RECORD and REPRODUCE. For FAST FORWARD and REWIND they operate at 300 ips averaged over 1200 feet of tape. Each tape transport has a control assembly that contains the electronic parts, relays, etc., that control the operation of the individual tape transports. A bias defeat switch, located on the chassis of the control assembly, permits removal of the bias from Channel B. A three-digit counter with reset knob is located on the front of each tape transport and provides an indication of tape usage.

**REMOTE CONTROL UNIT (RCU)**

The Remote Control Unit (RCU) permits operation of the RECORD function of either tape transport at locations away from the equipment cabinet. This unit (figure 7-5) contains the following controls and indicators: One three-position, center OFF, TRANSPORT selector switch; one two-position, RECORD-STANDBY switch; two RECORD lamps; and two STANDBY lamps. A record level VU meter and a two-position selector switch for monitoring the record level of Channel A or B are also included on the RCU.

**EQUIPMENT ACCESSORIES**

Each complete set of equipment is furnished with several accessories to aid in performing certain maintenance functions. These accessories and their functions are as follows: An alignment tape from which previously recorded test data may be reproduced for the purpose of checking or alignment of equipment electronics; a head demagnetizer for degaussing the head assembly and the tape guides with which the tape comes

in contact; a tape splicer used in the repair of magnetic tape or when the tape is cut for the purpose of editing; and two empty 7-inch reels. Also included in the equipment package are two extender service assemblies, one extender board assembly for servicing all record and reproduce amplifier modules, and one extender cable assembly for servicing the bias oscillator and power regulator modules.

**FUNCTIONAL OPERATION**

The AN/UNQ-7E Recorder-Reproducer Set is designed as a dual tape transport to record and reproduce audio frequencies on standard 1/4-inch magnetic recording tape. Two separate channels or "tracks" are used simultaneously on one transport or the other. Channel A, the longitudinal section of the tape, or "strip" nearest the machine, is used to record voice and reference tone, and Channel B, the strip on the outside of the tape, is used to record data information. There are three inputs on Channel A: Microphone, Line, and Bridging; and Channel B has two inputs: Line and Bridging. Recording can be accomplished on only one transport at a time. Previously recorded information on one transport can be played back at the same time other information is being recorded on the second transport.

All functions of the recorder-reproducer set can be operated at the front of the equipment cabinet. The RECORD and STOP functions can be operated at the RCU.

All toggle switches on the front of the recorder-reproducer cabinet are of the three-position, momentary-ON, center-OFF type with the exception of the POWER switch which is a two-position ON-OFF type. The associated numbers 1 and 2 refer to the upper and lower tape transports respectively. The functions of these switches and other controls and indicators are tabulated in tables 7-2 and 7-3.

The RECORD function is initiated at the recorder-reproducer by simultaneously operating the two RECORD switches to position 1 or 2 depending on transport selected. When initiating

Table 7-2.—Equipment Cabinet Operating Controls and Indicators

CONTROLS/INDICATORS	FUNCTION	NORMAL POSITION OR INDICATION
Power Switch	Controls Power to Recorder-Reproducer	ON or OFF
Power Indicator Lamp	Indicates when power is applied to equipment	Illuminated white when power is ON
Tape Speed (1 on each tape transport)	Selects either 3.75, 7.5 or 15 ips.	As desired
Stop Button (1 on each tape transport)	Stops tape.	Momentarily depressed
	NOTE	
	Stop button must be activated before change of operational mode.	
Fast FWD-REW switch (1 on each tape transport)	Initiates Fast Forward and Rewind	Center OFF
Tape Counter (1 on each tape transport)	Counts from zero to indicate tape usage	Setting of 000
Record switch (2)	Initiates Record function on tape transport 1 or 2, when actuated simultaneously	Center OFF position
Record lights (2)	Indicates when tape transport 1 or 2 is in Record mode.	Illuminates red during RECORD function
Reproduce switch	Initiates Reproduce function on tape transport 1 or 2.	Center OFF
Reproduce lights (2)	Indicates when tape transport 1 or 2 is in Reproduce mode.	Illuminates green during Reproduce function.
Channel A record Level Control	Controls Channel A record Signal level.	Not applicable
Channel B Record Level Control	Controls Channel B record Signal level.	Not applicable
Record Level VU Meters (2)	Indicates level of record signal.	Proportional to signal
Channel A output Level Control	Controls level of output signal in Reproduce mode.	Not applicable
Channel B output Level Control	Controls level of output signal in Reproduce mode.	Not applicable
Channel A and B output jacks.	See Paragraph 2.8	Not applicable

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Table 7-3.—Remote Control Unit Operating Controls and Indicators

CONTROLS/INDICATORS	FUNCTION	NORMAL POSITION OR INDICATION
Transport Selector Switch	Locks out local control of transport 1 or 2 and prepares transport for record function.	Center off
Record-Standby Switch	Initiates Record function on transport selected by Transport Selector switch.	Standby
Standby 1 lamp	Indicates Tape Transport 1 is in Standby mode, or nearing end of tape	Illuminates steady amber when in standby and flashes when near end of tape.
Standby 2 lamp	Same as above for Tape Transport 2	Same as above
Record Level VU meter	Indicates level of record signal for either tape transport selectively.	Proportional to signal
Channel A or B Switch	Selects channel to be monitored by VU meter.	At either A or B
Record 1 lamp	Indicates when Tape Transport 1 is in Record mode.	Illuminates red
Record 2 lamp	Indicates when Tape Transport 2 is in Record mode.	Illuminates red

the RECORD function at the RCU, the transport selector switch must be operated before the RECORD-STANDBY switch can control the RECORD function.

The Channel A and Channel B record levels, are set by the RECORD LEVEL controls on the recorder-reproducer control panel. It is not necessary to be in the RECORD mode of operation to obtain record level indications.

The STANDBY lamps located on the RCU will illuminate continuously when tape is threaded and transports are in the STOP position. The lamps also act as end-of-tape indicators by flashing when a transport is within 5 minutes of end of tape. This 5 minute warning is based on a tape speed of 7.5 ips. The time to end of tape will vary proportionately for the other tape speeds of 3.75 and 15 ips.

The meter on the RCU is used to monitor Channel A or B depending on the position of the Channel A-Channel B selector switch.

### Pre-operation Instructions

Before operating the equipment, perform the following steps:

1. Rotate all dimmer mechanisms on indicator lights counterclockwise to the full open position.
2. Turn POWER switch, on the central control panel, to ON. Observe that the white POWER light is illuminated.
3. Install a full reel of tape on the supply turntable of Tape Transports 1 and 2. Place an empty reel on each take-up turntable. Thread the tape from the supply reel, through the tape head (figure 7-3) and onto the take-up reel. Perform this operation on both tape transports.
4. Set both tape counters to 000.
5. Set speed selector on tape transports to desired speed.

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6. Adjust signal input level by observing appropriate VU meter.

NOTE: Perform the full sequence of the following instructions on Tape Transport 1 and then perform them on Tape Transport 2.

### Operating Instructions

Perform the following steps in operating the equipment:

1. Actuate both RECORD switches momentarily to position 1, simultaneously. Observe that tape begins moving forward at required speed, and that the RECORD 1 red lamp illuminates.

2. Press STOP button on Tape Transport 1. Observe that tape stops moving and RECORD lamp extinguishes.

3. Momentarily actuate the REPRODUCE switch to position 1. Observe that the tape moves as in Step 1 and that the REPRODUCE 1 green lamp illuminates.

4. Press STOP button on Tape Transport 1. Observe that the tape stops and REPRODUCE lamp extinguishes.

5. Actuate the FAST FWD-REWIND toggle switch momentarily to the FAST FWD position. Observe that tape moves rapidly from the supply reel to the take-up reel. Allow FAST FWD operation until the supply reel is very close to being empty before stopping the transport. Observe that the STANDBY 1 amber lamp at the RCU is flashing, denoting end of tape.

6. Reactuate the switch to the FAST FWD position and observe that the flashing amber light extinguishes and that both reels stop immediately after tape comes off the supply reel.

7. Thread the loose end of the tape across the heads and back onto the supply reel.

8. Actuate the FAST FWD-REWIND switch momentarily to the REWIND position. Observe that tape moves rapidly from the takeup to the supply reel. Stop the transport before full rewind so that tape remains threaded.

9. At the RCU observe that both STANDBY amber lamps are illuminated, then initiate RECORD at the RCU by actuating the TRANSPORT select switch to 1 and the RECORD-STANDBY switch to RECORD. Observe that STANDBY 1 amber lamp extinguishes and that RECORD 1 red lamp illuminates.

10. Return the RECORD-STANDBY switch to STANDBY and the TRANSPORT selector switch to the center position. Observe that the STANDBY 1 lamp illuminates and the RECORD lamp extinguishes.

NOTE: Perform the above sequence of steps on Tape Transport 2.

### AUXILIARY SWITCHES

AGC Defeat Switch. This toggle switch is located on record preamplifier card in the equipment cabinet and provides or defeats automatic gain control action on Channel B only. AGC action starts at 3 dB above optimum record level.

Bias Defeat Switch. This toggle switch is located on the control chassis of each tape transport and provides or eliminates record head bias on Channel B only. The bias defeat switch does not affect the erasing action of the erase head but controls only the record head bias necessary for normal audio recording.

### CAMERAS

Each of the various cameras used to record data from the analysis scope is equipped with an accessory kit. These kits include detailed instructions for proper operation required to produce photographs of the best quality. It is important that these operating instructions be studied thoroughly so that the photographs you take of a signal will show the exact fingerprint of the signal to the analyst at the ELINT center.

The following narrative on the various cameras addresses the capabilities but not their operations that are covered in the individual detailed instructions. Since most ships only have one camera, it is suggested that you obtain the

**UNCLASSIFIED**

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operating instructions for the camera on board your ship and familiarize yourself with them.

The Polaroid (CR-9 Model), KD-2, EYE MO (movie camera), or KS-63A or equivalent are the recommended cameras to be used for ESM analyzer scope photography.

The Polaroid CRZ-6 or CR-1A camera or equivalent camera is recommended for radarscope photography. The best application for these types is to record jamming presentations. The Polaroid camera has the

advantage of providing a print for immediate evaluation as well as for laboratory analysis.

The Polaroid CR-9 Oscilloscope Camera is specifically designed for oscilloscope spectrum analysis. The CR-9 has its own attachable hood which is compatible with the AN/WLR-1 scope, thus eliminating the need for a hood to be attached to the WLR-1. The CR-9 also features a trigger handle for ease of operation.

Photographic procedures for submitting photographs with ELINT Reports are covered in detail in chapter 14.

**UNCLASSIFIED**

## CHAPTER 8

## ECM SYSTEMS

(C) As enemy electronic equipment (especially radar tracking equipment) becomes more sensitive and versatile, more sophisticated jamming equipment is needed. During the early days of radar it was relatively easy to jam or obscure a target by simple brute force techniques. But jamming is becoming more and more difficult because of intelligent use of frequency and power/duty cycle relationships. Deception techniques can be expected to play an increasing role in future jamming efforts. It should be noted that saturation jamming techniques require a larger power output and more equipment space than do deception jammers. Deception jammers are especially useful against angle tracking radar systems, particularly missile seekers where there appears to be a strong preference for conical scan tracking. In this type of tracking, if the target is not on the axis of the scanning cone, a sinusoidal amplitude variation of the signal return results. The magnitude of the variation is proportional to the amount of error. In order to counter such a radar, a jammer can attempt either to saturate the radar, preventing it from seeing the amplitude variations, or cause a false error signal to be generated in order to throw the tracker off target. One disadvantage of saturation jamming is that the enemy system may use your noise saturation signal for homing purposes. The AGC circuits may neutralize the effect of the masking noise to some extent; therefore, the deception technique would appear to be the better method.

(C) The purpose of this section is to familiarize the reader with the most common operational jammer which he is likely to encounter in the fleet. Obviously, it would be impracticable to attempt to include every

jammer or deception device in use, since there is a vast array of equipment directed against a complex electronic system which includes, for example, radio, search radars, tracking radars, sonar, and recognition equipment.

(C) This chapter presents a representative countermeasures set in order to provide you with an understanding of the functions and basic operations of ECM.

## COUNTERMEASURES SET

(C) The countermeasures set (fig. 8-1) functions as a radar deception jammer and decoy repeater.

(C) As a deception jammer, the equipment protects targets from missiles using conic-scan automatic-tracking radar for guidance. The countermeasures set deceives these radars by receiving, amplifying, and introducing false scan modulation to the interrogating signals; then transmitting the 180° out-of-phase signals back to their source, thereby supplying erroneous directional information to the tracking radar.

(C) When used as a decoy repeater, the countermeasures set enlarges radar echoes to distract bombing/navigation radars from major targets to minor targets. Enlarged radar echoes make the minor targets appear to be the same size as major targets on the scope of the interrogating radar.

(C) Either mode of operation can be selected by local front panel controls or through the use of the remote control-indicator unit. Normally, remote control is used.

(C) When the countermeasures set is equipped with the radio frequency oscillator (not discussed), it has the additional capability

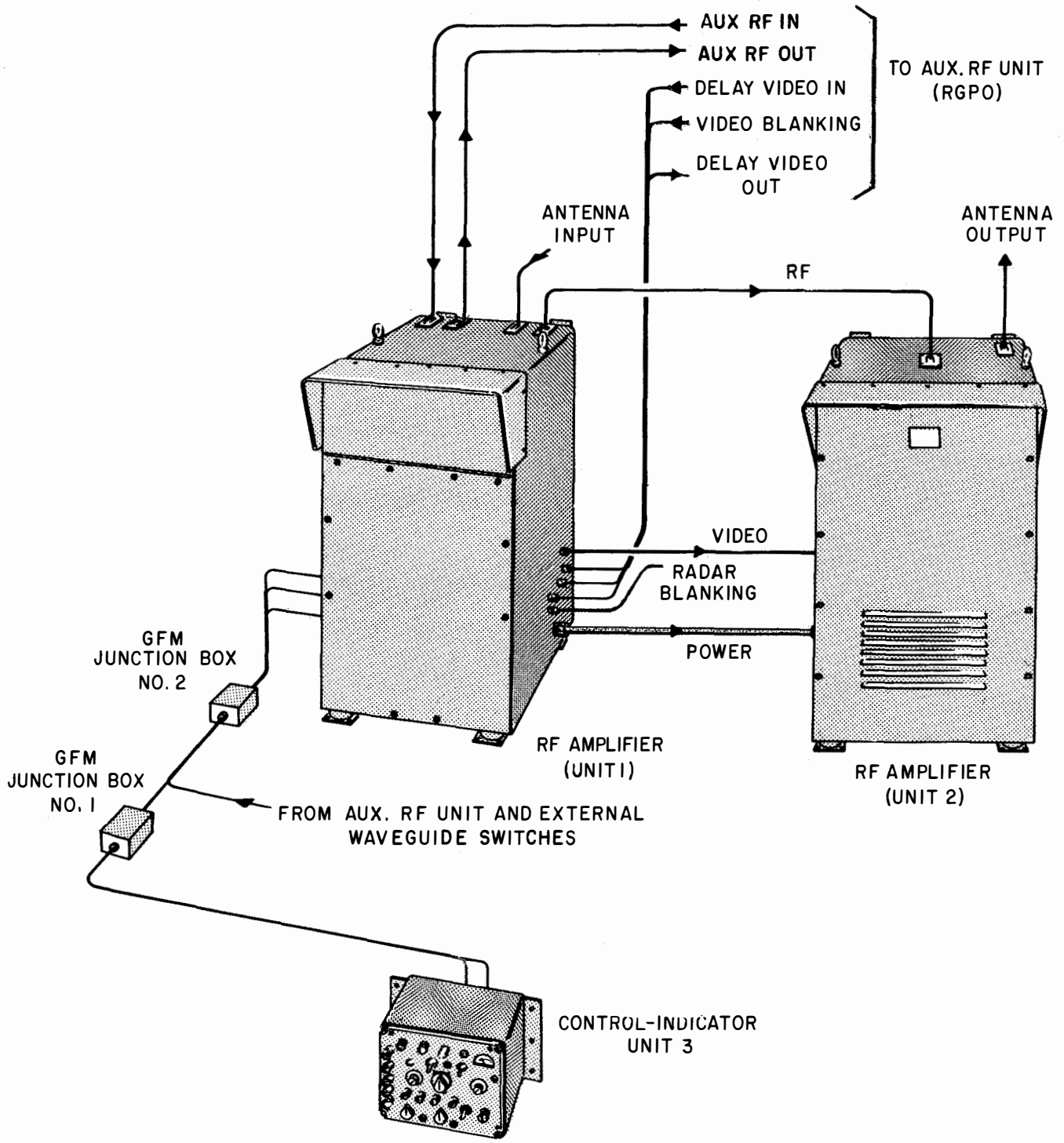


Figure 8-1.--(C) Countermeasures set (C).

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known as range gate pull-off (RGPO). The RGPO is used to monitor the range gates of guided missile radars and generate false (variably delayed) radar pulses which modulate the RF radiated back to the missile.

(C) The countermeasures set consists of three units: RF amplifier (unit 1), RF amplifier (unit 2), and control-indicator (unit 3).

### OVERALL OPERATION

(C) The countermeasures set is designed to perform two functions. In the DECOY mode of operation it enhances radar target echoes to divert airborne search and bomb-navigation radars from major to minor targets. In the TRACKBREAK mode of operation, when not equipped with the RFO unit, the set uses inverse gain to deceive guided missile automatic tracking radars by producing a false scanning beam radar tracking angle. A delay feature is used to prevent the set from responding to search radar when operating in the TRACKBREAK mode.

(C) The overall block diagram for the countermeasures set is given in figure 8-2. Radar pulses received at the antenna are applied to unit 1. These RF pulses are processed in the unit 1 receiver circuits where they go through one or two stages of RF amplification, depending upon whether the equipment is operating in the TRACKBREAK or the DECOY mode of operation. The amplified RF pulse output of the receiver circuits is applied to the transmitter circuits in unit 2 where it is further amplified and routed to the transmit antenna. The detected video output of the receiver circuits goes to a video amplifier whose output in turn goes to the modulator in unit 2; the modulator output is used to gate the TWT transmitter. An additional video output of the video amplifier is applied to the AGC and scan information circuits where the AGC voltage is developed and fed back to the video amplifier. The AGC and scan information circuits also extract the radar scan modulation envelope from the detected video pulse train and apply this scan information to the modulator. In the TRACKBREAK mode of operation, this scan modulation envelope modulates the video pulse train from the video amplifier and gates the TWT transmitter either off during the peak, or on during the trough of

the modulation envelope, depending upon the particular TRACKBREAK mode of operation.

(C) The low and intermediate level TWT power supplies (unit 1) provide the d.c. grid and beam voltages to both the low level and intermediate level TWT amplifiers in the receiver circuits. The TWT blanking circuits receive the external range gate pull-off delayed video, RGPO video blanking and radar blanking signals and route these signals to the proper amplifier and/or circuitry. The low voltage power supply generates the d.c. voltages for all low level circuitry in units 1 and 2. The local control panel and audio oscillator contain all local operating controls and indicators. Turn on, mode selection test checkout, and function monitoring are all performed at this panel. In addition, a variable audio oscillator signal is generated, which is supplied to the modulator to modulate the video pulse train when desired.

(C) In unit 2, the modulator power supplies furnish d.c. voltages to the electron multiplier modulator. The high level TWT power supply and high level TWT power supply regulator furnish the grid and beam voltages to the TWT transmitter.

(C) Unit 3 is a control-indicator with functions similar to those on the local control panel; it is used for operating the equipment from a remote location.

(C) The auxiliary RF input and output (unit 1) are RF pulse signals from and to an associated RGPO.

(C) In the TRACKBREAK mode of operation, these signals are used for range deception of guided missile radars.

### RF AMPLIFIER (UNIT 1)

(C) Unit 1 receives the search radar signal from the antenna system and detects and amplifies the video signal. The unit also generates an audio signal that is used as simulated conical scanning modulation. The unit contains TWTs, power supplies, and blanking circuits for these tubes, a video amplifier, an AGC circuit, low voltage power supplies, an audio oscillator, and a local control panel. In the TRACKBREAK modes, the low level TWT is bypassed to prevent early saturation and

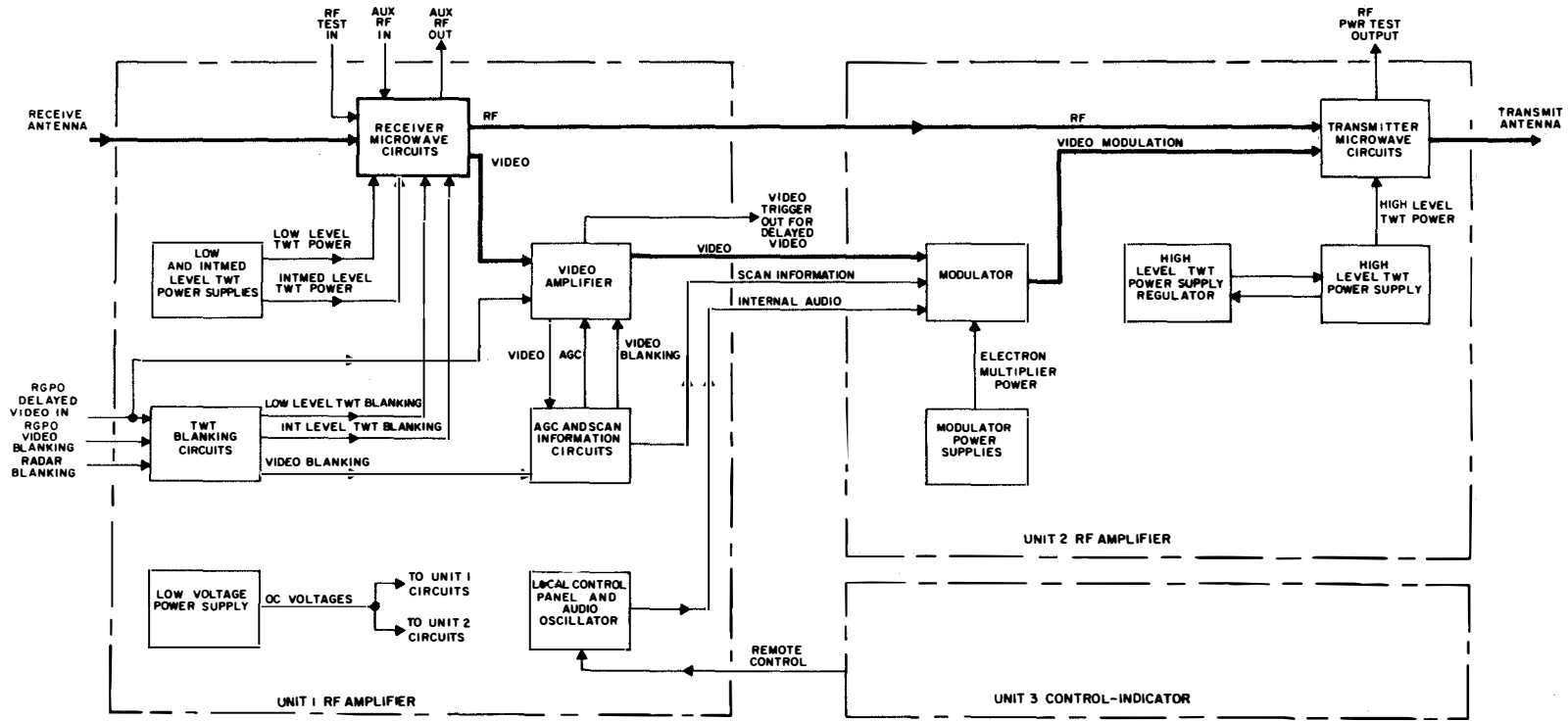


Figure 8-2.—(C) Countermeasures set block diagram (C).

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dynamic range compression (as the equipment is used with high gain antennas in these modes).

### **Unit 1 TRACKBREAK Mode Receiver Circuit**

(C) Figure 8-3 shows the receiver microwave circuit configuration for the TRACKBREAK mode. In the TRACKBREAK mode, the 4-port microwave switches are deenergized, the low level traveling wave tube is bypassed, and the intermediate level TWT becomes the first RF amplifier.

(C) Signals from the receive antenna are fed through the main line to the 1st 10 dB directional coupler. From the directional coupler, the signals are applied to the 1st switched attenuator, which is normally set for 0 dB attenuation. This attenuator control is adjusted at a particular installation to compensate for differences in isolation between the receive and transmit antennas. From the 1st switched attenuator, the signal goes through the 1st 4-port microwave switch, the 6 dB directional coupler, the 2nd 10 dB directional coupler, the 2nd microwave switch, the 2nd switched attenuator, and then to the intermediate level TWT input. The 2nd attenuator is set to prevent saturation of the video detector. The 6 dB directional coupler couples a portion of the incoming signal through ports 4 and 3 of the 1st switch to the low level TWT. The amplifier output of the TWT goes through ports 4 and 3 of the 2nd switch to the associated RGPO unit.

(C) The auxiliary RF input from the RGPO unit is applied through the coupling arm of the 2nd 10 dB directional coupler into the main input line. The 2nd switched attenuator is used to adjust the intermediate level TWT gain in the TRACKBREAK modes of operation. The amplified RF output of the intermediate level TWT is applied through the 3rd 10 dB directional coupler to the output flange. A sample of this output signal is connected to a video detector, which detects the RF signal and furnishes this detected video to the video amplifier.

(C) The low level TWT blanking input is a negative pulse coincident with the blanking input from the associated RGPO unit during RGPO operation. This pulse is applied to the

low level TWT to gate the tube off for that portion of the RF pulse not required by the RGPO unit.

(C) The intermediate level TWT blanking input, a composite of the blanking input and delayed video input from the RGPO unit and the radar blanking signal, is applied to the intermediate level TWT. The RGPO blanking input acts to gate the tube off for that portion of the input pulses not required by the RGPO unit, as well as to prevent the wide RGPO RF output pulse from blocking the video amplifier. The delayed video pulse unblanks the TWT to allow transmission of the coincident portion of the RGPO RF pulse. The radar blanking signal acts, in all operating modes, to gate the TWT off to prevent transmission due to own ship's radar input signals.

### **Unit 1 DECOY Mode Receiver Circuit**

(C) In the DECOY mode of operation, as opposed to the TRACKBREAK mode, the two microwave switches and the two switched attenuators are energized and the low level TWT is employed as the 1st RF amplifier (fig. 8-4).

(C) The RF input signal proceeds through the directional coupler and switches attenuator as described for the TRACKBREAK mode. The switched attenuator is again adjusted to compensate for antenna isolation at a particular installation. The signal out of the switched attenuator is routed through ports 2 and 3 of the 1st microwave switch to the input of the low level TWT. The amplified output of the low level TWT goes through ports 4 and 2 of the 2nd microwave switch to the 2nd switched attenuator, and then to the input of the intermediate level TWT. The 2nd attenuator is now set to adjust the intermediate level gain to the DECOY mode. The amplified output of the intermediate level TWT passes through the 3rd 10 dB directional coupler and out of the unit (also as described in the TRACKBREAK mode).

### **Unit 1 Video Amplifier**

(C) The video amplifier provides the circuitry to amplify the output of the video

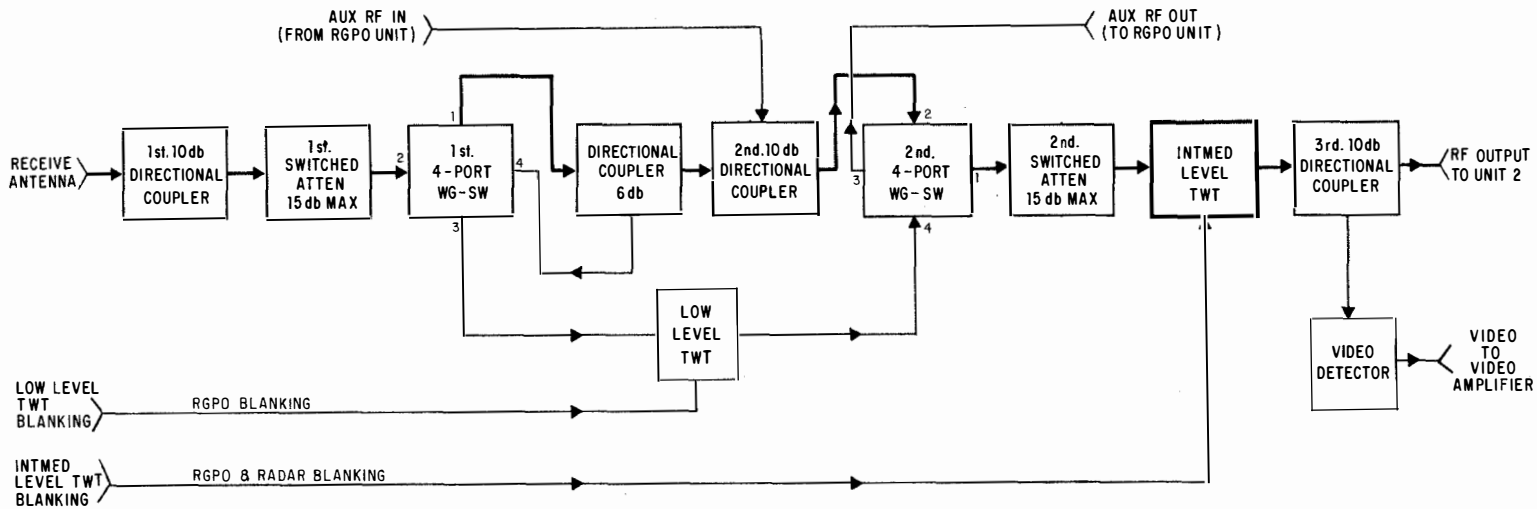


Figure 8-3.--(C) Unit 1 receiver circuit (TRACKBREAK mode) (C).

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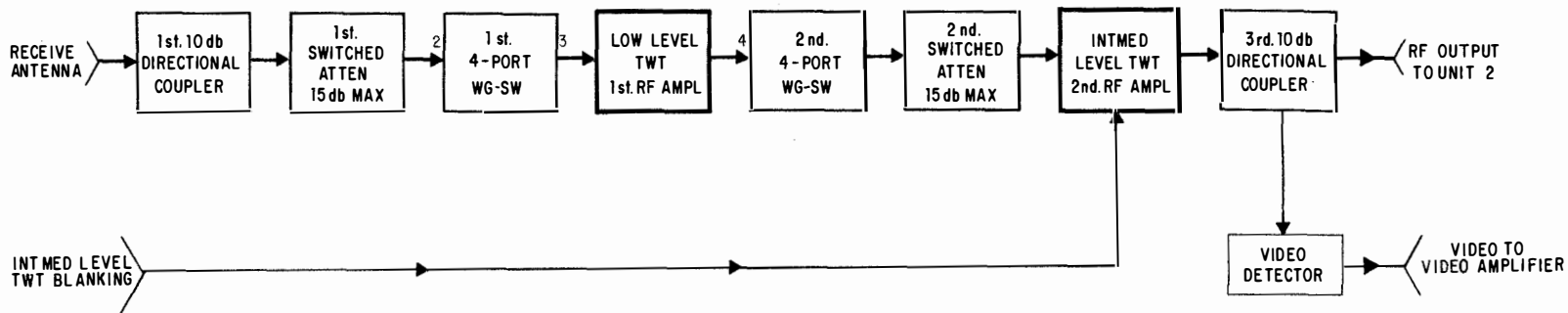
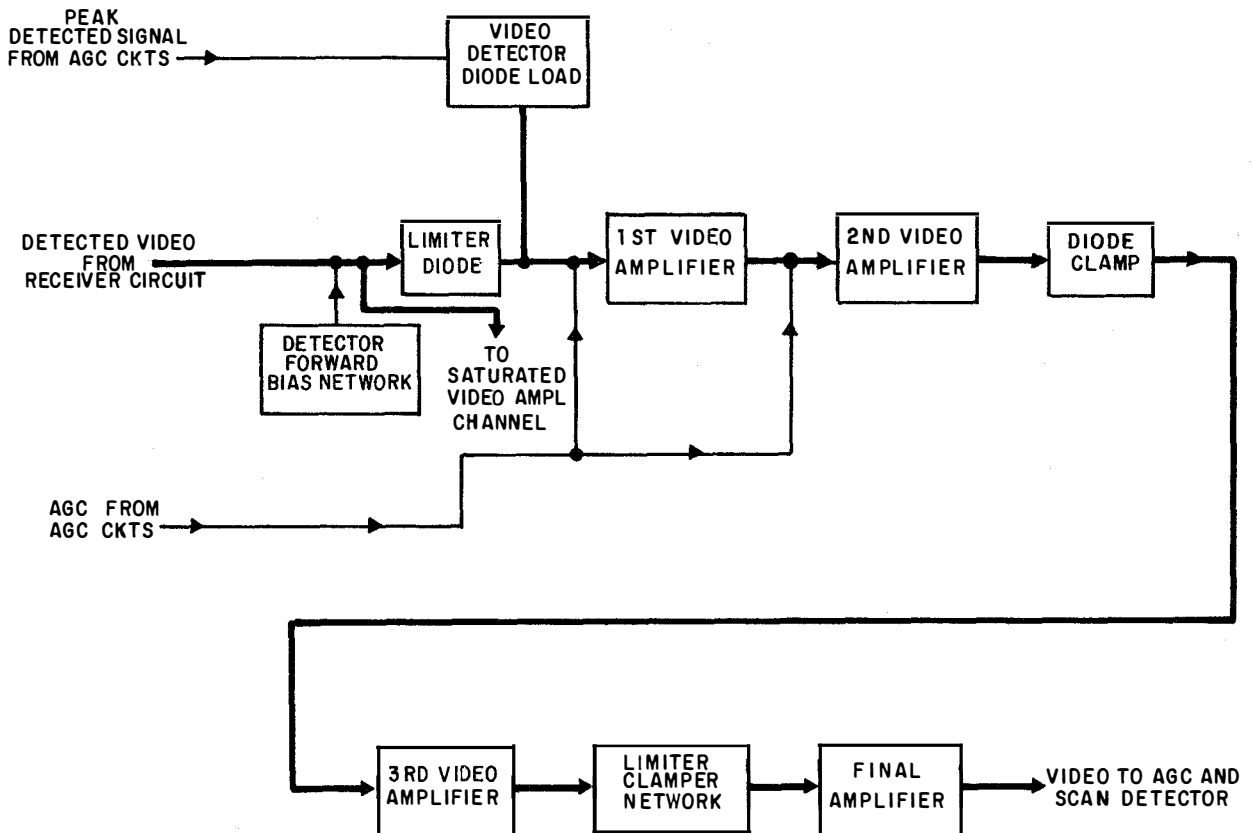


Figure 8-4.--(C) Unit 1 receiver circuit (DECOY mode) (C).

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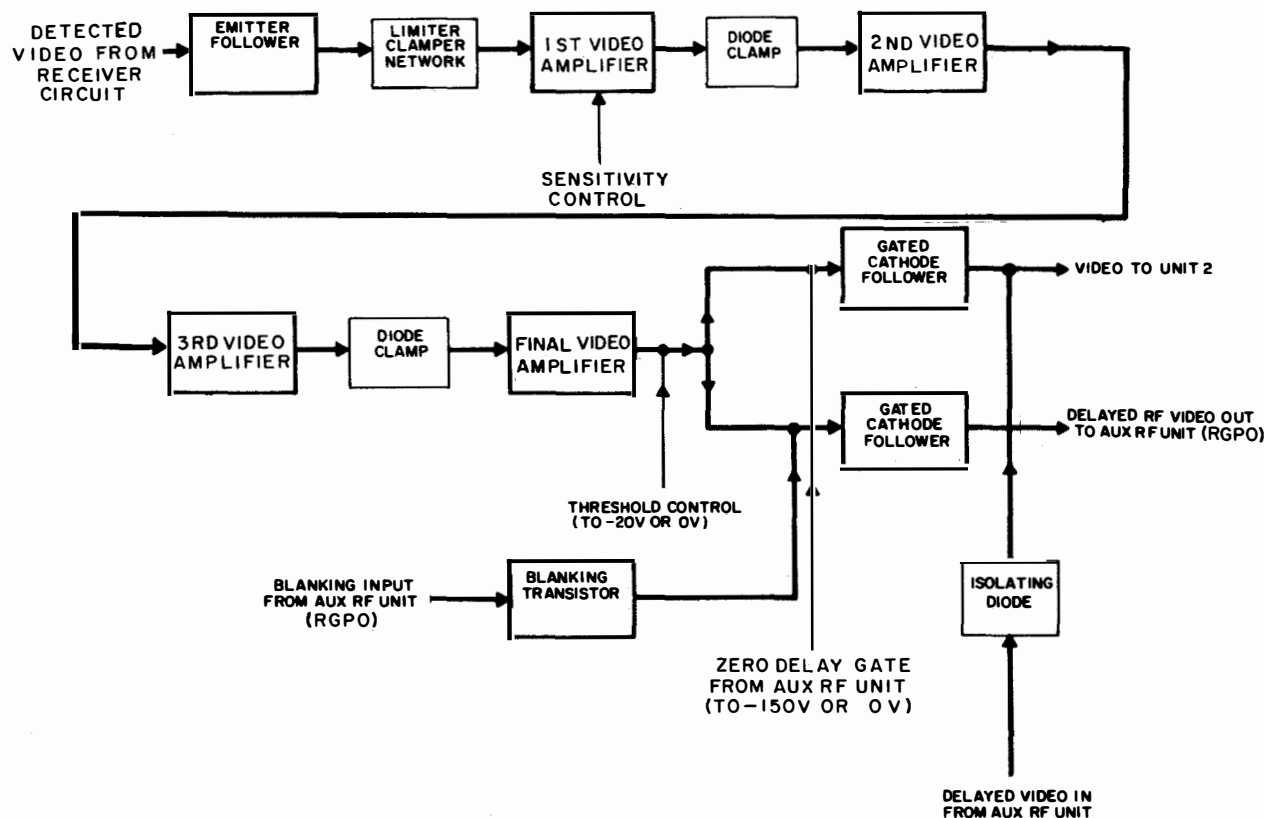
Figure 8-5.—(C) Unit 1 video amplifier (linear channel) (C).

detector. It contains a dynamic load for the video detector and two channels; a linear video amplifier, and a saturated video amplifier. The block diagrams for the video amplifier channels are given in figures 8-5 and 8-6.

(C) The video detector diode load is controlled by the AGC circuitry to present a high load impedance for low signal levels, and a low impedance for high signal levels. In this manner, it acts to reduce the detector output voltage swing and allows the detector to accommodate higher input levels without saturating.

(C) The video signal from the video detector diode in the receiver microwave circuits is applied to the 1st video amplifier. A limiter diode (fig. 8-5) is provided at the amplifier input to limit strong video signals; attenuation of low

level video signals is negligible. To flatten the frequency response and enhance the signal-to-noise ratio of the video detector, forward bias is provided. The video signal is applied simultaneously to the video detector diode load tube, and to the two video amplifier channels. The diode load tube provides a dynamic load for the video detector diode. On high signal levels, the load tube conducts a greater amount as it is connected to a peak detector in the AGC circuit and acts as a low impedance. For low signal levels, the opposite effect is true, and the diode load presents a high impedance to the video detector. The action of the diode load supplements the AGC of the system by reducing the high level detector output, and increases the RF power which can be accommodated by the video detector without distortion.

**CONFIDENTIAL**

067.277

Figure 8-6.—(C) Unit 1 video amplifier (saturated channel) (C).

(C) LINEAR VIDEO AMPLIFIER.—As shown in figure 8-5, the linear video amplifier channel consists of four video amplifiers, which provide an output video signal to the AGC and scan detector circuits. The linear video amplifier channel is subjected to a large range of input signals as the RF signals go from threshold to saturation levels. Therefore, the first two stages are controlled by AGC voltage to provide the large dynamic range required.

(C) Different quiescent AGC levels are automatically applied for the TRACKBREAK and DECOY modes of system operation. As only one stage of RF amplification is used prior to the detector in the TRACKBREAK mode, the video detector input and output levels are lower and, therefore, a smaller amount of bias is applied for this mode than for the DECOY mode. The input signal is amplified in the first

two video amplifiers. The 2nd amplifier applies the signal through a diode clamp to the 3rd video amplifier. The diode clamp eliminates any trailing edge overshoot to aid recovery after strong signals. The 3rd video amplifier supplies the final video amplifier through a limiter-clamper network. The network limits the amplitude of strong signals and clamps the baseline to zero volts. The final video amplifier again amplifies the signal and supplies it to the AGC and scan detector circuits.

(C) SATURATED VIDEO AMPLIFIER.—The saturated video amplifier channel (fig. 8-6) consists of an emitter follower and four transistor stages driven to saturation. The 1st and 3rd amplifiers are NPN semiconductors, while the 2nd and 4th are PNP. The alternate polarity of these cascaded

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transistors allows each transistor to be driven to saturation, thus minimizing overshoot and recovery problems. The overall channel is a high gain video amplifier which introduces a minimum time delay to the video signal. The outputs are used for gating the modulator and the auxiliary RF (RGPO) unit.

(C) The signal is applied to the emitter follower, which isolates the saturated video amplifier channel from the linear amplifier channel and supplies the video signal to the 1st video amplifier. Positive and negative overshoots are clipped by the limiter-clamper network which also limits the input signal. The signal is amplified by the video amplifier and applied to the 2nd video amplifier through a clamping diode. The sensitivity of the saturated video channel is controlled at the 1st amplifier by controlling the gain of this stage. The sensitivity is separately adjusted in the TRACKBREAK and DECOY modes. The channel is made less sensitive in the DECOY mode since the input noise level is higher than in the TRACKBREAK modes. The 2nd amplifier amplifies the video signal and applies it to the 3rd amplifier. The output of this video amplifier is applied to the 4th (final) amplifier through another diode clamp, which aids recovery on strong signals. The signal is again amplified and supplied to the gated cathode followers. A threshold potentiometer controls the output of the final amplifier. Zero volts is applied to the collector to disable the stage until such time as the signal strength from the antenna exceeds a predetermined threshold level. At this time, a negative voltage is applied to the collector, enabling the stage and allowing output pulses to pass on to the cathode followers. The video output of one cathode follower is applied to the auxiliary RF (RGPO) unit where it is utilized as a trigger pulse. During the time the auxiliary RF input from the RGPO unit is present, a positive video blanking signal is applied to the base of the blanking transistor, causing the transistor to look like a short circuit to the pulse at the grid of this cathode follower. The detected RGPO pulse, therefore, is prevented from retriggering the RGPO unit. The saturated video pulses for the modulator in unit 2 are supplied by the other gated cathode follower. The grid of this

cathode follower is controlled by a zero delay gate from the auxiliary RF unit. Normally this point is at zero volts to allow video pulses to pass through the cathode follower to the unit 2 modulator. During RGPO operation the gate remains at zero volts for the dwell time; then the gate applies a negative voltage to cut off the tube and prevent the receive antenna pulses from being transmitted. The delayed video input pulses from the auxiliary RF unit are applied to the cathode follower output through an isolating diode and out to unit 2. These pulses are needed to gate the unit 2 modulator to transmit RGPO pulses since the detected pulses through the saturated video channel are blocked at the cathode follower input by the zero delay gate.

#### **Unit 1 AGC and Scan Information Circuits**

(C) The AGC and scan information circuits receive the amplified video pulse train from the linear video amplifier channel and develop the AGC and threshold control voltages for the video amplifier as well as the demodulated scan information for the modulator. This section contains three major functional circuit groups—pulse width limiting circuits, AGC and threshold circuits, and scan information circuits. The block diagrams for this section are given in figures 8-7 through 8-9.

(C) PULSE WIDTH LIMITING CIRCUITS.—The pulse width limiting circuits utilize only the first fraction of a microsecond of the amplified video pulses to provide a stretched pulse-for-pulse output to the other circuits in this section. The limiting circuits provide these standard width pulses to the AGC and scan detectors to ensure that the detectors are not sensitive to pulse width or repetition rate. In addition, pulse width limiting prevents sampling of the pulse during time periods of possible system oscillation. When RF regeneration is present, due to either system RF gain higher than the antenna isolation or from reflective surfaces in close proximity to the antennas, the system can act as an oscillator which increases the pulse amplitude and width

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until the system saturates. Any modulation on the pulse would therefore be lost. Because of the inherent system delay plus the transmission time between equipment and antennas, RF oscillation does not start until a fraction of a microsecond after a pulse is received. Therefore, limiting the pulse sampling time to the leading fraction of a microsecond minimizes the problem. After limiting, the pulses are stretched to provide interpulse storage of energy for the AGC, threshold, and scan information circuits.

(C) As the block diagram of figure 8-7 illustrates, video pulses from the linear video amplifier channel are applied to an isolating cathode follower whose output goes to the amplifier, the summing network, and the scan information circuits. The output pulse of the amplifier is delayed in a delay line and applied to the summing network, where it is added to the undelayed pulse from the cathode follower. The summing network output is a standard length wide pulse regardless of the input video pulse width. The stretched output pulses are supplied to both the scan information circuits and the AGC threshold circuits. A video blanking signal from the auxiliary RF (RGPO) unit is supplied to the input cathode follower to blank any video pulse developed from the RGPO

input pulse (which is coincident with the video blanking pulse). In this manner, RGPO pulses are prevented from affecting the AGC and scan information circuits.

(C) **AGC AND THRESHOLD CIRCUITS.**—The AGC and threshold circuits receive the stretched pulses and provide three outputs to the video amplifier section. The AGC output is a negative d.c. voltage proportional to input pulse amplitude, and is applied to the linear video amplifier channel to preserve the input video signal magnitudes. A second output controls the video detector diode load in the video amplifier to reduce the detector output voltage swing. The threshold control output enables the last stage of the saturated video amplifier channel when the input signal exceeds the threshold level.

(C) The stretched pulses from the pulse width limiting circuits are amplified by the 1st amplifier (figure 8-8) and then clamped to the quiescent AGC level for the TRACKBREAK or DECOY modes and peak detected in the peak detector and clamping network. The resulting negative d.c. level is applied to a cathode follower whose output is the AGC bus for the linear video amplifier. The 1st amplifier output

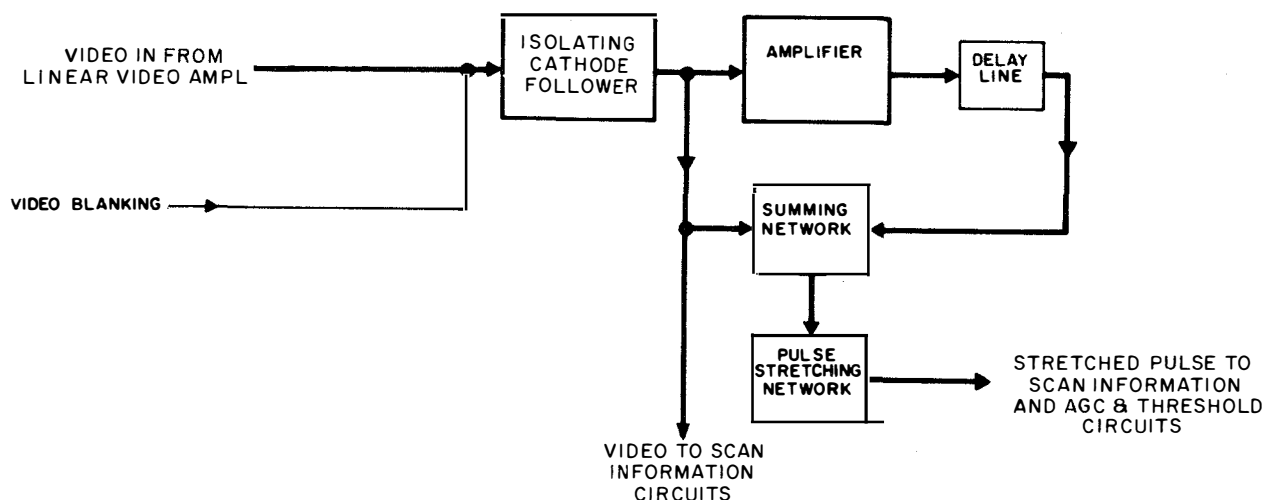
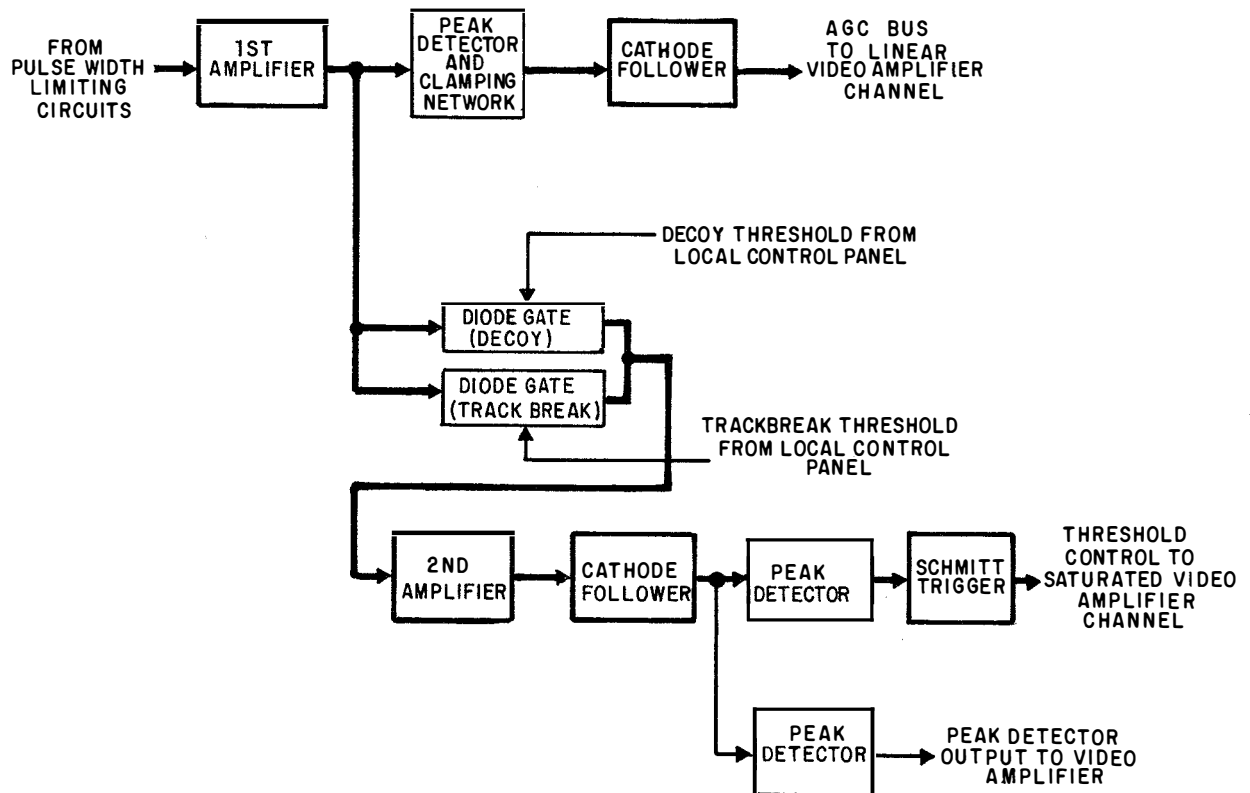


Figure 8-7.—(C) Unit 1 AGC and scan information (pulse width limiting circuits) (C).

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Figure 8-8.—(C) Unit 1 AGC and scan information (AGC and threshold circuits) (C).

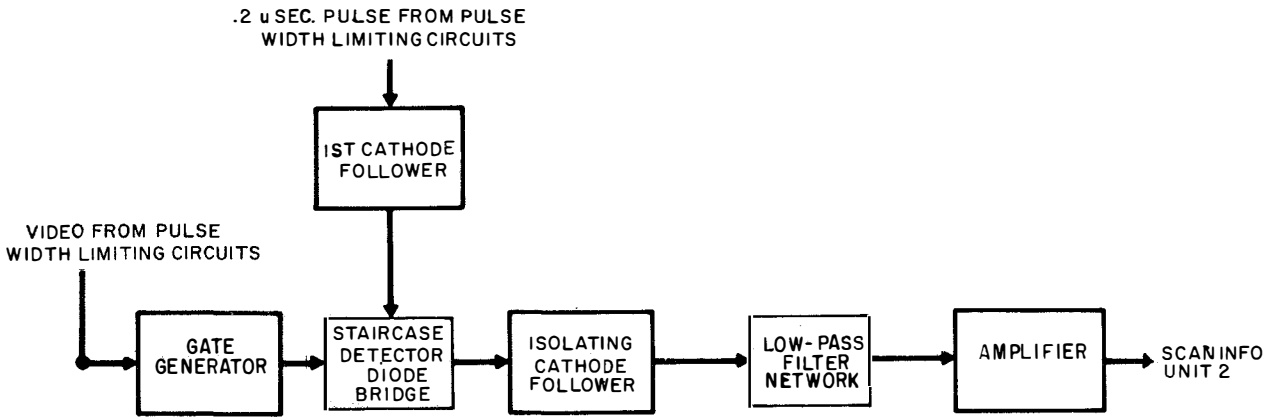
is also applied to the DECOY and TRACKBREAK threshold gating diodes. Depending upon the mode of operation, one diode inhibits and the other passes the negative, amplified, stretched pulses to the 2nd amplifier. The amplifier output is applied to the peak detector circuit through a cathode follower. The peak detector circuit output fires the Schmitt trigger, whose output drops from near zero volts to a negative voltage, which is supplied as collector voltage to the final video amplifier in the saturated video amplifier channel. The cathode follower output is also applied to another peak detector whose output controls the video amplifier diode load.

(C) SCAN INFORMATION CIRCUITS.—The scan information circuits receive the video input from the video amplifier as well as the stretched pulses from the pulse

width limiting circuits. The scan modulation on the latter pulses is demodulated in a staircase (or boxcar) detector and supplied to the unit 2 modulator.

(C) The scan information circuits are illustrated in figure 8-9. They receive both the input video from the cathode follower and the stretched pulses from the pulse stretching network of the pulse width limiting circuits. The video from the cathode follower is applied to the gate generator which generates a "sampling pulse" that is fed to the staircase (or boxcar) detector diode bridge and supplies the forward bias to enable the detector gate during the sampling pulse. The stretched pulses (coincident with the sampling pulse) are applied through the 1st cathode follower to the staircase detector. A staircase pattern which is in accordance with the modulation envelope of the incoming pulse is

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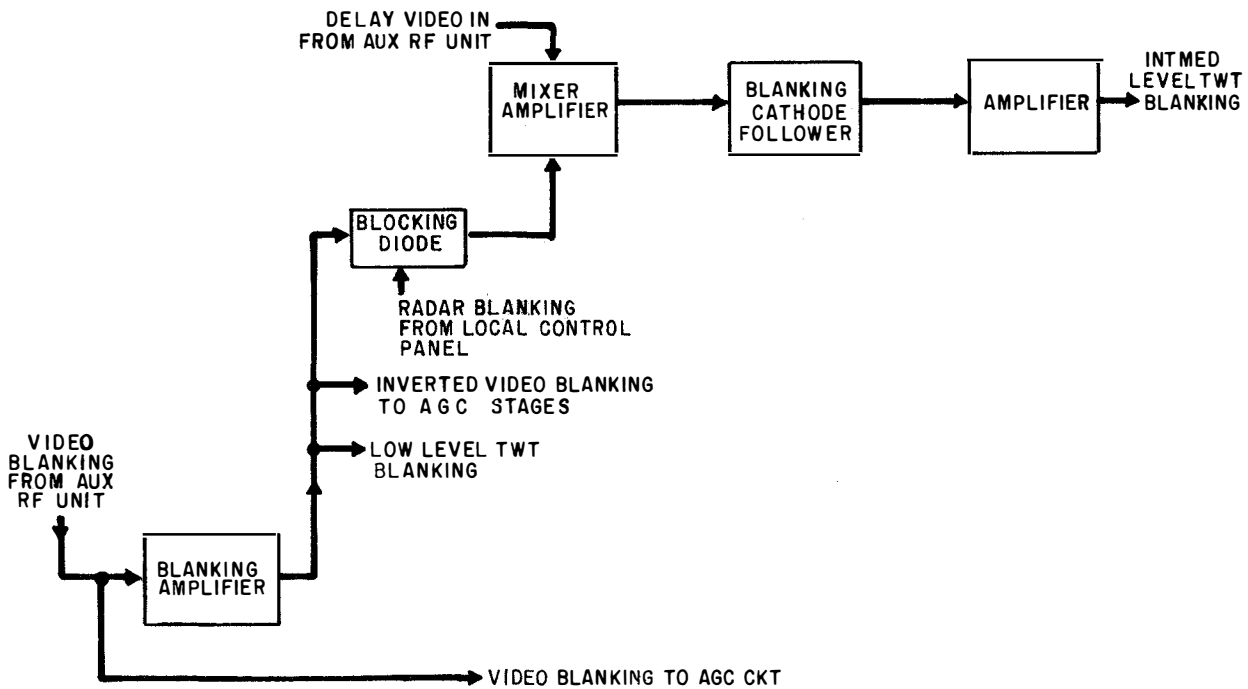
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Figure 8-9.—(C) Unit 1 AGC and scan information (scan information circuits) (C).

applied through an isolating cathode follower to a low-pass filter network which smooths the voltage steps. The resultant sine wave is amplified and the output signal is supplied to the unit 2 modulator.

**Unit 1 TWT Blanking Circuits**

(C) The TWT blanking circuits receive the radar blinking signal and various blanking signals



067.281

Figure 8-10.—(C) Unit 1 TWT blanking circuit (C).

CONFIDENTIAL

from the auxiliary RF (RGPO) unit. These signals are combined and routed to the TWTs and AGC circuits for blanking.

(C) The blanking section consists of four tubes for mixing and amplification of the various blanking signals. The block diagram for the TWT blanking circuits is given in figure 8-10.

(C) The positive video blanking signal from the auxiliary RF unit is applied to the blanking amplifier and also routed to the AGC circuit (from which it is applied to the video amplifier for blanking the saturated video amplifier channel). The amplified, inverted output of the blanking amplifier goes to three places; the low level TWT, the AGC circuits (where it is added to the positive video input from the linear video amplifier channel), and through a blocking diode to the mixer amplifier. The blocking diode keeps the positive video pulse, which is present on the lead to the AGC circuits, from reaching the mixer amplifier. The blocking diode also prevents the inverted video blanking signal from coupling back through the radar blanking input lead. The negative radar blanking signal is added

to the inverted video blanking signal in the mixer amplifier. The positive, delayed video signal from the auxiliary RF unit is also applied to the mixer amplifier so that the output is the sum of the radar blanking and video blanking minus the delayed video. This composite output goes through a blanking cathode follower and is again amplified. The amplified, negative, composite blanking signal is used to blank the intermediate level TWT.

**Unit 1 Local Control Panel and Audio Oscillator**

(C) The local control panel and audio oscillator contains all of the local operating controls and indicators. In addition, a variable oscillator signal is generated in the audio oscillator for use by the modulator circuits (and an external modulator) when desired by the operator.

(C) Equipment turn-on, mode selection, test checkout, and function monitoring are all performed at the local control panel. Figure 8-11 shows all operating controls and indicators.

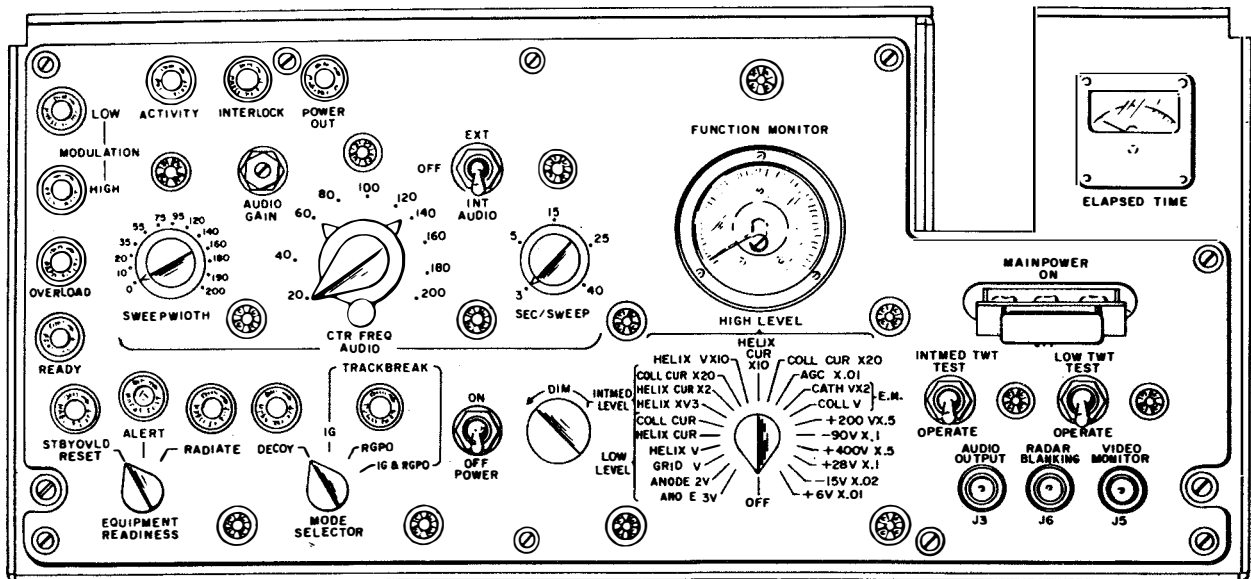


Figure 8-11.—(C) RF amplifier (unit 1) (C).

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(C) The block diagram for the audio oscillator is given in figure 8-12. The audio oscillator circuits utilize four vacuum tubes to provide a swept-frequency, audio signal whose center frequency, sweep width, and sweep period can each be separately varied from either the local or remote control panels.

(C) The sweep rate pulse generator consists of a unijunction transistor relaxation oscillator whose pulse repetition period is controlled by the voltage applied, and the RC time constant of the emitter circuit. The negative pulse train output of the sweep rate pulse generator is applied to both sides of the bistable multivibrator and alternately turns off first one

and then the other side. The resulting square wave is taken from the multivibrator and applied to an integrating circuit. The long time constant of this network results in an essentially linear sweep for both the positive and negative going portions of the input square wave, and the voltage excursion of the resulting triangular wave is kept relatively constant as the sweep period is changed. The triangular wave is applied through a cathode follower to the sweep amplifier. After amplification, the triangular wave is applied to a paraphase amplifier, which drives the control winding of the saturable reactor (oscillator variable inductance). The oscillator variable inductance is used to

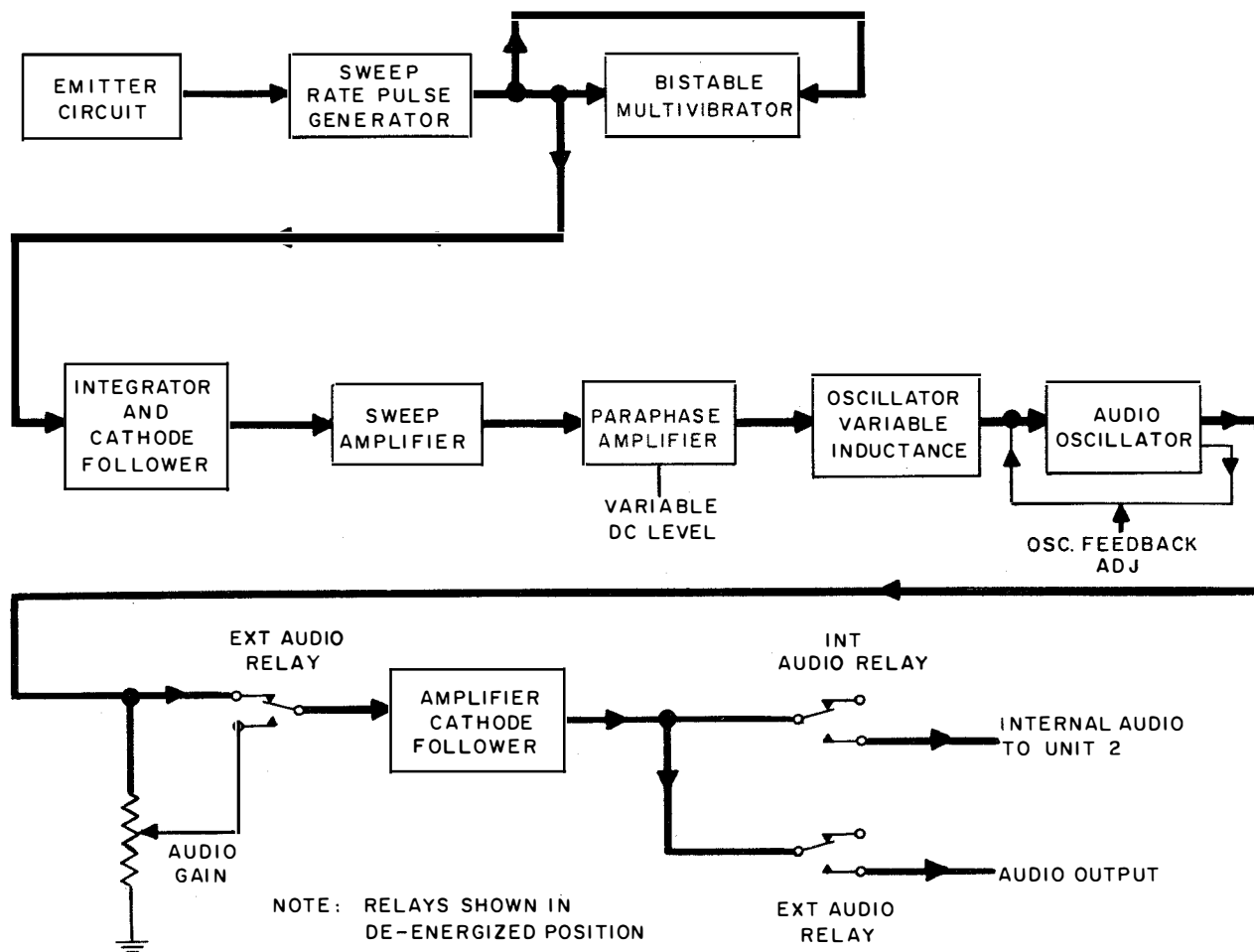


Figure 8-12.—(C) Unit 1 audio oscillator circuits (C).

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(C) Two input phases of 1550 v.a.c. are supplied across a half-wave rectifier circuit. The regulator section is a conventional cathode-referenced control amplifier, series pass-tube circuit. The series pass-tube acts as an instantaneously variable resistance in series with the load which maintains constant voltage across the load. The control amplifier functions as an error signal amplifier, comparing its cathode reference voltage (developed by the two regulators) and the voltage sample from the voltage divider network. This divider provides information on the attempted excursions of the regulated output voltage. Voltage sources for the focusing and acceleration electrodes (anodes 1, 2, and 3) of the TWT are provided by dividing networks on the regulated output. Grid bias is provided in parallel with the 1st zener regulator diode in the negative return leg of the supply. The regulated d.c. filament voltage for the TWT is developed across the second zener regulator, with the resulting 6.3 v.d.c., obtained from the

d.c. voltage output from the full-wave rectifier circuit. Current overload protection for the TWT helix is provided by a series relay whose contacts are part of the overload chain.

(C) The intermediate level TWT power supply is an electrically independent supply which provides negative operating voltages to the intermediate level TWT. The cathode is supplied a negative 3000 volts.

(C) This power supply block diagram is shown in figure 8-14. It applies its input power (1600 v.a.c.) to the voltage doubler circuit. The doubler output feeds the regulator section (consisting of two paralleled series pass-tubes). These tubes act as instantaneously variable resistors in series with the load which maintains a constant voltage across the load. The control amplifier provides a variable control voltage to the series pass-tube grids. The two sections of the control tube are connected as a cathode-coupled difference amplifier whose output error voltage is a function of the

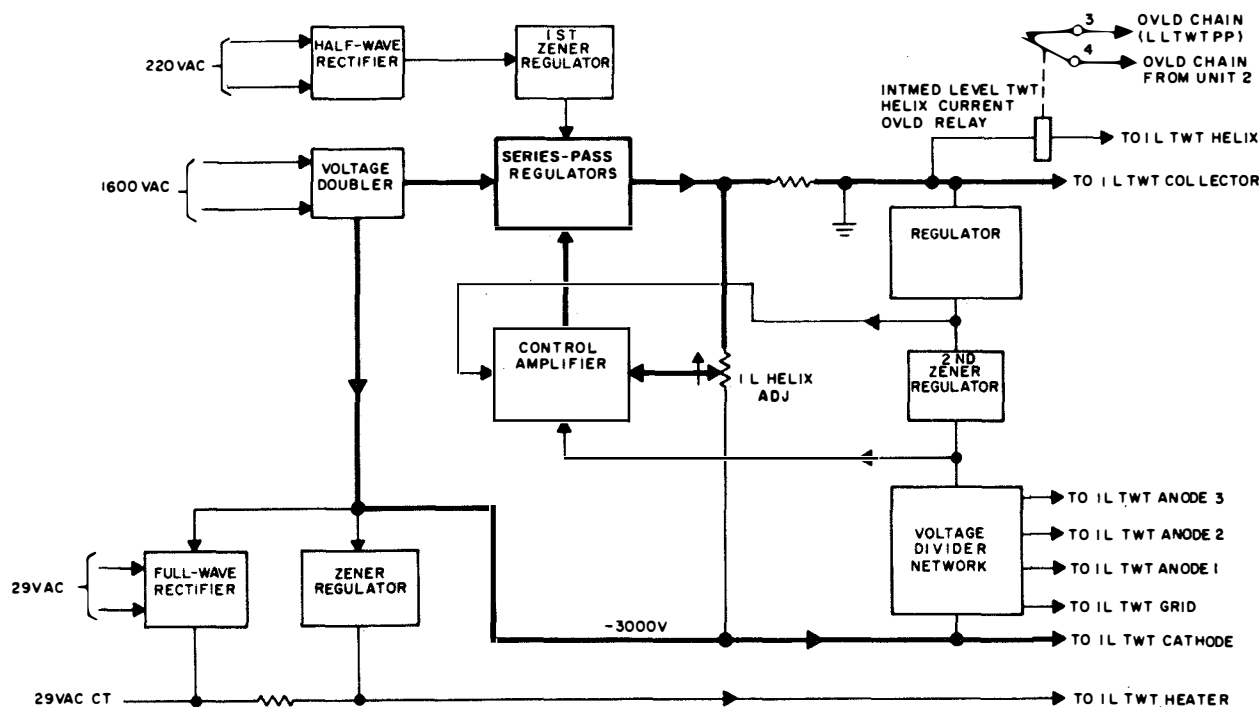


Figure 8-14.—(C) Unit 1 intermediate level TWT power supply (C).

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difference between the two grids. One grid and the cathode are returned to the fixed regulated voltages through the action of the regulator tube and the 2nd zener regulator, respectively. A portion of the output voltage is developed across the IL HELIX ADJ potentiometer and applied to the other difference amplifier grid. As the output voltage tries to go more negative, the control amplifier supplies a negative-going error voltage to the grids of the series pass-tubes which increases the drop across the pass-tubes and keeps the output voltage constant. Voltages for the grid and three anodes are provided from taps on a voltage divider network across the regulated output. A regulated d.c. voltage for the intermediate level TWT filaments is developed, and current overload protection for the TWT helix is provided in the same manner as for the low level TWT.

#### Unit 1 Low Voltage Power Supply

(C) The low voltage power supply portion of unit 1 consists of four functional circuit groups; the +200 v. power supply, the +400 v. power supply, the -90 v. power supply, and the +6 v. and -15 v. power supply.

(C) +200 V. POWER SUPPLY.—The +200 v. power supply receives a three-phase, 200 v.a.c.

input and provides a regulated +200 v.d.c. output for use as plate voltage in units 1 and 2.

(C) As shown in figure 8-15, the +200 v. power supply utilizes three-phase power and three-phase full-wave bridge rectifiers because of the high d.c. current requirement. The regulator circuit is a conventional series type of degenerate regulator utilizing a power triode as the series pass regulator tube. A portion of the output voltage is developed across the +200 v. ADJ potentiometer and applied to the grid of the d.c. control amplifier whose cathode is returned to a fixed regulated (or reference) voltage from the +400 v. supply. The control amplifier plate drives the control grid of the series pass-tube. Therefore, any change in output voltage is applied degeneratively, through the control amplifier, to the series regulator.

(C) +400 V. POWER SUPPLY.—The +400 v. power supply receives a three-phase, 420 v.a.c. input, and provides a regulated +400 v.d.c. to unit 2.

(C) The +400 v. power supply (figure 8-16) is nearly identical to the +200 v. power supply described above. A three-phase, full-wave rectifier bridge, series regulator, and d.c. control amplifier are utilized as described above with the output voltage sample for the control amplifier being developed across the +400 v. ADJ potentiometer. The voltage regulator tubes are

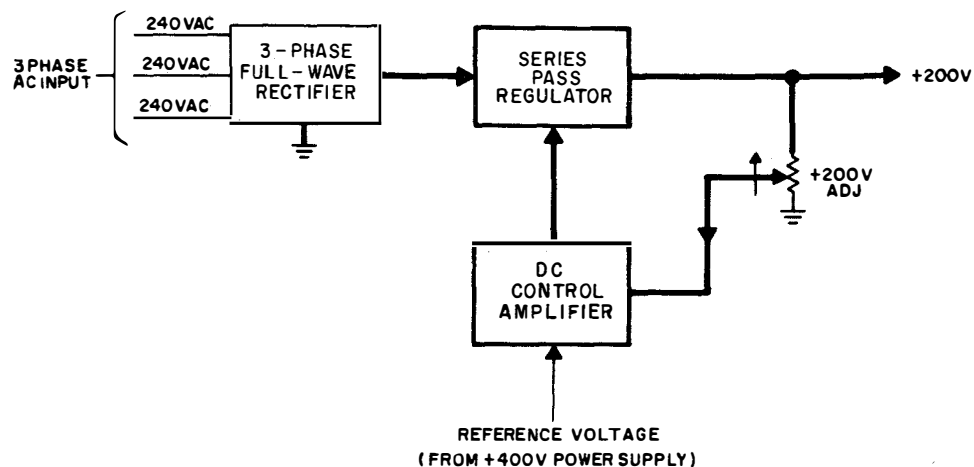
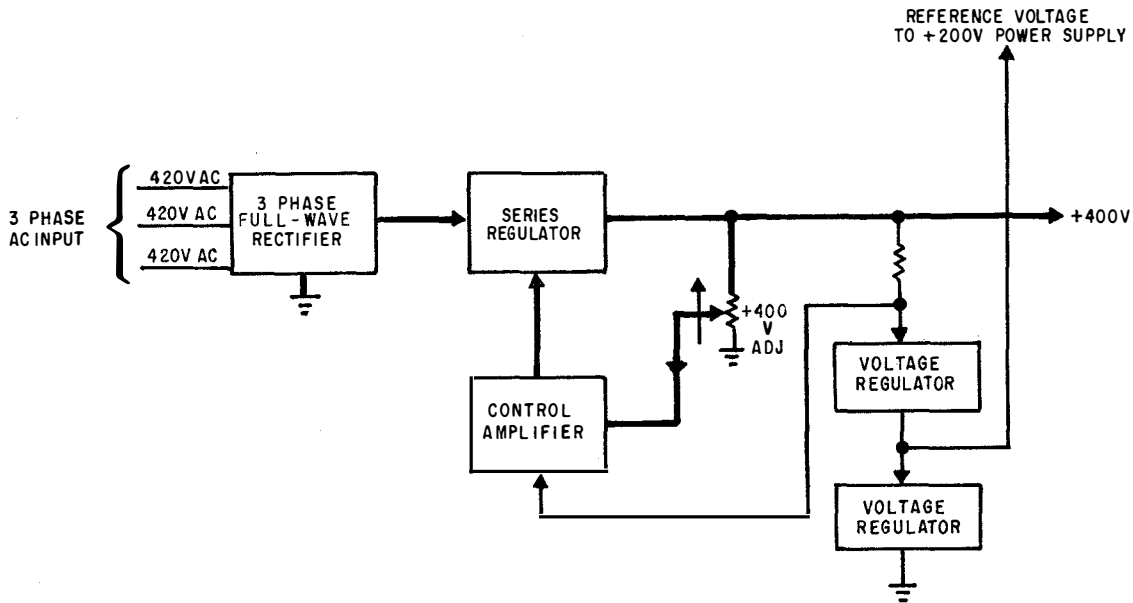


Figure 8-15.—(C) Unit 1 +200 V power supply (C).

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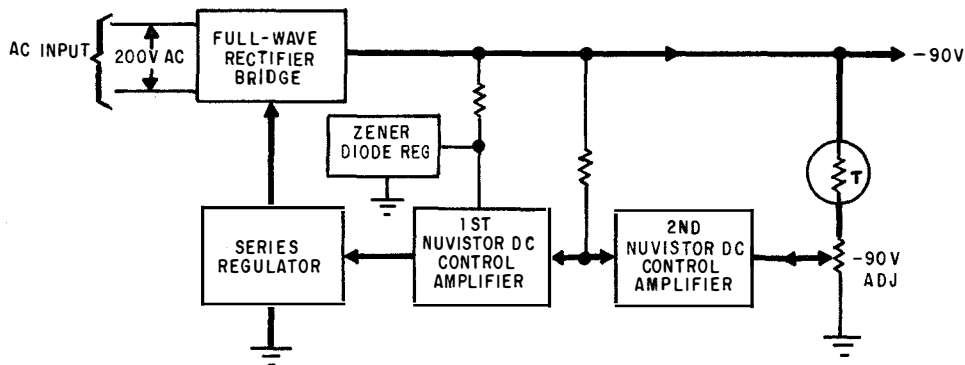
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Figure 8-16.—(C) Unit 1 +400 V power supply (C).

used to provide stable reference voltages for the cathodes of the control amplifiers in the +200 v. and +400 v. supplies.

(C) -90 V. POWER SUPPLY.—The -90 v. power supply uses two phases of 200 v.a.c. to develop a regulated -90 v.d.c. for use in units 1 and 2.

(C) The block diagram of the -90 v. power supply is illustrated in figure 8-17. The two input phases are applied across a full-wave rectifier bridge. The series regulator is in the ground return leg of this supply, but acts in the same manner as those previously described. A portion of the output voltage is developed across the -90 v. ADJ potentiometer and applied to the



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Figure 8-17.—(C) Unit 1 -90 V. power supply (C).

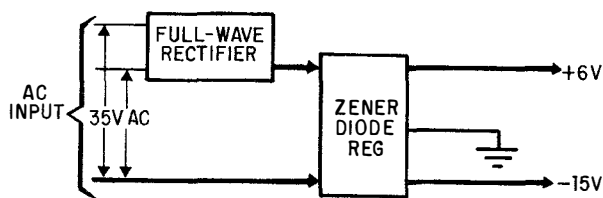
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grid of the 2nd nuvistor control amplifier, which is cathode-coupled to the 1st nuvistor control amplifier. The 1st nuvistor amplifier grid is tied to a reference voltage developed across a zener diode regulator. The two control amplifiers act together as a difference amplifier, therefore the 1st amplifier plate goes more or less positive as the 2nd amplifier grid goes less or more negative. The 1st amplifier plate signal controls the series pass-tube grid, thereby providing the necessary degenerate action. The thermistor provides the temperature compensation of the 2nd control amplifier grid voltage since the zener diode voltage at the grid of the 1st amplifier varies somewhat with temperature.

(C) +6 V. and -15 V. POWER SUPPLY.—The +6 v. and -15 v. power supply receives two phases (and the center tap) at 35 v.a.c. and supplies zener-diode regulated +6 v.d.c. and -15 v.d.c. for use by the video amplifier and local control assembly transistor circuits. Because the regulation requirements for these voltages are not severe, these supplies are quite simple, as figure 8-18 illustrates. The input voltages are applied to a full-wave rectifier. The d.c. output voltage is applied across the zener diode regulating circuit, with a ground reference supplied between the diodes, thus obtaining +6 v. and -15 v.

### RF AMPLIFIER (UNIT 2)

(C) Unit 2 contains three major subassemblies: a modulator, a power supply, and a high level TWT power supply, plus the cabinet-mounted RF components of the transmitter circuits, and primary power circuits.



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Figure 8-18.—(C) Unit 1 +6 V. and -15 V. power supply (C).

### Unit 2 Transmitter Circuits

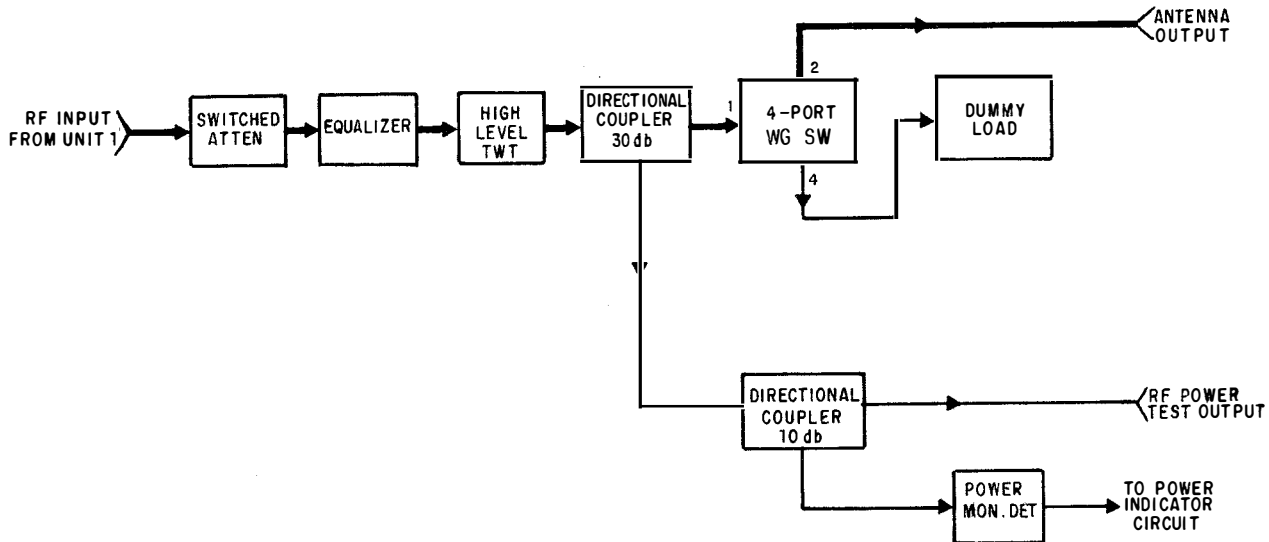
(C) The operation of the transmitter microwave circuits is the same for both the TRACKBREAK or DECOY modes of operation and is shown in block diagram form in figure 8-19. The RF signal from unit 1 is applied to a switched attenuator whose attenuation is separately adjusted for both modes. The attenuator output goes through the equalizer (to flatten the overall frequency response), and then to the high level TWT. The amplified output of the TWT goes to a 30 dB directional coupler whose main arm in turn connects to a 4-port microwave switch. In the RADIATE condition, the output signal goes through the deenergized ports 1 and 2 to the transmitting antennas. In the ALERT condition the switch is energized and the output terminated in the dummy load, which is capable of dissipating the full-power output.

(C) A sample of the RF output is taken from the 30 dB directional coupler and applied, through a 10 dB directional coupler, to the PWR TEST OUTPUT adapter. A separate sample from the 10 dB directional coupler is sent to a detector, whose output goes to the power monitor circuitry.

### Unit 2 Modulator

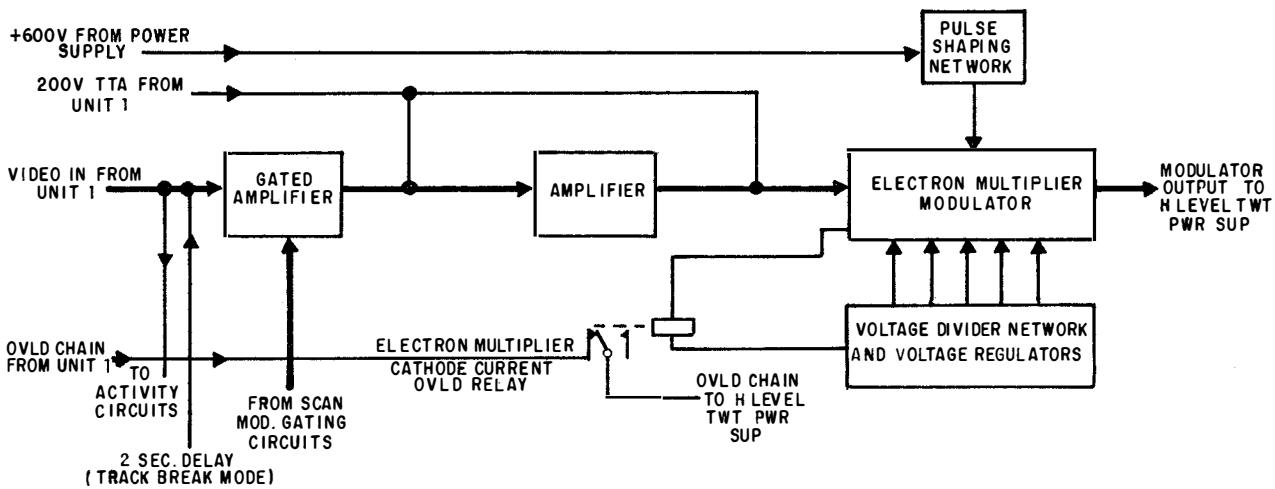
(C) The modulator assembly contains the necessary circuitry to turn on the high level TWT. In addition, it provides various other functions such as scan modulation amplification and gating, pulse width limiting, activity indication, and delay, percent modulation indication, power indication and duty cycle overload.

(C) MODULATION CIRCUITS.—The modulator circuits (figure 8-20) contain the gated and modulator driver amplifiers and the electron multiplier modulator, together with voltage dividers and regulators for the electron multiplier dynodes. The circuit group receives video amplifier plus two gating signals; one a combined pulse width limiting and scan modulating gating signal from the scan

**CONFIDENTIAL**

067.290

Figure 8-19.—(C) Unit 2 transmitter circuit (C).



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Figure 8-20.—(C) Unit 2 modulator (modulator circuits) (C).

modulation gating circuits, and the other, a 2-second delay activity gate (in the TRACKBREAK modes only) from the activity circuits. In the DECOY mode, the scan modulation gate and activity gate are disabled; the gated amplifier is normally on, and is gated off only through pulse width limiting action.

Therefore, for each video input pulse, a modulator output pulse is supplied to the high level TWT. In all TRACKBREAK modes, the gated amplifier is biased off by the 2-second delay activity gate until input video signals are present for two or more seconds. Conversely, once activated, the gate biases the amplifier on

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until signals are lost for two or more seconds, thus making the equipment insensitive to momentary loss of signal. In the inverse gain (IG) mode, the gated amplifier is gated on during the trough of the modulation envelope on the received pulse train by the scan modulation gate (minus the pulse width limiting gate). In the RGPO mode, the scan modulation gate is disabled. In the IG + RGPO mode, the amplifier is gated off by the scan modulation gate during the peak of the received pulse train modulation envelope.

(C) The plate voltage for the two amplifiers is supplied from the low voltage power supply circuits in unit 1, and is temporarily removed to disable the modulator drive under duty cycle overload condition.

(C) The electron multiplier modulator itself is an electron multiplier tube which operates on the secondary emission principle and exhibits good rise time, low delay, and fast recovery characteristics. A total of nine elements are employed in the tube, which include cathode, control grid, accelerating grid, five cascaded dynodes, and a collector; the output is taken from the last dynode. Electrons leaving the cathode are accelerated and then travel through the five dynode elements to the collector. Each dynode is held at a progressively higher potential with respect to the cathode so that some

electrons strike these elements. This collision causes secondary emission of the dynode elements similar to that experienced in a tetrode vacuum tube. The overall effect at the last dynode is a high electron density or electron multiplication for the interval the tube is gated on. The voltage regulators regulate the potentials for the second, third, and fourth dynodes to ensure stable operation.

(C) The pulse shaping network provides a rising pulse top (or ramp) to compensate for pulse droop due to the TWT grid coupling capacitor and high level TWT power supply.

(C) SCAN MODULATION GATING CIRCUITS.—The scan modulation gating circuits (illustrated in figure 8-21) receive the scan modulation signal from the unit 1 scan information circuits, the internal audio signal from the local control panel audio oscillator, the pulse width limiting gate, and also various scan control signals. The control signals are used to select the proper phasing, depending upon the mode of operation as described above, for the output scan modulating gating signal which controls the screen grid voltage of the modulator circuit gated amplifier. This scan modulation gate is generated when the scan modulation signal reaches a level corresponding to a set percentage of modulation. The pulse width

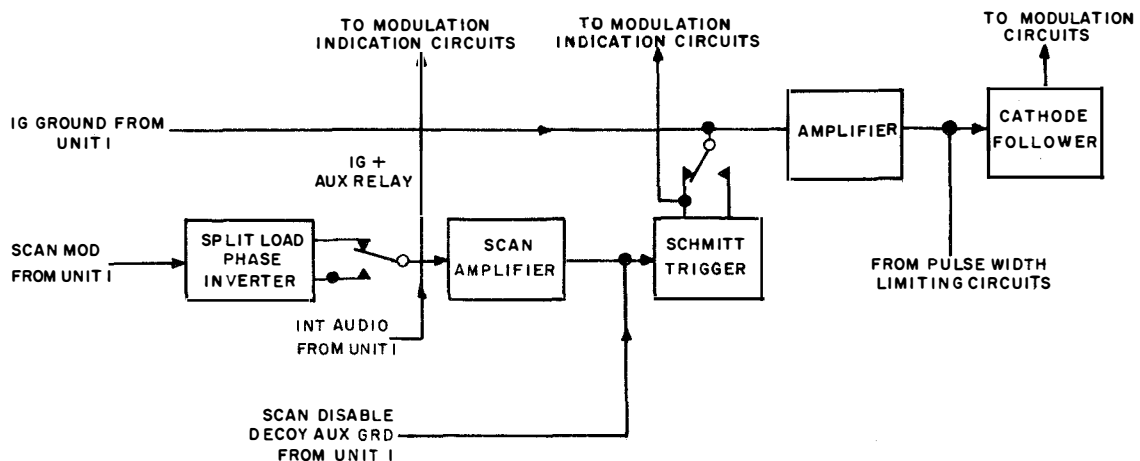


Figure 8-21.—(C) Unit 2 modulator (scan modulation gating circuits) (C).

067.292

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limiting gate is added to the scan modulation gate at the output cathode follower.

(C) The gating circuits input stage is a split load phase inverter which supplies two outputs: a cathode output which is in phase with the unit 1 signal, and a plate output which is  $180^\circ$  out of phase (in phase with the received radar signal). The IG + AUX relay selects the correct phase and supplies it to both the scan amplifier and the modulation indication circuits. The internal audio signal is coupled to the scan amplifier. The amplified output is applied to a Schmitt trigger which has one half normally in conduction and the other half normally cut off. Two essentially square-wave output gates are obtained from the two Schmitt trigger plates (one in phase, with the other  $180^\circ$  out of phase, with the received radar signal). The proper output is selected by contacts of the IG + AUX relay and connected to an amplifier. The amplifier is driven either from saturation to cut-off (in the IG mode) or from cut-off to saturation (in the IG + RGPO mode) by the square-wave gate. The amplifier output is d.c. coupled to a cathode follower which supplies screen voltage to the gated amplifier in the modulator circuits. The chopped input from the pulse width limiting circuits is also supplied through the cathode follower to gate the gated amplifier off during the negative portion of the chopped input.

(C) In the DECOY and RGPO modes of operation, the scan amplifier is disabled by grounding its plate supply; therefore, no gate is generated. In these modes, the amplifier-cathode

follower circuits act to keep the gated amplifier (figure 8-20) in a normally on condition.

(C) In the IG mode the gated amplifier is normally off, and in the IG + RGPO mode the amplifier-cathode follower circuits function to keep the gated amplifier normally on as in the DECOY and RGPO modes. The IG + AUX relay is energized in this mode, and there is only one phase inversion in the scan amplifier. The positive portion of the Schmitt trigger output square wave corresponds to the negative portion of the input scan modulation (or the peak of the received radar pulses). Thus, the gated amplifier is gated off during the peak of the received RF pulse train modulation.

(C) PULSE WIDTH LIMITING CIRCUITS.—The pulse width limiting circuits of figure 8-22 receive the modulator input pulses and limit the modulator output pulses to  $1 \mu\text{sec}$ . in the TRACKBREAK mode ( $5 \mu\text{sec}$  in the DECOY mode) to prevent spurious RF build-up of the transmitted pulse due to leakage and/or reflection. For input pulse widths greater than 1 (or  $5 \mu\text{sec}$ , depending upon the mode of operation) microsecond, a gate is generated which turns off the modulator circuit gated amplifier for a preset period of from .2 to .5  $\mu\text{sec}$ . Thus, wide input pulses result in chopped output pulses with 1 or  $5 \mu\text{sec}$ . on-time and .5  $\mu\text{sec}$ . maximum off-time.

(C) The positive, saturated video input pulses from unit 1 are supplied to the base of

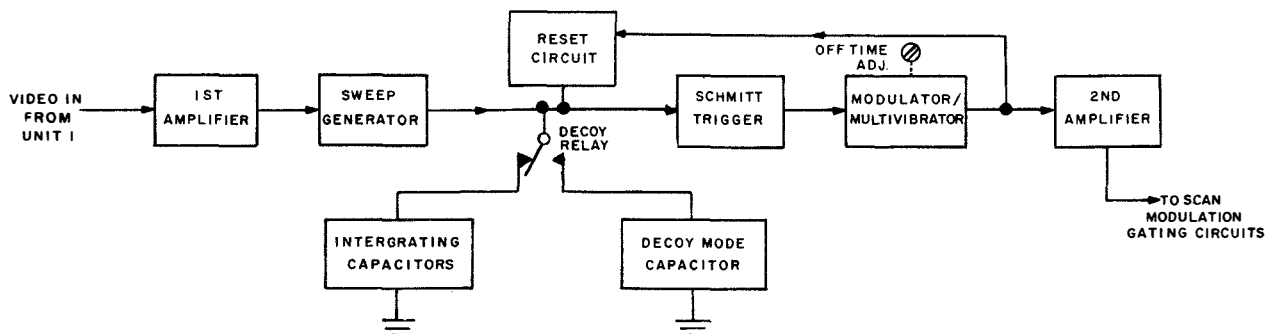


Figure 8-22.—(C) Unit 2 modulator (pulse width limiting circuits) (C).

067.293



the 1st (transistor) amplifier, which is normally cut off. The positive pulse turns it on for the duration of the pulse and shunts most of the bias current through. Since this current has kept the sweep generator on, which in turn held the integrating capacitors at nearly ground potential, the sweep generator now cuts off and the integrating capacitors begin to charge toward the collector supply voltage. The time at which the voltage across the capacitors is sufficiently large to trigger the Schmitt trigger is nearly  $1 \mu\text{sec.}$  in the TRACKBREAK mode (shown), and  $5 \mu\text{sec.}$  in the DECOY mode with the DECOY relay energized and the DECOY mode capacitor connected in place of the integrating capacitors. When the Schmitt trigger fires, the normally on side turns off and triggers the monostable multivibrator. The multivibrator output is nominally a  $.2 \mu\text{sec.}$  wide positive pulse (the pulse can be set from  $.2$  to  $.5 \mu\text{sec.}$  by the OFF TIME ADJ potentiometer), which is fed back to the reset transistor circuit to turn it on and provide a low impedance discharge path for the integrating capacitors, thus permitting the Schmitt trigger to reset. The capacitors begin to charge again and another multivibrator output pulse will be produced if the video input pulse is present for another  $1.0 \mu\text{sec.}$  (or  $5.0 \mu\text{sec.}$  in the DECOY mode). The capacitor voltage, therefore, is a positive sawtooth with about  $1.0$

or  $5.0 \mu\text{sec.}$  rise time and  $.2 \mu\text{sec.}$  fall time. When the video input pulse ends, the 1st amplifier cuts off, permitting current to flow into the base of the sweep generator, turning it on, and discharging the capacitors.

(C) The positive  $.2 \mu\text{sec.}$  multivibrator output pulses are coupled to the 2nd amplifier where they are amplified and inverted. The  $.2 \mu\text{sec.}$  negative pulse output is applied to the scan modulation gating circuits to cut off the stage, and thus, the gated amplifier is cut off for  $.2 \mu\text{sec.}$  every  $1.0$  or  $5.0 \mu\text{sec.}$  during a long video input pulse.

(C) ACTIVITY CIRCUITS.—The activity circuits also receive the modulator input pulses and use them to deenergize the normally energized activity relay, whose contacts drive the ACTIVITY indicator lamps on the local and remote control panels. In the TRACKBREAK modes of operation, the relay also activates the 2-second delay gate which turns on the modulator circuit gated amplifier control grid after the relay has been kept deenergized for 2 seconds.

(C) As illustrated in figure 8-23, positive, saturated video input pulses are applied to the cathode follower which supplies a low impedance output to the pulse width limiting circuits and to the 1st pulse stretcher. The

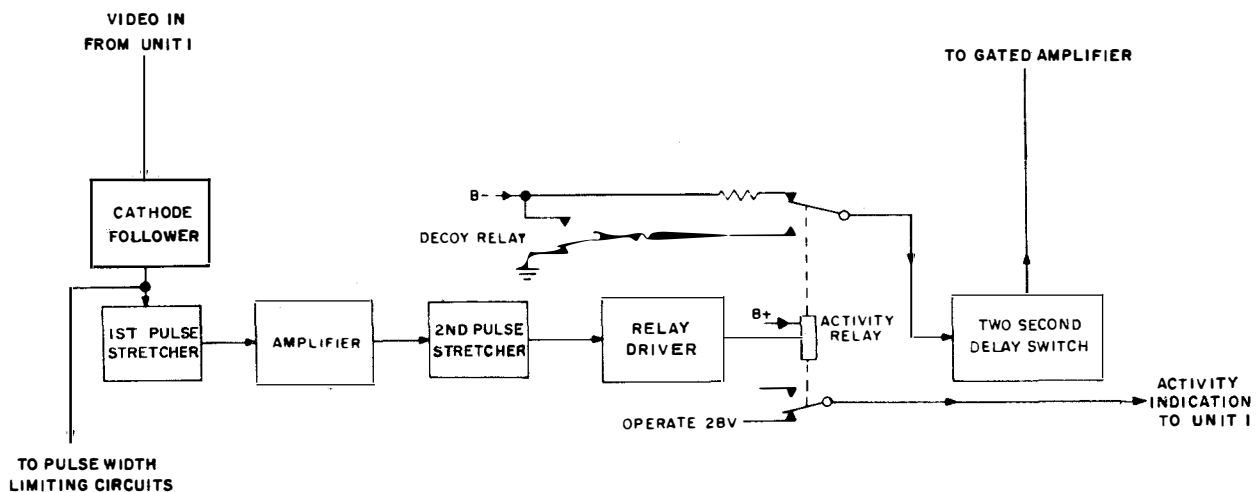


Figure 8-23.—(C) Unit 2 modulator (activity circuits) (C).

067.294

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positive, stretched pulses are coupled to an amplifier where they are amplified and inverted. The negative output pulses are again stretched, by the 2nd pulse stretcher, and used to turn off the normally conducting relay driver stage. The normally energized activity relay is thus deenergized by the presence of input pulses and couples 28 volts to the local and remote control panel ACTIVITY indicators. When the activity relay is deenergized, it activates the 2-second delay switch circuit which controls the control grid bias voltage of the modulator circuits gated amplifier (figure 8-20). In all TRACKBREAK modes of operation and with no incoming signal, the 2-second delay switch tube is heavily in conduction and cuts off the gated amplifier. When the activity relay deenergizes, the switch tube is biased off and the gated amplifier is biased on.

(C) If video input pulses disappear, the activity relay is energized and the 2-second discharge time constant keeps the gated amplifier biased on until activity is absent for 2 seconds to protect against momentary loss of signal.

(C) In the DECOY mode of operation, the decoy relay is energized and, regardless of the condition of the activity relay, the 2-second delay switch is cut off. Under these conditions, the gated amplifier is biased on and the delay circuit is deactivated.

(C) POWER INDICATION CIRCUITS.—The power indication circuits receive a detected transmitted pulse sample from the power monitor detector. When the proper input pulse amplitude is applied, the normally energized power indication relay deenergizes and applies

28 volts to the POWER OUT indicators on the local and remote front panels.

(C) Positive pulses from the RF power monitor detector are applied to the monostable multivibrator. (Refer to figure 8-24.) When the input pulse amplitude represents a minimum RF power output of 100 watts, the stage acts as a cathode-coupled monostable multivibrator and a wide positive pulse is fed to a clamper integrator circuit. This voltage (negative) is applied to the grid of the normally conducting relay driver stage. Therefore, the stage cuts off and the normally energized power indication relay deenergizes and connects 28 volts to the POWER OUT indicator lamps.

(C) MODULATION INDICATION CIRCUITS.—The modulation indication circuits receive the modulation signal and a portion of the scan modulation gate from the scan modulation gating signal. The scan modulation gate sample indicates modulation in excess of 2.5 percent and is used to fire a silicon controlled rectifier which in turn supplies a ground return path (through the normally energized contacts of the high modulation relay) to turn on the LOW MODULATION indicators on the local and remote control panels. When the amplitude of the modulation input indicates 50 percent modulation, the normally energized high modulation relay is deenergized and connects 12 v.a.c. to the HIGH MODULATION indicators. With the relay deenergized, the LOW MODULATION indicator ground return path is open and the indicator turns off.

(C) The low modulation indication circuit (figure 8-25) receives the scan modulation gate

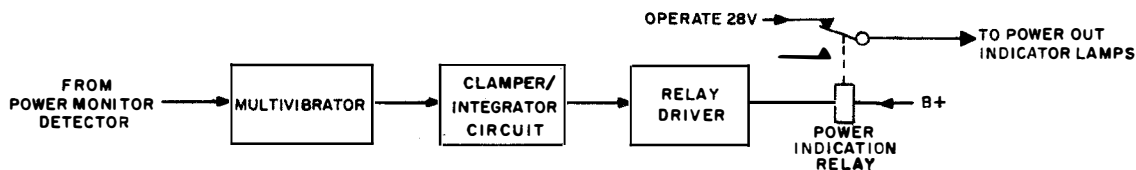
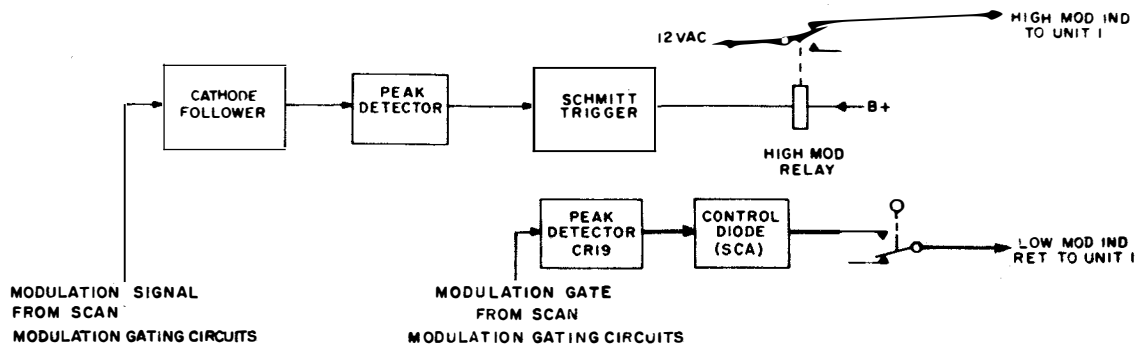


Figure 8-24.—(C) Unit 2 modulator (power indication circuits) (C).

067.295

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067.296

Figure 8-25.—(C) Unit 2 modulator (modulation indication circuits) (C).

from the Schmitt trigger in the scan modulation gating circuits (figure 8-21). The waveform is peak detected and the positive d.c. output of the detector fires the silicon controlled rectifier (SCR), which completes the ground return path for the LOW MODULATION indicator lamps through the contacts of the normally energized high modulation relay. When the modulation falls below 2.5 percent, the Schmitt trigger does not fire and the d.c. control voltage for the SCR is removed. However, the main current flow through the SCR must be interrupted in order to shut off the diode. Therefore, 12 v.a.c. is used to energize the indicator lamps, and current flows through the SCR only during the positive half cycle. The diode current is interrupted every half cycle and the SCR turns off when the control voltage is removed.

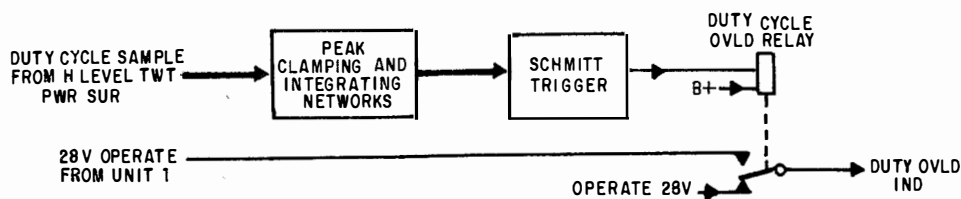
(C) The high modulation indication circuit (also figure 8-25) receives the scan modulation signal from the output of the split-load phase inverter in the scan modulation gating circuits. Since this pickoff point is prior to the injunction of the internal audio signal, the high modulation circuit is not activated by the internal audio. The signal is fed through a cathode follower and is peak detected. The resulting positive d.c. voltage is proportional to the percentage of modulation. The level corresponding to 50 percent modulation triggers the normally off section of the Schmitt trigger. When the Schmitt trigger fires, the normally on section cuts off and the normally energized high modulation

relay deenergizes. With the delay deenergized, the SCR is disconnected from the LOW MODULATION indicator lamps and 12 v.a.c. is connected to the HIGH MODULATION indicator lamps.

(C) DUTY CYCLE OVERLOAD CIRCUITS.—The duty cycle overload circuits receive and integrate a sample of the modulator pulses applied to the high level TWT grid. When the equipment duty cycle exceeds 1 percent, the duty cycle overload relay energizes and initiates the “five times try-try-again” cycle. The block diagram of the duty cycle overload circuits is shown in figure 8-26.

(C) A portion of the positive modulator pulses to the high level TWT grid is supplied from the high level TWT power supply. The pulse train waveform is shifted in a negative direction by the peak clamping network, and the integrating network corresponds the negative portion of the waveform to a negative potential which is proportional to the duty cycle of the incoming pulse train. Normally, one side of the Schmitt trigger is conducting and the other side is cut off. However, when the duty cycle exceeds 1 percent, the negative d.c. voltage cuts off the conducting side. With this side cut off, the other side conducts and energizes the duty cycle overload relay which provides 28 volts to turn on the OVERLOAD indicator lamps and initiate the “five times try-try-again” cycle.

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Figure 8-26.—(C) Unit 2 modulator (duty cycle overload circuits) (C).

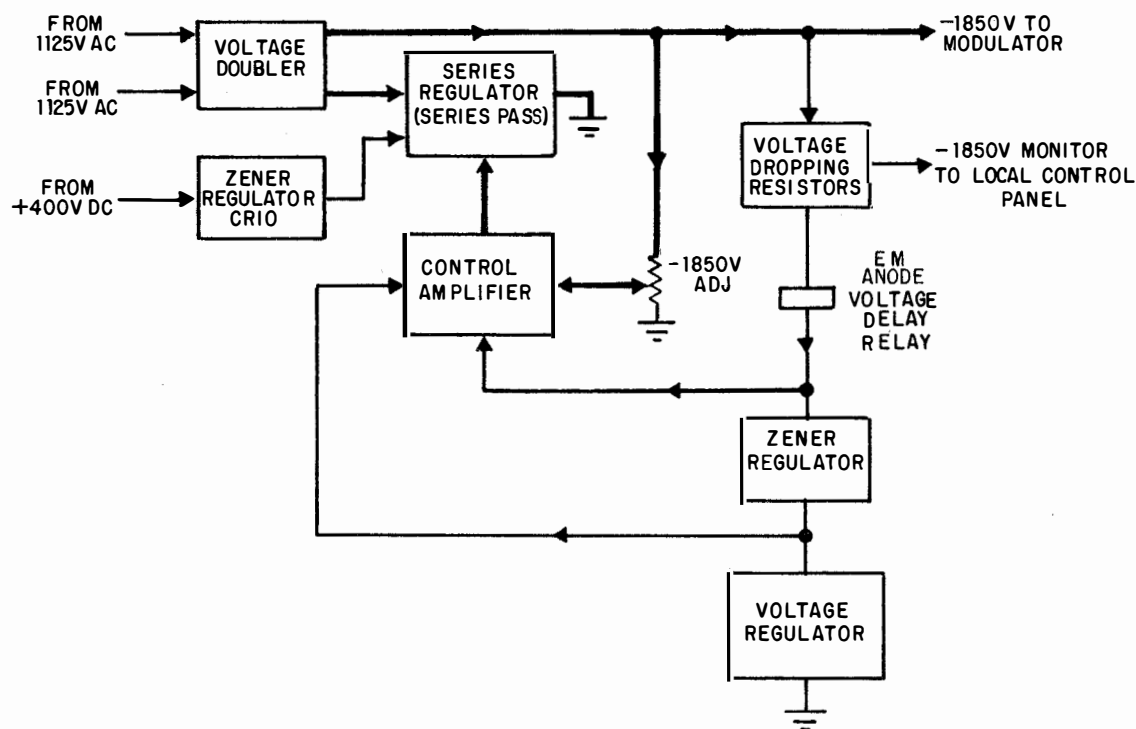
### Modulator Power Supply

(C) The modulator power supply contains the two modulator power supplies (-1850 and +600 volt).

(C)-1850 VOLT POWER SUPPLY.—The -1850 volt power supply (figure 8-27) provides a regulated, negative 1850 volts to the modulator,

from which the electron multiplier cathode, control grid, accelerating grids, and dynode voltages are derived. The supply consists of a voltage doubler which feeds a series pass-tube controlled by a feedback amplifier.

(C) The two input phases are applied to the voltage doubler circuit. One side of the doubler output connects to the series regulator which is in the ground return leg of the supply; this tube



067.298

Figure 8-27.—(C) Unit 2 modulator power supply (-1850 V.) (C).

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acts as a variable resistor in series with the load which maintains a constant a.c. voltage across the load. The control amplifier provides a variable control voltage to the series pass-tube grid. The two sections of the control tube are connected as a cathode-coupled difference amplifier whose output error voltage is a function of the difference between the two grids. One grid and the common cathode are returned to fixed regulated voltages through the action of the voltage regulator and the zener regulator respectively. A portion of the output voltage is developed across the -1850 VOLT ADJ potentiometer and applied to the other difference amplifier grid. As the output voltages try to go more negative, the control amplifier supplies a negative going error voltage to the grid of the series pass-tube which increases the drop

across the pass-tube and keeps the output voltage constant.

(C) +600 VOLT POWER SUPPLY.—The +600 volt power supply is illustrated in figure 8-28. It provides a regulated, adjustable 400 to 1000 volts to the electron multiplier collector. The supply consists of a full-wave rectifier, series pass-tube, and control amplifier in the usual configuration.

(C) The two input phases are applied across the full-wave rectifier. The regulator section is a conventional cathode-referenced control amplifier, series pass-tube circuit. The series regulator acts as the series variable resistance which maintains constant voltage across the load. The control amplifier functions as an error signal amplifier, comparing its cathode reference voltage (developed by the regulator with the EM

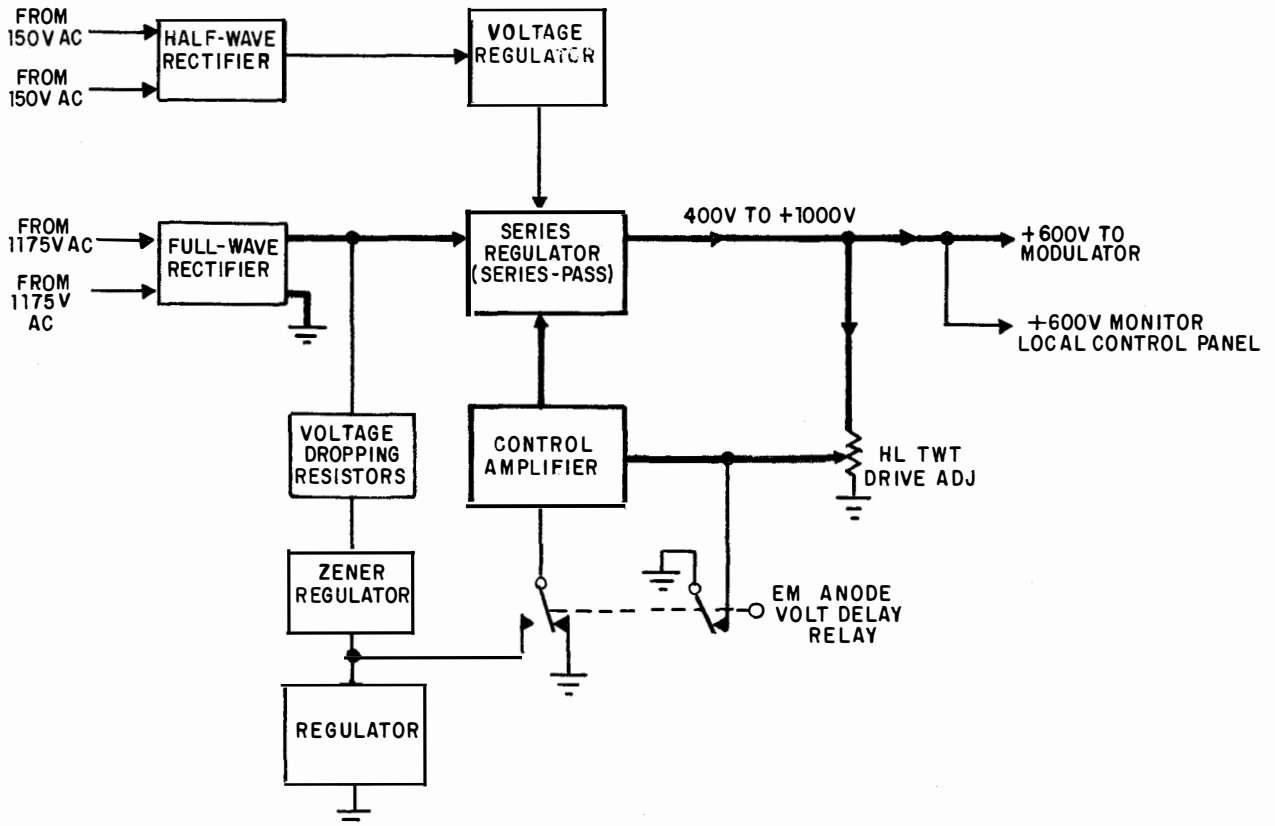


Figure 8-28.—(C) Unit 2 modulator power supply (+600 V.) (C).

067.299

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ANODE VOLTAGE DELAY relay energized) and the voltage sample developed across the HL TWT DRIVE ADJ potentiometer. As the output voltage tries to go more positive, the control amplifier supplies a negative-going error signal which causes the series pass-tube to conduct less, thereby increasing its plate-to-cathode voltage drop and maintaining the voltage across the load constant. Separate inputs are applied to the half-wave rectifier circuit. The output is applied across the voltage regulator to develop the regulated screen voltage for the series regulator pass-tube. Prior to the EM ANODE VOLT DELAY relay energizing, the grid and cathode of the control amplifier are grounded, thus zero-biasing the stage. The resulting heavy conduction of the control amplifier depresses the series regulator pass-tube grid, which results in only a small output voltage. Then the relay energizes and the voltage quickly jumps to its proper value.

#### High Level TWT Power Supply

(C) The high level TWT power supply operates in conjunction with the high level TWT power supply regulator circuits to supply high voltage to the high level TWT grid and cathode. (The block diagram for these circuits is shown in figure 8-29.)

(C) The high level TWT power supply consists of a voltage doubler with a series pass-tube in the return leg of the supply. The pass-tube is controlled by a feedback control amplifier and, in turn, controls a magnetic amplifier. The magnetic amplifier is used to control the a.c. input to the doubler, thereby tending to keep a constant voltage on the plate of the series pass-tube. Energy storage capacitors and coupling networks for pulsing the high level TWT grid plus protective buffering and spark gap components are also included in the power supply.

(C) The input transformer voltage is applied to the voltage doubler. The doubler output is applied to the series pass-tube. The series pass-tube is controlled by the output of the

control amplifier whose two sections are connected as a cathode-coupled difference amplifier and whose output error voltage is a function of the difference between the two grids. One grid and the common cathode resistor are supplied regulated reference voltages from the voltage reference tubes and regulators. The regulator tubes receive their input from the half-wave rectifier circuit. A sample of the high voltage output is developed across the HV ADJ potentiometer whose wiper is connected to the second difference amplifier grid. Therefore, as the output voltage tries to go more negative, the control amplifier supplies a negative-going error voltage to the grid of the series pass-tube. The resulting increased voltage drop across the pass-tube maintains the voltage across the load constant.

(C) A sample of the voltage across the series pass-tube is supplied to the control winding of the magnetic amplifier. When the voltage across the series pass-tube increases, the current through the control of the magnetic amplifier acts to increase the impedance of the gate windings in series with the input transformer. The input to the transformer is lowered, thus reducing its output until the voltage across the series pass-tube drops to its previous value.

(C) The TWT grid is held about 100 volts negative with respect to the cathode due to the action of the zener regulator diode in the negative output leg of the supply. The positive modulation pulse is coupled to the TWT grid by means of the coupling capacitor and allows the TWT to conduct and amplify a simultaneously applied RF signal. The d.c. restorer acts to restore (or clamp) the d.c. level to the capacitor on the trailing edge of the pulse.

(C) Arc protection is provided by the two spark gaps as well as buffering resistors (not shown) which limit the current from the energy storage capacitors under arcing conditions.

(C) Current overload protection for the TWT collector is provided by the series HIGH LEVEL TWT COLLECTOR CURRENT OVERLOAD relay whose contacts are part of the overload chain.

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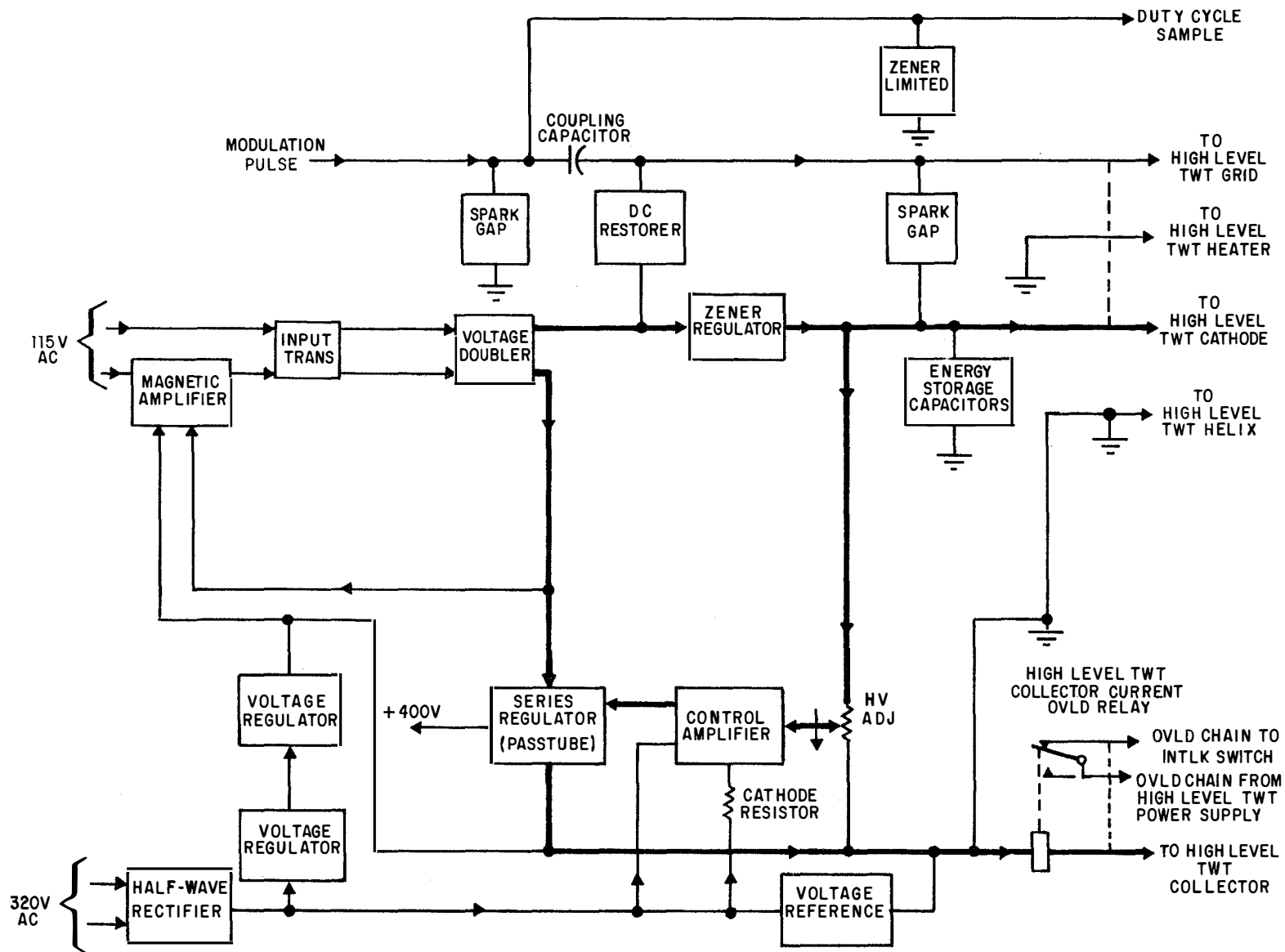


Figure 8-29.—(C) Unit 2 high level TWT power supply (C).

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175

CONFIDENTIAL

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**CONFIDENTIAL****CONTROL-INDICATOR  
(UNIT 3)**

(C) The control-indicator (unit 3), provides the switches, controls, and indicators required to operate the countermeasures set from a remote position. Figure 8-30 shows the face of this unit. When the LOCAL-REMOTE switch on the front panel of the unit is set to the REMOTE position, operation of the set is controlled from unit 3. When the LOCAL-REMOTE switch is set to the LOCAL position (or when the unit 1 or 2 interlock switch is open), operation of the set is controlled from unit 1. The functional operation of unit 3 control circuits is identical to the description given for unit 1. The LOCAL-REMOTE switch is the only operating control provided in unit 3 that is not located on the local control panel of unit 1. The FUNCTION

MONITOR switch, FUNCTION MONITOR meter, and the AUDIO GAIN controls are the only operating controls on the unit 1 local control panel that are not contained on unit 3.

**ANTENNA GROUP**

(C) The antenna group functions as a direction-finding (DF) receiving system (figure 8-31) and also provides the antenna elements for separate ECM transmitting and receiving systems.

(C) The direction-finding capability permits the operator to maintain the ECM receiving and transmitting elements pointing at the desired bearing.

(C) The antenna consists of a servo-drive pedestal located between two shrouds. The

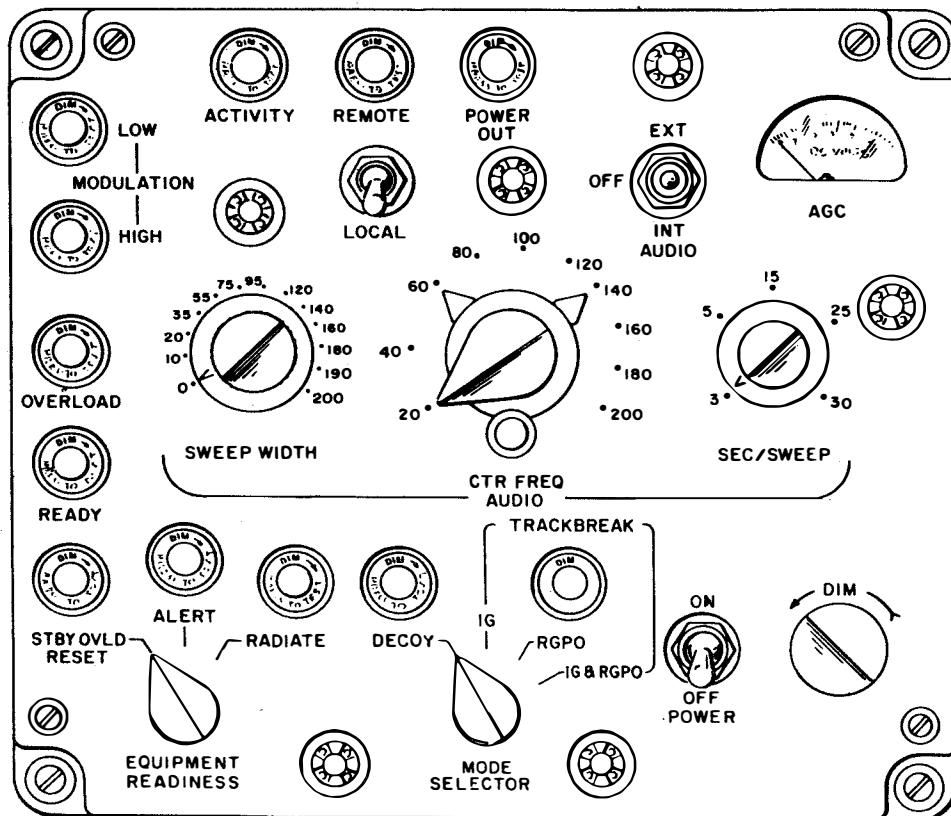


Figure 8-30.—(C) Control-indicator (unit 3) (C).

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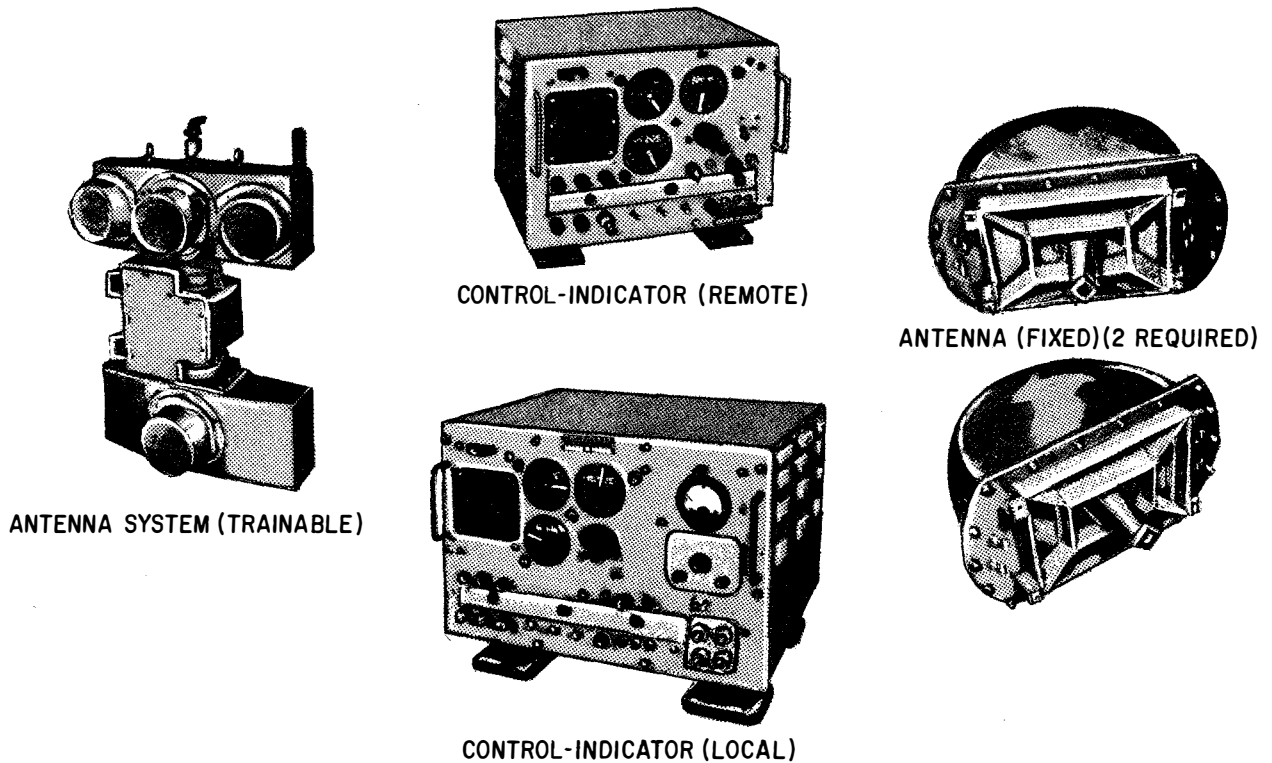


Figure 8-31.—(C) Antenna group (C).

067.302

upper shroud contains the circularly polarized conical horn used for ECM receiving, as well as the pair of circularly polarized DF horns with their associated electronic switching mechanism. The lower shroud contains the circularly polarized conical horn used for ECM transmitting.

(C) The configuration is vertical with the ECM transmitting horn mounted below the pedestal and the ECM receiving horn with the pair of DF horns mounted directly above the pedestal. The shrouds are geared together so that they train simultaneously in parallel horizontal planes at  $0^\circ$  in elevation, and point in the same azimuth direction.

(C) The DF horns are mounted in the upper shroud and skewed in the horizontal plane, one to each side of the ECM receiving horn major

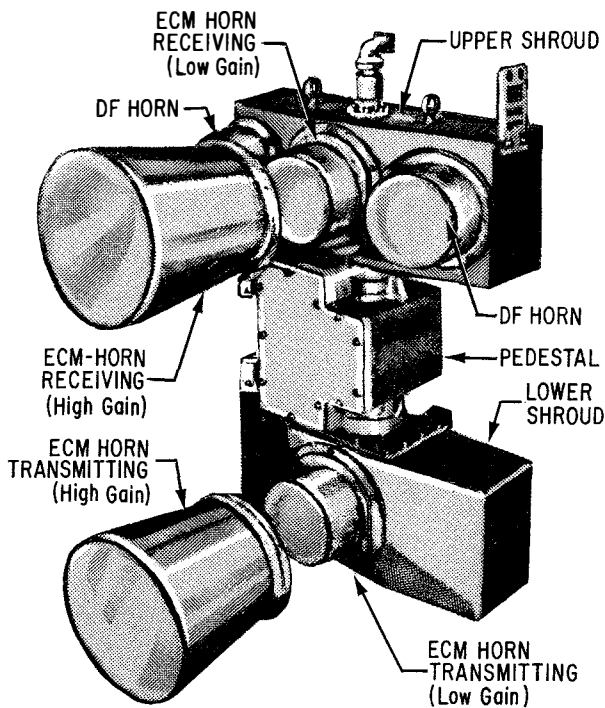
axis, to provide amplitude comparison lobing capability.

(C) Two complete antenna groups are installed on each ship. One antenna system is mounted facing port, and the other one faces to starboard. The antenna systems are capable of continuous rotation in either azimuth direction.

(C) The fixed antenna, when used in pairs, serves as a broad-beam receiving and transmitting antenna.

## ANTENNAS

(C) Each trainable antenna assembly is supplied with two pairs of interchangeable circularly polarized ECM horns, as shown in figure 8-32. One pair of horns are high gain,

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067.303

Figure 8-32.—(C) Trainable antenna-basic components (C).

narrow-beam devices, while the second pair of horns are low gain, wide-beam devices.

(C) Only one pair of horns is installed in the shrouds at a time. Upon installation on each ship, the appropriate pair of ECM horns are used to provide the desired beamwidth. Design is such that a minimum of effort is required to change horn pairs.

(C) The DF antenna system consists of a pair of circularly polarized conical horns with the same requirements as specified for the low gain, wide-beam ECM receiving horn. The DF horns are alternately switched into a single waveguide by an electronic RF switch. The switching is controlled by the local control-indicator. The horns are trained to any desired bearing by the servo-drive system.

### CONTROL-INDICATOR

(C) The local control-indicator provides control of the antenna group and enables

accurate alignment of the ECM horns on a specific radar target by DF means. All RF and video signal amplification and DF programming is contained in this unit.

(C) A low noise TWT is utilized as an RF preamplifier for the DF section to achieve the wide-open bandwidth and the threshold sensitivity required. A CRT display is used by the operator for DF positioning.

(C) When the chassis is extended for servicing, master control is automatically transferred to it. This means that the remote, and normally master unit, is no longer in control. When the chassis of this unit is replaced and locked, master control is automatically returned to the remote unit.

(C) The control-indicator utilizes a low noise TWT for RF amplification. The detected RF output is amplified in a log video amplifier. The video output, displayed on a CRT is utilized for signal tracking by signal amplitude matching techniques.

(C) A trigger video limited output signal provides synchronization for the CRT sweep from RF threshold to the maximum input level. The control amplifier for driving the antenna assembly provides sufficient drive to ensure that the antenna meets the slewing requirements. Screwdriver controls are provided on the servoamplifier to mix the "rate" and "error" information to ensure a hunt-free servosystem.

(C) The control-indicator also contains a bearing conversion unit to eliminate the need for a separate synchro amplifier, which allows simultaneous display of both relative bearing and true bearing information.

(C) The remote control-indicator duplicates the controls and indicators of the local control-indicator. A LOCAL-REMOTE selector located on the front panel selects the controlling unit. The remote control-indicator contains the CRT display with associated sweep circuits and power supplies, RF gain control, lobing rate control, test pulse switch, and pulse width limit switch.

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## CHAPTER 9

## EW PUBLICATIONS AND INSTRUCTIONS

Doctrinal and tactical publications, as well as operation orders (OPORDERS) and operation plans (OPLANS), provide valuable information to EWs. Personnel in CIC must be familiar with these publications since all evolutions performed in CIC are based on doctrinal concepts or tactical procedures contained in them.

OPERATION PLANS  
AND ORDERS

EWs must have certain advance data in order to perform CIC functions intelligently. Your major source of information is the OPLAN and/or the OPORDER specifying your ship's designated tasks. The ship's communication plan, derived from the communication annex, is also of special interest to you because it supplies pertinent communication information in advance. The ensuing paragraphs present basic differences between OPLANS and OPORDERS; for details concerning each, refer to NWP 11.

## OPERATION PLAN

An OPLAN is generally designed for operations extending over a considerable time and area. Ordinarily, it is based upon, and therefore restricted by, appropriate assumptions such as a given current situation will follow a certain course of events, which is assumed to be true in the absence of positive proof. Since the OPLAN is prepared well ahead of the actual operation, it may specify when it is to become effective, or it may simply state that it becomes effective when directed by appropriate authority. The OPLAN is the basis for

OPORDERS, issued by subordinate commanders, directing specific assigned tasks.

## OPERATION ORDER

An OPORDER is a directive issued by a commander for the purpose of effecting the coordinated execution of an operation in the immediate or near future. No assumptions are included in the OPORDER, and unless otherwise stated, it is effective from the time and date specified.

In most respects, the OPORDER and OPLAN are prepared in the same format. An occasion may arise, however, when speed is of such importance that an OPORDER must be prepared in message form and disseminated by rapid communications. This need may result from unexpected wartime developments or, in peacetime, from the need to supplement the standing OPORDER of an organized force.

TACTICAL WARFARE  
PUBLICATIONS

Tactical warfare publications promulgate tactics, doctrine, procedures and terminology of the United States Navy. They incorporate the results of fleet experience, provide information about the capabilities and limitations of equipment and systems, and include other pertinent data supplied by systems commanders, laboratories, and other naval organizations.

These publications provide direction and guidance for the solution of operational problems. However, because it is impossible to

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present a solution to every conceivable operational situation, the guidelines must be used with good judgment and with consideration for the requirements of the particular tactical setting.

As primary sources of tactical doctrine information, the tactical warfare publications may be used as:

1. Ready references to current tactics, doctrine, and procedures.
2. Bases for orientation and training programs.
3. Study material for increasing professional knowledge and gaining a better understanding of the naval planning process.

Standardized procedures contained in these publications establish a basic uniformity of tactics that can help increase the effectiveness of operations throughout the fleets. Reference to these procedures greatly reduces the volume of special instructions in operation plans and orders.

**HANDLING  
CONSIDERATIONS**

All unclassified material in tactical doctrine publications is considered privileged information and is to be treated as **FOR OFFICIAL USE ONLY**. No material in tactical doctrine publications may be disclosed to foreign nationals or international organizations without the specific prior approval of the Director of Naval Intelligence (DNI).

All tactical doctrine publications must be safeguarded and accounted for in accordance with their security classification, the procedures set forth in the Information Security Program Regulation (Security Manual) (OPNAVINST 5510.1), the instructions contained in Tactical Warfare Publications Guide (NWP-0), and instructions contained in individual letters of promulgation. The Security Manual governs should any conflict arise between instructions.

**Extracting**

Extracts from tactical doctrine publications may be made and reproduced for use in training or operations of United States forces subject to the following conditions:

1. All extracts must be properly marked with their security classification and safeguarded in accordance with the Security Manual.
2. Prior approval must be obtained from DNI before extracting/reproducing material which is marked **FORMERLY RESTRICTED DATA, RESTRICTED DATA, or NOFORN**.
3. Tactical Warfare publications may not be extracted without prior approval in accordance with CMS-4 (current series).

**Binder Color Code**

Binders for United States tactical doctrine publications have been color coded according to security classification. This color code is:

Secret – red  
Confidential – yellow  
Unclassified – blue

All NATO publications have a white binder regardless of security classification. Binders not conforming to this system will be correctly color coded as new revisions are printed.

**EW PUBLICATIONS**

There are many doctrinal and tactical publications that you as an EW may come in contact with and use in situations other than day-to-day operations. Most of these will not normally be held in the EW safe. Chapter 2 of NWP-0, Tactical Warfare Publications Guide, is a comprehensive listing of all tactical warfare publications currently in use. Following is a list of Secret publications that are normally used in EW, with a brief explanation of each.

1. NWP 31, Antiship Missile Defense—Provides doctrine and procedures for

antiship missile defense. Includes information on electronic warfare and anti-air warfare in an antiship missile threat environment.

2. NWP 32, Anti-air Warfare—Details AAW organization and doctrine.

3. NWP 33, Electronic Warfare—Provides doctrine and procedures for electronic warfare. Includes information on electronic countermeasures, counter-countermeasures, and acoustic warfare. Also provides information on types of electronic equipment and guidance for employment of electronic warfare in naval operations.

4. NWP 33-1, Tactical Planning Guide for Passive/Active Emission Control—Provides direction and guidance in planning for and tactically maintaining an intelligent emission posture that will maximize the probability of successfully accomplishing an assigned mission.

5. NWP 34, Navy Operational Deception—Provides guidance for conducting tactical deception operations and countering enemy tactical deception.

6. NWP 12-1, Tactical Air Threat Analysis—Provides intelligence analysis concerning

a. Threat descriptions, including scientific and technical information, characteristics, and performance capability.

b. Threat priorities relative to U.S. Navy attack carrier force and amphibious Fleet Marine Force missions.

c. Threat operational employments.

7. NWP 12-6, Tactical Electronic Warfare Planning Guide—Presents in tabular format the significant intelligence and technical data needed for a broad spectrum appraisal of U.S. Navy EW capabilities with respect to the real world threat.

8. NWP 12-6-1 (Volumes 1 and 2), Threat Emitter Evaluation Guide—The Threat Emitter Evaluation Guide is a specially-prepared, tactical tool designed to permit rapid and confident

emitter, platform, and weapon system evaluations in tactical electromagnetic environments. It facilitates the acquisition of timely information on probable enemy intentions, including the imminence of attack, through ESM-system use. Recommended active countermeasures and EMCON options that an OTC should consider are included.

9. DST-1730S-465-YR, Radiation Characteristics of Electronic Equipment—Contains details concerning the characteristics of noncommunication emitters.

10. ST-HB-1-70-INT, Radar Handbook Eurasian Communist Countries—Contains details on Communist world airborne, land-based, and surface radars and IFF systems. Volume I contains airborne radars and IFF; volume II, landbased radars and IFF; volume III, surface radars and IFF.

11. STIC-CS-10-10-YR, Naval Guided Missile Systems Eurasian Communist Countries and Cuba—Contains details on known guided-missile systems, including operational employment of the ships and submarines involved.

## INSTRUCTIONS

An instruction contains authority or information having continuing reference value or requiring continuing action. It remains in effect until superseded or otherwise canceled by the originator.

An instruction serves one or more of the following functions:

1. Regulates or is essential to effective administration
2. Establishes policy
3. Delegates authority or assigns responsibility
4. Establishes an organization structure
5. Assigns a mission, function or task

**UNCLASSIFIED**

6. Initiates or governs a course of action or conduct

7. Establishes a procedure, technique, standard, guide, or method of performing a duty, function, or operation

8. Changes, supersedes, or cancels another instruction

There are many instructions for electronic warfare, and you should read them all. Although it is beyond the scope of this book to explain each one, a few are listed below along with the purpose of each.

1. OPNAVINST 003430.1, Joint Electronic Warfare Policy (U)—Promulgates the electronic warfare policy of the armed services of the United States as approved and established by the Joint Chiefs of Staff on 7 March 1969.

2. OPNAVINST 5430.30, Electronic Warfare Organization in the Navy—Delineates and clarifies responsibilities and relationships for centralized coordination of electronic warfare matters to ensure an integrated and effective electronic warfare capability in the Navy.

3. OPNAVINST 03430.4, Navy Electronic Warfare Policy (U)—Promulgates the Navy electronic warfare policy. This instruction supplements OPNAVINST 003430.1; together they provide the necessary guidance and direction for employment of Navywide electronic warfare in surface, subsurface, and air phases.

4. OPNAVINST 003430.13, Security of Electronic Warfare Operations (U)—Promulgates policy guidance to prevent disclosure of electronic warfare information when in the vicinity of Sino-Soviet bloc forces.

5. OPNAVINST S9670.5, Electronic Warfare Installations for Surface Ships—Promulgates policy and guidance for the installation of electronic warfare support measures (ESM) and electronic countermeasures (ECM) equipments in ships and provides information concerning current and future operational equipment.

**PUBLICATION CHANGES AND CORRECTIONS**

To ensure that publications are reliable sources of information, changes and corrections must be entered accurately and immediately when effective. EWs maintain and enter authorized changes in various publications that are retained in CIC. A change may consist of pen-and-ink, cutout, or page insertions promulgated to amend or add to the contents of a basic publication. Changes are serially numbered (Change No. 1, Change No. 2, etc.). For accountability purposes, changes are considered as publications within themselves when register numbers are assigned. The register number of a change issued to a holder has no relationship to the register number of the basic publication.

A correction is an interim change issued in the form of a naval tactical warfare publication memorandum correction, a message addressed to all commands, or errata. Corrections promulgate amendments of an emergency or temporary nature when time does not permit preparation of a serially numbered change. In time, a major change confirms all minor corrections made after the previous change.

The memorandum corrections contain short corrections, which are issued as needed, and invariably are effective upon receipt. They normally consist of one or two pages and may contain temporary insert pages. Custodians route memorandum corrections as soon as they are received. Individual holders make required corrections and note the memorandum number near the correction. Message corrections announce urgent amendments that also are entered immediately upon receipt. Errata, when such knowledge is known far enough in advance to permit the printing and inclusion, may accompany a basic publication at the time of initial distribution to correct serious textual errors or to change the status or accountability of the text.

**MAKING CHANGES AND CORRECTIONS**

All holders of Naval Warfare Publications (NWP) must be informed on the correct

procedures for entering changes and corrections. The following minimum procedures must be followed where applicable:

1. Check the foreword or letter of promulgation for the effective date of the change or correction and ensure that the publication to be corrected also is effective. The governing effective date is the date on the Letter of Promulgation.

2. Prior to beginning the actual entry, carefully read the specific instructions contained in the change or correction.

3. Use any dark ink, except red, for pen-and-ink entries. Red ink is not visible under red lights used at sea.

4. Type and paste in lengthy pen-and-ink corrections.

5. When provided, use cutouts in preference to pen-and-ink.

6. Before inserting the cutout, all matter superseded by the cutout shall be deleted in ink.

7. Use flaps only if there is no room to cement the cutout on the page.

8. If available, use rubber cement or mucilage in preference to glue or gummed tape. Gummed tape often sticks pages together, impairs usage, and may cause pages to tear.

9. After entering a pen-and-ink correction, note the source of the correction in the margin adjacent to the entry.

10. Make a page check and record it in the Record of Page Checks upon completing any page change.

11. Enter appropriate information on the Record of Changes and Corrections page after entering the change or correction.

12. Destroy residue (burn or shred) left over from the change and superseded pages of the publication.

### PUBLICATION INVENTORY

To provide positive control of publications a watch-to-watch inventory of the publications kept in EW is used. At the change of the watch, the watches jointly conduct a sight inventory of every publication. The signing of the publication custody log (figure 9-1) by the relieving watch certifies that the publications were sighted and that the relieving watch is now responsible for them. All signatures are to be in ink and any discrepancies are to be resolved prior to relieving the watch.





CHAPTER 10

ANALYSIS AND IDENTIFICATION

(U) To determine whether a detected signal is an enemy or friendly transmission, it must be analyzed and compared with the characteristics of known equipments. Each transmitter possesses certain characteristics or a combination of characteristics peculiar to its purpose. Analysis of a signal is based on identifying the modulation and scan characteristics.

MODULATION

(C) Modulation is the alteration of a carrier frequency to convey intelligence. A continuous wave (CW) transmission has essentially no modulation, however it can be used as a radar for moving targets. Interrupted continuous wave (ICW) is used for Morse code.

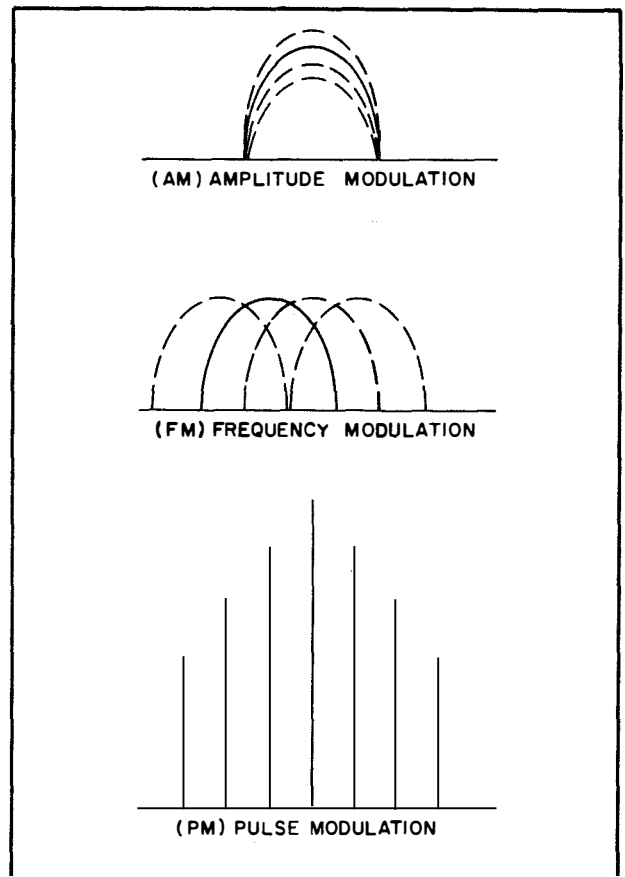
BASIC TYPES OF MODULATION

(C) AMPLITUDE MODULATION (AM).—Used for voice, music, TV video, and communications.

(C) FREQUENCY MODULATION (FM).—Used for voice, music, TV audio carrier, communication, and radar.

(C) PULSE MODULATION (PM).—PM may be used in radars for all types of targets. PM has two characteristics no other type of modulation has—pulse width (PW) and pulse repetition frequency (PRF). The three basic types of modulation are shown in figure 10-1.

(C) Pulse width (PW) is the length of time the transmitter of a radar is turned on at one



074.206

Figure 10-1.—(C) Types of modulation (C).

point in time, measured in microseconds. Theoretical minimum range and the range resolution (ability to discriminate between two targets on the same bearing) is determined by the PW of a radar. The formula for determining

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minimum range is  $164 \times \text{PW} = \text{minimum range}$  (164 is the radar range in yards per microseconds). Pulse width also affects maximum range; the wider the pulse, the more average power and thus an increased detection range.

(C) Various radars have their own peculiarities in terms of pulse width. For example, search radars (both air and surface) tend to have wider pulse widths than do weapon control radars. When we use a search radar we are not so interested in obtaining good resolution as we are in simply detecting a ship or aircraft. The longer pulse widths used in search radars enables us to increase the range above that normally found in weapons control radars, but, in turn, we sacrifice resolution.

(C) Weapon control radars usually have a very narrow pulse width to obtain good resolution and short minimum ranges. Table 10-1 shows the PW for the probable range capability of a search radar. Notice that as the pulse width increases, the range increases and vice versa.

(C) Pulse shape and good range accuracy require a sharp rise time of the pulse. If a radar has a  $0.3 \mu\text{sec}$  rise time, it will already have a plus or minus 45 yard range error without going into other factors that will add to this. Good range resolution requires a narrow pulse; short minimum range requires a narrow pulse with a steep trailing edge. Long-range radars require a flat-topped pulse of long duration.

(C) Because of all the above features of a pulse, the designers of a radar try to obtain a square, flat-topped pulse. In practice, however,

it is unusual for a radar to have a perfect pulse. Often it is a characteristic of a certain model radar to have peculiarities in the pulse shape, such as a slanting top, or ringing on the bottom of the trailing edge which help to identify that model. In turn, each installation of this model radar will have its own variations of the identifying pulse shape characteristic that will only change with a change in the major tubes or circuits concerned with the transmitter or duplexer of that individual installation.

(C) When observing pulse shape, the operator must use caution in making adjustments to the gain and bandwidth controls since these two controls will distort the received pulse and present a false pulse shape on the analysis scope.

(C) Pulse repetition frequency (PRF) is the number of pulses transmitted per second. PRF limits the distance a pulse can travel and be reflected back before the next pulse is transmitted, therefore, the unambiguous maximum range is limited by the interval between two consecutive pulses and can be determined by applying the formula  $82,000/\text{PRF} = \text{Unambiguous Maximum Range}$ . Table 10-2 shows PRF to probable range capability.

(C) The pitch of the audio output of an ESM receiver is determined by the PRF of the intercepted signal since PRF is an audio frequency. A long-range radar should be recognized the instant that it is detected, because the audio tone will be a low-pitched, buzzing sound which corresponds to a low PRF. Conversely, a fire control radar can be recognized because of its high, shrill pitch. PRF versus range capability is shown in table 10-2. Of

Table 10-1.—(C) PW and Probable Range Capability (C)

	PULSE WIDTH (USEC)	PROBABLE RANGE CAPABILITY
NARROW:	UNDER 1	SHORT RANGE
MEDIUM:	1 TO 4	MEDIUM RANGE
WIDE:	OVER 4	LONG RANGE

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Table 10-2.—(C) PRF and Probable Range Capability (C)

	PULSE REPETITION RATE	PROBABLE RANGE CAPABILITY
LOW	UNDER 350	LONG RANGE
MEDIUM:	350 TO 1000	MEDIUM RANGE
HIGH	OVER 1000	SHORT RANGE

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course, it is impossible to tell what the PRF is by the audio pitch. However, the audio pitch of an intercepted radar signal does indicate the approximate PRF and should always be considered by the operator. A very strong, steady, high pitched signal will cause quite a different initial reaction than a signal that has a low pitch particularly if the operator has reason to believe that the signal is an enemy fire control radar.

(C) The operator should always beware of signals that have a changing audio pitch. This indicates that the radar has a varying PRF, and only complex radar systems are capable of doing this. Most 3D radars have this capability. Their PRF varies along with their carrier frequency for each vertical angle of transmission. However, the biggest threat is the missile guidance radar which also has a varying PRF that can be heard. The PRF of a missile guidance radar is varied to provide information to the missile. Should an operator hear a signal that has a varying pitch, he can quickly determine the type of radar it is by observing the signal characteristics on the analysis scope. For example, the pulse width and/or pulse amplitude of a missile guidance radar signal will probably also be varying. Another method of distinguishing the different types of radar is by determining the type of scan the radar is using.

(C) The further away from the center axis of the conical scanning radar pattern your ship is, the more pronounced the audio tone will be. If your ship is in the off-target position you will hear a chatter in the earphones. If the radar is locked-on you will only hear the loud PRF tone.

(C) In lobe switching, as in conical scan, if the target is not in the locked-on position you will hear a loud chatter in the earphones, and if the signal is locked-on you will only hear the PRF tone. You will also see the difference on the third trace of the analysis scope.

(C) The signal from a helical scan radar is similar to circular scan, except that the amplitude of each burst will progressively get stronger and weaker as the radar antenna changes its elevation.

(C) The interception of a spiral scanning radar is somewhat like a conical scan, except for having amplitude variations and a harsher chatter in the earphones. There is no lock-on indication of this scan.

(C) Frequency is the number of complete cycles per second, measured in hertz. Radar frequencies are measured in mega-hertz, normally between 25 MHz and 10,000 MHz and the frequency is inversely related to wavelength as explained earlier in this book. Frequency directly affects the distance the wave will travel. The higher the frequency the shorter the range and the lower the frequency the longer the range. Table 10-3 shows the frequency and the probable range capability.

(C) Beam width is the area, in degrees, filled with RF energy in both the horizontal and vertical planes. The beam width is determined by frequency, shape, and size of the radiating antenna and determines the bearing accuracy of the radar. Radars with wide beams can normally be associated with the long range detection systems. Radars with narrow beams are normally associated with fire control, weapons guidance, navigation and tracking radars which require a higher degree of bearing accuracy. It is hard to determine beam width accurately with intercept search equipment. The formula for beam width is  $BW = \frac{LD \times 360}{SPR}$ .

(C) Lobe duration is the measurement of the time the main beam of emitter is illuminating the target. On certain type scans, the lobe duration can be measured utilizing the ESM system. The quality of the lobe duration

Table 10-3.--(C) Frequency and Probable Range Capability (C)

	FREQUENCY MHz	PROBABLE RANGE CAPABILITY
LOW:	25 TO 3000	LONG RANGE
MEDIUM:	3000 TO 5500	MEDIUM RANGE
HIGH:	OVER 5500	SHORT RANGE

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measurement is dependent on many factors, i.e., operator skill, signal strength, speed of emitter rotation, emitter beam width and whether or not side and back lobes are present.

(C) Polarization is the plane in which the major portion of RF energy leaves the antenna with respect to the Earth's surface and is not always obtainable due to antenna limitations. In order to obtain polarization, the receiving antenna must be rotating. Search radars normally use horizontal polarization while special and precision radars use vertical polarization. The polarization of an intercepted signal when known can increase the effects of own ships ECM/ECCM efforts considerably.

**TYPES OF SCAN****Circular**

(C) Circular scan is normally used for search and detection radars and gives a full 360° coverage. Circular scan is measured in seconds per rotation (SPR). Figure 10-2 shows a circular scan.

(C) The identifying characteristic of the circular scan is that the signal is heard only for short periods (bursts) which recur at regular intervals.

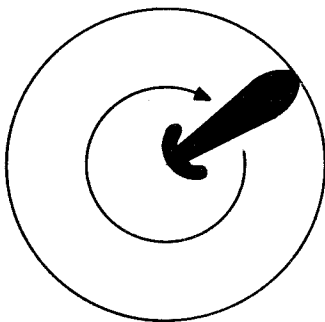
**Sector**

(C) Sector scan is a modification of circular scan and is used to search a specific sector,

normally 180° or less. (See figure 10-3.) Sector scan is measured in seconds per cycle (SPC).

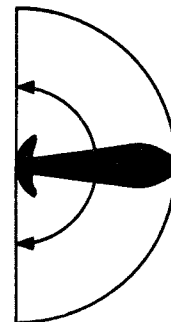
(C) Sector scan can be differentiated from circular scan by the following characteristics. The signal from a sector scan radar is heard at two instances during each cycle. If the intercept station is located exactly on the center line of the scanning sector, the signal burst will occur at evenly spaced intervals and will sound like a fast circular. If the intercept station is located off this center line the intervals are no longer of equal duration. Instead, the silent periods between signal bursts are alternately long and short. The difference in the length of intervals becomes larger and larger as the position of the intercept station approaches the edge of the sector. If the intercept station lies directly on the edge of the sector, the two signal bursts may merge into one.

(C) The ESM operator, being able to determine if he is in the center axis of the sector search or off to one side, will sometimes be able to determine the exact moment his ship has been picked up by the radar, since it is often a standard practice for radar operators to get the sector search pattern so that the target under observation is in the center axis of search. Many airborne radars use fixed sector search patterns with the center axis dead ahead of the aircraft, so that if the intercepted signal changes from an off-centered sector to a pattern similar to a circular scan, you know the aircraft has changed course toward you and has probably seen you on its equipment.



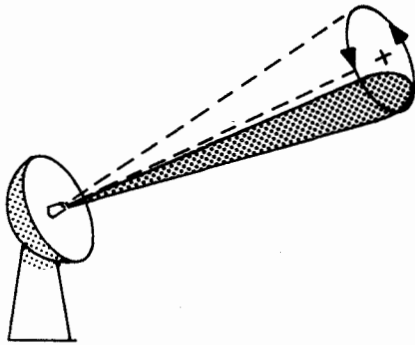
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Figure 10-2.—(C) Circular scan (C).



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Figure 10-3.—(C) Sector scan (C).



0189.109

Figure 10-4.—(C) Conical scan (C).

### Conical

(C) Conical scan is a rotating beam about an axis with a nutator. Conical scan is used for precision tracking primarily for weapons control. Conical scan is shown in figure 10-4 and is measured in cycles per second (Hz).

### Spiral

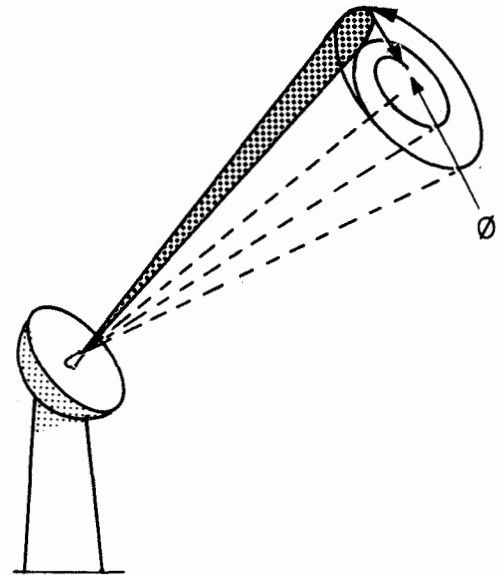
(C) Spiral scan is an expanding and contracting of the center of the beam from "Ø" to its outer limits and back to the center and is a modification of the conical scan. Spiral scan is normally used for target acquisition and is measured in Hz. (See figure 10-5.)

### Lobe Switching

(C) Lobe switching is used for weapons control and can be either two-way or four-way lobe switching. (See figure 10-6.) Lobe switching is measured in Hz.

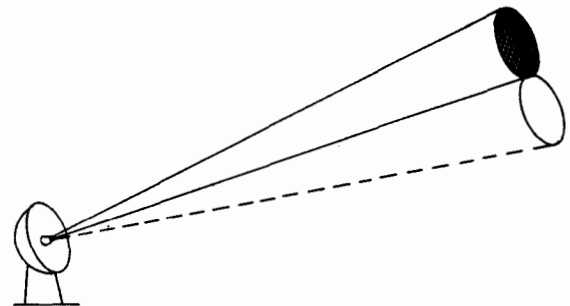
### Horizontal/Vertical

(C) Horizontal/vertical has two electronically scanning antennas. One is horizontally oriented, the other is vertically oriented. Each antenna emits a separate RF signal and is used for target and missile tracking and guidance. (See figure 10-7.)



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Figure 10-5.—(C) Spiral scan (C).



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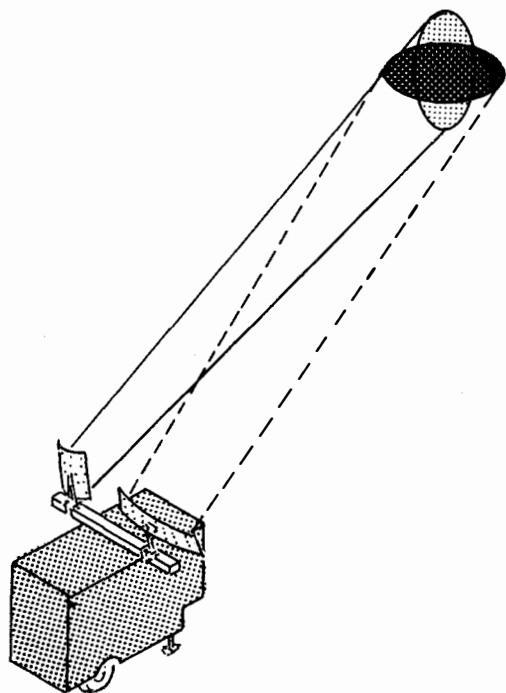
Figure 10-6.—(C) Lobe switching (C).

(C) A horizontal search scan with abrupt changes in elevation at the end of each sector level. Each horizontal search is called a "bar". Raster scans may be 4, 8, or 16 bar rasters and are normally used for airborne acquisition and weapons control search. (See figure 10-8.) Raster is measured in bars per second (BPS).

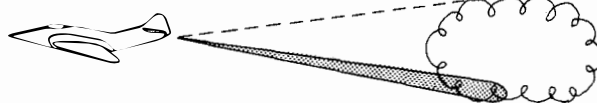
### Palmer

(C) A palmer scan is a conical motion superimposed on either a circular, sector, or

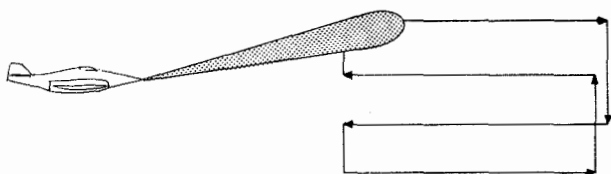
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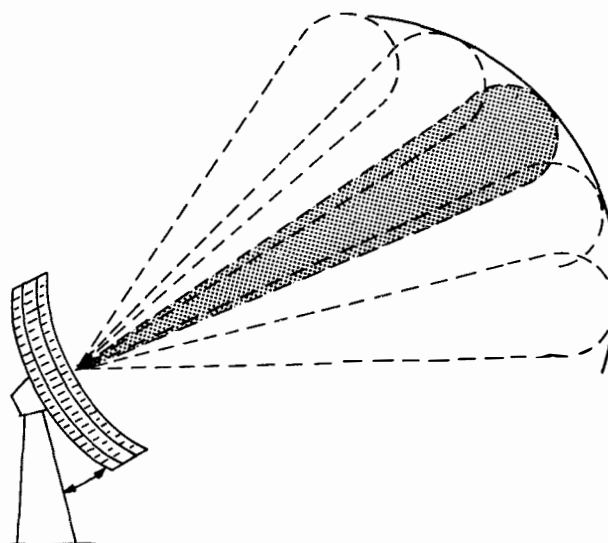
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Figure 10-7.—(C) Horizontal/vertical (C).



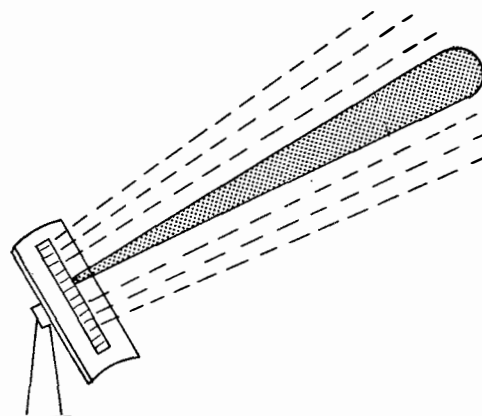
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Figure 10-9.—(C) Palmer scan (C).



0189.86  
Figure 10-8.—(C) Raster scan (C).



A. MECHANICAL



B. ELECTRONIC

0189.88  
Figure 10-10.—(C) Vertical sector (C).

raster scan and used for airborne weapons controls search and is measured in BPS/Hz. (See figure 10-9.)

**Vertical Sector**

(C) This can be accomplished either mechanically or electronically. Figure 10-10 shows both methods. Vertical sector scan is normally a function of (3D) height finding radars used for target acquisition and tracking and is measured in seconds per sector.

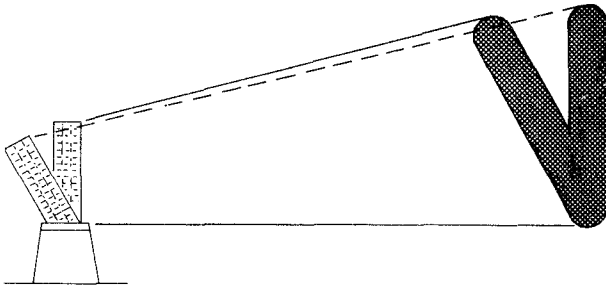
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**V-Beam**

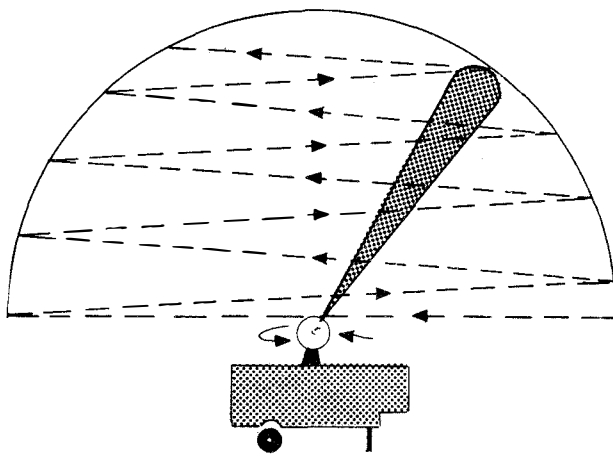
(C) V-beam consists of circular scanning, two transmitters, two frequencies and two radar antennas. It uses two different returning echoes to determine elevation. (See figure 10-11.)

**Helical**

(C) Helical scan is a circular scan with vertical deflection and is normally conducted by a mobile or fixed ground installation. It is used for GCA and ATC. (See figure 10-12.)



0189.89  
Figure 10-11.--(C) V-beam (C).



0189.90  
Figure 10-12.--(C) Helical scan (C).

**Monopulse**

(C) Simultaneous lobes form a single narrow pulse. The returned echo is inverted by a microwave lens. The error signal gives an input to train the antenna. It is presently used in newer types of weapons control and tracking radars. Table 10-4 shows scan type in relation to radar function. (See figure 10-13.)

(C) The initial evaluation of the intercepted signal is the responsibility of the ESM equipment operator.

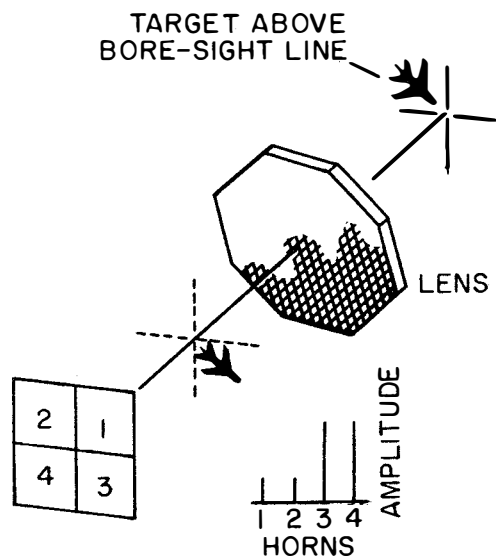
(C) The operator must:

1. (C) Make an initial evaluation of the signal based on the parameters and audio of the signal and determine the function and platform of the emitter.
2. (C) Record the parameters of the intercepted emitter including frequency, PRF, PW, antenna rotation rate, scan type, polarization, and any other identifying information.

Table 10-4.--(U) Scan Type Relation to Radar Function (U).

SCAN TYPE	PROBABLE RADAR FUNCTION
PALMER	WEAPONS CONTROL SEARCH
CIRCULAR	SEARCH
SECTOR	SEARCH
HÉLICAL	LAND BASED SEARCH (NORMALLY)
VERTICAL	HEIGHT FINDER
RASTER	WEAPONS CONTROL OR AIRBORNE FIRE CONTROL SEARCH
SPIRAL	WEAPONS CONTROL SEARCH
CONICAL	PRECISION TRACKING
LOBE SWITCHING	PRECISION TRACKING
HORIZONTAL/VERTICAL (TWS)	SEARCH AND WEAPONS CONTROL

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Figure 10-13.—(U) Mono-pulsed (U).

3. (C) Compare these characteristics with those in the friendly and enemy sections of the EW annex to the OpOrd or a threat emitter guide published by the CTF. If the parameters match one of these signals, this is probably the correct signal. In the event the parameters do not match or if no list of emitters is available, the operator or a trained ESM evaluator, will proceed with the evaluation by checking Radiation Characteristics of Electronic Emissions for possible emitters that include the detected characteristics. Ensure that all signal parameters coincide with the selected emitters.

4. (C) Correlate ESM information with other intelligence information such as current surface or air radar contacts, geographical location of both intercepting and intercepted units, and operating radars of intercepted air and surface contacts.

5. (C) Make the final decision as to nomenclature, type, and degree of threat.

#### COMMON EVALUATION CRITERIA

(C) The remainder of this chapter is intended to help you to become proficient in

analyzing and identifying radar emissions by becoming familiar with rapid evaluation guidelines and radar radiating characteristics which affect capabilities.

#### CHARACTERISTICS (C)

Frequency (indicates platform)

Pulse Repetition Frequency (General range estimate)

#### RAPID EVALUATION GUIDELINES (C)

25 - 3000 MHz normally used with:

1. long-range air search
2. early warning
3. NAVAIDS (TACAN, etc.)

3000 - 5500 MHz normally used with:

1. surface search
2. navigation
3. height finding (3D) radars
4. medium-range air search and acquisition

5500 MHz and higher normally used with:

1. precision tracking radars
2. short-range radars
3. submarine, airborne, and portable equipment in this range may be used for search, navigation, etc.
4. FM or CW above 5000 MHz may indicate missile guidance or speed measuring devices.

349 PPS and below—  
long-range radar  
350-1000 PPS—  
medium-range radar  
1000 PPS and above—  
short-range radar

Higher PRF yields more hits every time the beam passes, hence more echo power returned and better accuracy.

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CHARACTERISTICS (C)	RAPID EVALUATION GUIDELINES (C)	CHARACTERISTICS (C)	RAPID EVALUATION GUIDELINES (C)
Pulse Width (General range estimate and platform)	<p>1 microsecond and below—short-range 1 - 4 microseconds—medium-range 4 microseconds and above—long-range</p> <p>Modulated PW usually indicates missile guidance radars. Wide PWs with high power normally requires large cooling systems and heavy assemblies.</p> <p>Pulse trains with circular scans may indicate IFF interrogation while pulse trains with steady patterns may indicate IFF response or NavAids such as Tacan, Loran, Beacons, etc.</p>		<p>Search, acquisition and weapons control:</p> <ol style="list-style-type: none"> <li>1. Spiral scan</li> <li>2. Raster (primarily airborne)</li> <li>3. Palmer scan</li> <li>4. Any search type can be used</li> </ol> <p>Height-finding:</p> <ol style="list-style-type: none"> <li>1. Vertical scan</li> <li>2. Multiple beam or vertical frequency scan</li> <li>3. Circular scan with V-beam</li> <li>4. Nodding scan (rough HF capability)</li> </ol> <p>Search radars:</p> <ol style="list-style-type: none"> <li>1. Circular scan (360° in azimuth)</li> <li>2. Sector scan (less than 180° in azimuth)</li> </ol>
Scan Rate (SPR) (Aids in determining purpose and range)	<p>20 SPR (slow—usually mechanical scan, normally used by height-finders and long-range wide beam radars. 10 - 20 (medium)—long-range radars 4 - 10 (medium high)—medium-range radars 2 - 4 (high)—short-range radars.</p> <p>SPR/RPM FORMULA:</p> $\text{SPR} = \frac{60}{\text{RPM}} \quad \text{RPM} = \frac{60}{\text{SPR}}$ <p>Narrowbeam radars may be slower because they can illuminate the target for a longer period and thus receive more power in the echo.</p>	Additional data that will give validity to the above guidelines	<p>Bearing. The rate of change may indicate the type of platform. Example: a fast rate of change will probably be airborne. Under specific tactical situations the bearing will have added significance.</p> <p>Beam width: Weapons control radars use very narrow beam-widths for good bearing resolution; long- and medium-range search use wider beam widths to provide larger area coverage and thereby enhance detection probability.</p> <p>Beam width, while sometimes difficult to measure, can be obtained by an experienced operator utilizing a stop watch and the analysis scope.</p>
Type of Scan (function)	<p>Acquisition and tracking</p> <ol style="list-style-type: none"> <li>1. Conical scan</li> <li>2. Monopulse</li> <li>3. Lobe switching</li> <li>4. Any narrowbeam radar can be used.</li> </ol>		<p>Polarization: It is helpful if available; long-range radars normally use horizontally polarized beams, short-range radars may use vertical, horizontal, circular, or cross polarization.</p>

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(C) Table 10-5 is a condensed rapid evaluation guide using the information described above.

**SIGNAL RECOGNITION**

**Equipment Traces**

(C) Panoramic.—Frequency versus relative signal amplitude: the horizontal axis represents frequency and the vertical axis represents relative signal amplitude. The bandwidth is swept by a narrow-band amplifier at about 30 Hz.

(C) DF.—The DF trace is a horizontal rectangle with the line of position representing bearing and the vertical deflection representing amplitude. (See figure 10-14.)

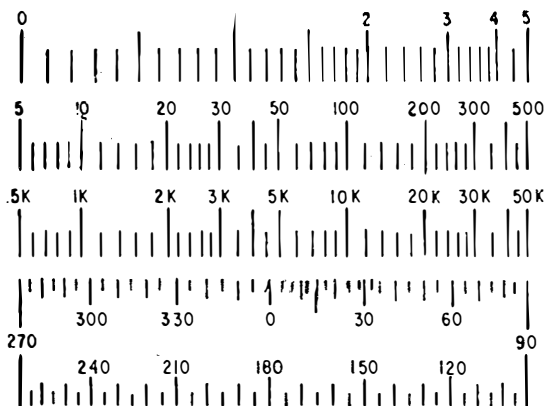
**Table 10-5.—(U) Rapid Evaluation Guideline (U).**

	LONG RANGE	MED RANGE	SHORT RANGE	REMARKS
FREQUENCY	25-3000 MHz	3K-5.5K MHz	5.5K MHz AND ABOVE	PRIMARY PLATFORM DETERMINING TRAIT
PRR	0-349 PPS	350-1000 PPS	1000 PPS AND ABOVE	PRIMARY MAXIMUM RANGE DETERMINING TRAIT
PW	4 USEC AND ABOVE	1-4 USEC	0-1 USEC	MINIMUM RANGE AND RANGE RESOLUTION
SCAN RATE	(MECH) 20 SPR AND UP 10-20 SPR	4-10 SPR	2-4 SPR	AID IN DETERMINING TYPE AND RANGE

TYPE SCAN (AID IN DETERMINING EMITTER FUNCTION)

SEARCH	HEIGHT FINDING	WEAPONS CONTROL TRACK	WEAPONS CONTROL SEARCH
CIRCULAR SECTOR HELICAL	VERTICAL CIRCULAR (V-BEAM) MULTI-BEAM (FREQUENCY SCAN) NODDING	CONICAL LOBE SWITCHING MONO-PULSED	SPIRAL (CONICAL RATE) RASTER PALMER

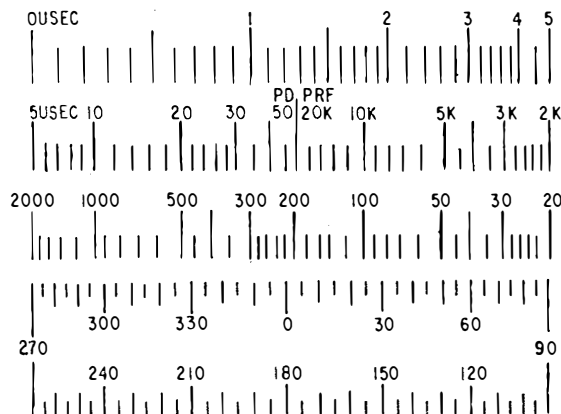
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**Figure 10-14.—(U) Analysis traces and DF trace with a signal bearing 015° (U).**

(C) Analysis.—The first scale is exponential and the second and third scales are logarithmic. The trace lengths are: 0-5 μsec for the top trace, 5-500 μsec for the second trace, and 500-50K μsec for the third trace. This scale is used for calibration. (See figure 10-14.) Under normal operations, you will use the PD-PRF scale shown in figure 10-15 to analyze a signal.

(C) Acquisition scope.—The horizontal axis represents frequency, the vertical axis represents



189.94

**Figure 10-15.—(U) Analysis (PR-PRF) scale (U).**

time, and the intensity represents signal amplitude. (See figure 10-16.)

### Using the Traces

(C) The panoramic trace is used to determine the type of modulation, bandwidth, signal to noise ratio and frequency relationship.

(C) By using the analysis traces you can determine PW, PRF (interchangeable with PD and PRF), lobe duration, type of scan, pulse repetition time, and pulse shape. From the DF trace you find bearing (true or relative) and polarization. The first indication of a signal will be from either the acquisition scope or the earphones.

### ANALYSIS OF A SIGNAL

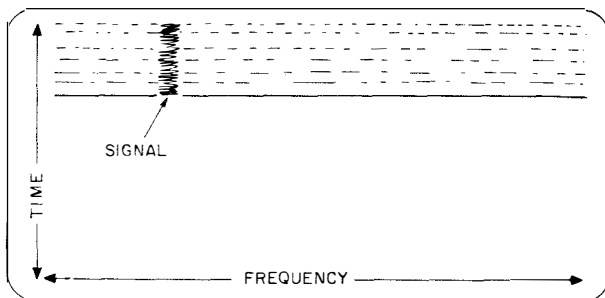
(C) When analyzing a signal you should follow the steps described below:

#### Determine The Bearing

(C) Adjust the gain until bearings may be read from the DF trace, stop the antenna on the signal bearing. DO NOT switch to manual until the antenna speed has decreased to zero. Normally, bearings can be determined in the frequency range of 300 to 10,750 MHz.

#### Determine Polarization

(C) Set the antenna selector to DF and change the polarization switch to horizontal and



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Figure 10-16.—(U) Acquisition scope (U).

back to vertical until polarization is determined. The position that gives the strongest signal is the correct polarization. However, you must remember that you cannot obtain polarization with all antennas. Normally, polarization can be determined in the range of 300-2400 MHz.

#### Determine Type of Modulation

(C) Observe the panoramic trace. Figure 10-1 shows the panoramic trace with AM, FM, and pulse modulated signals.

#### Determine True, Image or Spurious Response

(C) Observe the panoramic trace while manually tuning the frequency counter. If you are decreasing the frequency, the signal on the panoramic trace will move to the left if it is a true response and right if it is an image. Conversely, if you are increasing the frequency, the true response will move to the right on the panoramic trace and an image will move to the left. Obtain the true response first. If you have an image response, tune to the true response by twice the IF of the band you are using. It will be either up or down depending upon the local oscillator for that band.

(C) For example, if you are in band 5 and the image has a frequency of 600 MHz, the local oscillator tracks above. If the IF for band 5 is 160 MHz, you would add 320 (two IFs) to 600 = 920 MHz, tune up to 920 MHz and read the true response. Another example, if you are in band 7 and have a true response whose frequency is 3150 MHz, the local oscillator tracks below the incoming RF. The IF is 400 MHz; add the 800 MHz to the 3150 MHz and tune up to 3950 MHz to find the image response.

(C) If you have a signal and you want to find out if it is the true or a harmonic frequency (spurious), observe the pan trace and frequency dial, manually tune the center rail from one end of the pan trace to the other, reading the frequency at both ends. Subtract the lower

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frequency from the upper; it should equal the bandpass of tuner selected. If it does, it is a true response. If not, it is a harmonic.

**Determine the Frequency**

(C) Now that you have a true response, use the fixed oscillator to bloom the signal on the pan trace and read the center frequency from the dial. Figure 10-17 shows the difference between a signal that has been bloomed and one that has not.

**Pulse Width**

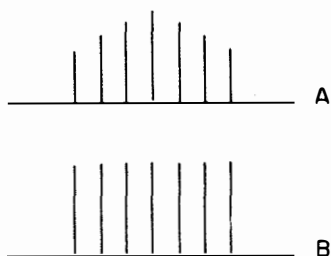
(C) Turn the manual gain down until you can hear only the major lobe of the radar (circular or sector) in the earphones as it passes your antenna. Ensure that the Sync level is set so that the three analysis traces are triggered each time the main lobe passes the antenna.

(C) If more than one signal appears on the pan trace, turn the bandwidth switch to narrow and manually tune to the desired signal.

(C) If PW is less than 5  $\mu\text{sec}$ , read from left to right on the top trace. Figure 10-18 shows a PW of 5  $\mu\text{sec}$ .

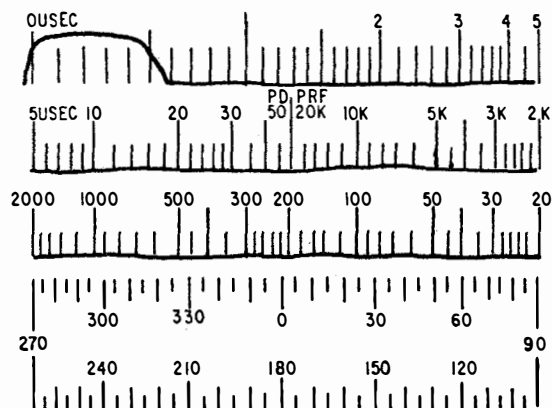
(C) If the pulse width is between 5 and 50  $\mu\text{sec}$ , read from left to right on the first half of the second trace.

(C) If the PW is greater than 50  $\mu\text{sec}$ , PW may be determined by converting the PPS to



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Figure 10-17.—(U) Pan trace, A has not been bloomed B has been bloomed (U).

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189.97

Figure 10-18.—(U) Analysis scope, PW 0.5  $\mu\text{sec}$  (U).

time. Read the PW on the PRF scale and divide PRF reading into one.

(C) For more accurate PW, take readings at both half power points, subtract leading edge scale reading from trailing edge scale reading. This gives you the effective PW.

**Pulse Repetition Frequency**

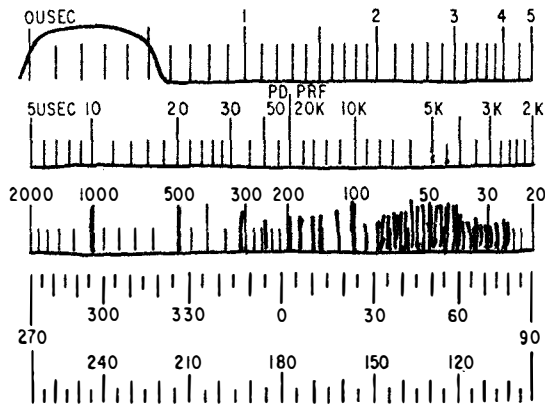
(C) If PRF is between 20 and 2000 PPS, read right to left on the third trace.

(C) If PRF is between 2000 and 20K PPS, read right to left on the last half of the second trace.

(C) For improved accuracy, count over to the third rail (left to right) on the third trace and multiply scale reading by 3. Figure 10-19 shows a PRF of 1000 on the PRF scale.

**Determine Type of Scan**

(C) Observe the display on the third trace between 100 and 20 PPS. Presentations shown will indicate the scan type if used in conjunction with audio from the earphones. Figure 10-20 illustrates the type of scan and the indication you will see.



189.98

Figure 10-19.—(U) Analysis scope, PRF 1000 pps, PW 0.5 μsec (U).

### Scan Rate

(C) Circular and possible sector: Determine the scan rate by using a combination of audio and video presentations. Use a stop watch and time from the start of one major lobe to the start of the next major lobe and this will give SPR.

(C) Complex: Obtain scan rate in hertz per second, bars per second, or frames per second from the third trace. Read from the left to the right to the first null (low point) and read scan rate directly from the scale.

(C) After you have analyzed the signal, return to scan by depressing the scan button. The signal frequency is now stored in the storage channel. If you want to stay in the same band, just rotate the DF antenna and adjust both the IF and audio gain controls. If you are going to use a different band, check the antenna selector for proper position, check antenna control unit for proper DF antenna and adjust IF and audio gain.

(C) Suppose you want to check the signal that you had analyzed. To return to the stored signal, select the proper band, select the proper antenna (DF or OMNI), rotate the antenna if applicable, and increase the gain until the signal

appears on the analysis scope. If the signal does not appear, you have followed the preceding steps correctly, then the signal is no longer being received.

### Common and Complex Signals

(C) AM.—Voice or tone modulated will always be loudest in the AM function. Figure 10-21 shows the pan trace and analysis scope with an AM modulated signal.

(C) FM.—Voice or tone modulated will always be loudest in the FM function. Figure 10-22 shows how an FM modulated signal will appear on the pan trace and analysis scope.

(C) Television.—AM and FM signals that are 4.5 MHz apart in the United States. The audio carrier is FM and the video carrier is AM. Some countries use AM for the audio and video and the separation may be from 5 to 9 MHz apart either above or below.

(C) Tacan Beacon.—Uses a pulsed signal with random PRF and pulsed pairs 3.5 μsec PW with a 12 μsec spacing. The frequency range for the lower band is 962 to 1024 MHz and 1151 to 1213 for the upper band. It also has an identification code every 37 seconds (Morse Code).

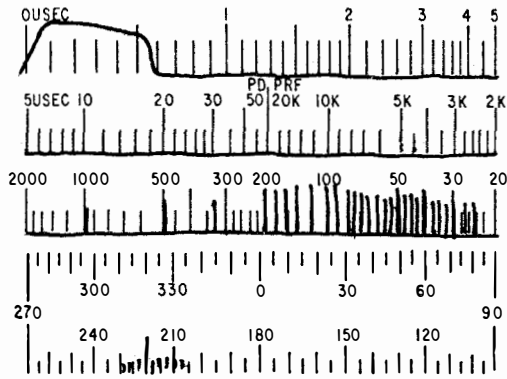
(C) Tacan Interrogation.—On the aircraft, pulses are the same as the beacon, 3.5 μsec PW and 12 μsec between leading edges. The PRF is lower and steady and the frequency range is 1025 to 1150 MHz, 63 MHz above or below Tacan beacon for range.

(C) U.S. IFF Interrogation.—Has a frequency of 1030 MHz, with a 1 μsec pulse pairs PW and a spacing of 3, 5, or 8 μsec depending upon the MODE.

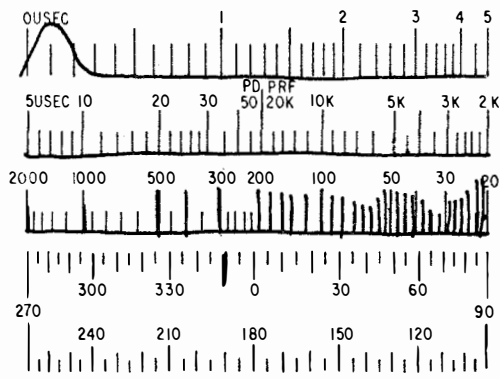
(C) U.S. IFF Reply.—The frequency is 1090 MHz, and the PRF will be 410 PPS or less with a 21 μsec pulse train determined by the CODE.

(C) Pulse Compression.—Normally used with a long pulse radar, the formula for minimum range and range resolution will not apply for a

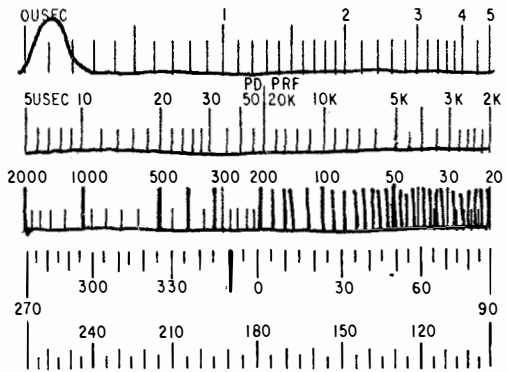
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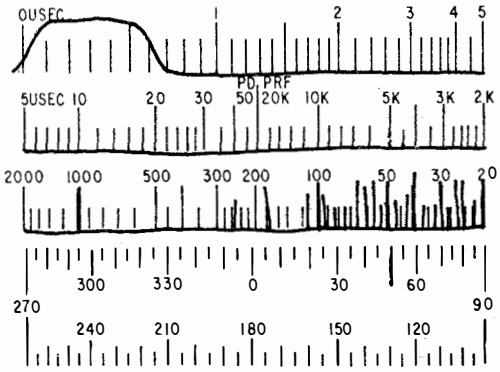
A-CIRCULAR SCAN



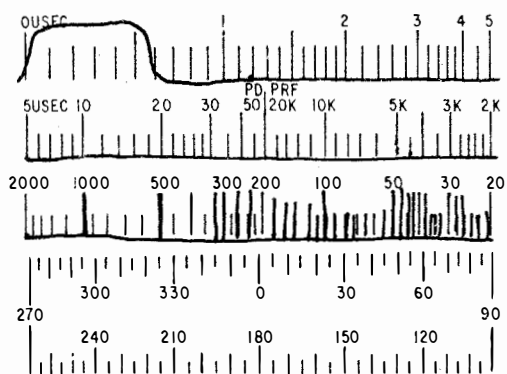
B-CONICAL SCAN



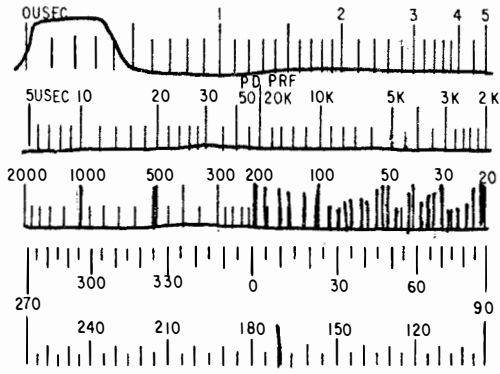
C-CONICAL LOCKED ON



D-SPIRAL SCAN



E-LOBE SWITCHING

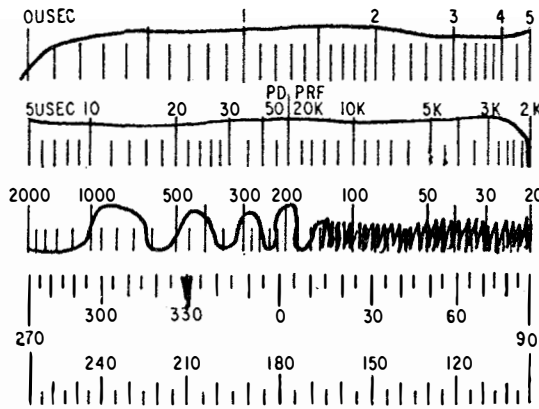


F-VERTICAL SECTOR

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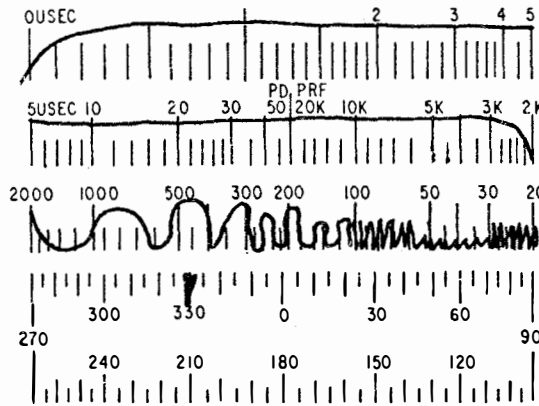
Figure 10-20.—(U) Analysis scope, A-circular scan, B-conical scan searching, C-conical scan locked on, D-spiral scan, E-lobe switching, F-vertical sector (U).

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Figure 10-21.—(U) Pan trace and analysis scope with an AM modulated signal (U).



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Figure 10-22.—(U) Pan trace and analysis scope with an FM modulated signal (U).

pulse compression radar. The U.S. is the only country employing pulse compression radars at this time, however, the U.S.S.R. has radars of this type in the development stages.

(C) Data Transmission.—May include AM, FM, pulse, or any combination of them. This signal can also contain several channels of information and is used in link 14 and in Satellite Command transmission.

(C) Heavy Signal Densities.—(World Wide) will be in the 1000, 3000 and 9000 MHz range.

**Band and Signal Relationships**

**Band 1:**

- 50-54 MHz Amateur AM
- 54-72 MHz TV-AM and FM
- 70-80 MHz Soviet communications
- 72-76 MHz Aeronautical beacons
- 76-88 MHz TV-AM and FM
- 88-100 MHz FM broadcast

**Band 2:**

- 90-103 MHz FM broadcast
- 100-150 MHz Soviet VHF communications
- 108-132 MHz Aircraft and airport communications AM
- 132-144 MHz Government use, AM-or-FM
- 144-148 MHz Amateur-AM
- 148-152 MHz Government use
- 152-174 MHz General communications
- 174-180 MHz TV-AM and FM

**Band 3:**

Most signals are below 250 MHz.

- 160-174 MHz General communications
- 174-216 MHz TV-AM and FM
- 216-225 MHz Some radars and communications
- 225-250 MHz Military UHF-AM

**Band 4:**

Most signals are bunched below 450 MHz.

- 300-400 MHz Military UHF-AM
- 328-336 MHz ILS glide path
- 400-450 MHz Some long-range radars
- 420-450 MHz Amateur-AM
- 450-510 MHz ASW data link
- 470-600 MHz UHF TV-AM and PM

**Band 5:**

Most signals above 900 MHz.

Heavy signal density around 1000 MHz.

- 550-890 MHz UHF TV-AM and FM
- 900-1100 MHz Tacan and IFF

**CONFIDENTIAL****Band 6:**

Most signals are from 1000 to 1500 MHz.

1000-1500 MHz	Tacan and IFF long- and medium-range radars
2000-2110 MHz	Studio to transmitter lines

Shortly after intercept the signal fingerprints change to:

Freq-	9299 MHz
PRF-	3715
PW-	0.4 $\mu$ sec
Scan-	Circular at 3.8 SPR
Page	223

**Band 7:**

Most signals between 3000 and 3500 MHz. There are several U.S. height-finder radars around 3500 MHz. Signals of all kinds exist around 3000 MHz (high density area).

**Signal Number Two**

Freq-	8020 MHz
PRF-	1700
PW-	0.8 $\mu$ sec
Scan-	Horizontal sector at 2.25 SPR
Page	293

**Band 8:**

Most signals are around 5600 MHz. Primarily shipboard surface search radars, and some missile control radars.

**Signal Number Three**

Freq-	9320 MHz
PRF-	311
PW-	1.7 $\mu$ sec
Scan	Horizontal sector at 4.2 SPR
Page	117

**Band 9:**

Most signals are between 8600 and 9600 MHz. Radars in this band are small, short-range and medium-range search, airborne and submarine radars, precision radars, missile control, and microwave relays.

**Signal Number Four**

Freq-	3220 MHz
PRF-	311 ppps
PW-13	1.0 $\mu$ sec pulses
Scan-	Steady
Page	369

**IDENTIFICATION**

(C) You have been given the information on how to analyze a signal and now we will identify the signal from the signal characteristics (called fingerprints).

(C) The page number following the fingerprint is the page number from the threat emitter evaluation guide (NWP 12-6-1, Vols 1 and 2). Check the appropriate page after you have made your identification as to platform, probable range, and threat.

**Signal Number One**

Freq-	9299 MHz
PRF-	1170
PW-	1.0 $\mu$ sec
Scan-	Circular at 3.8 SPR

**Signal Number Five**

Freq-	9335 MHz
PRF-	1170 pps
PW-	0.7 $\mu$ sec
Scan-	Sector at 3.2 SPR
Page	109

(C) In order to correctly identify a signal it sometimes takes a lot of digging through various publications. At times you will be unable to identify the signal because of new developments and variants of equipment already in existence, therefore, the agencies concerned with keeping the identification publications current need your help.

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## **CHAPTER 11**

# **COMMUNICATIONS**

(U) This chapter will give you an overall picture of the various methods of communications, both internal and external including the methods, procedures, and code words that are used, as well as the different types of communications available in the EW modules of the various ships of the fleet in which you will serve.

(U) Every effort is made to stress speed, accuracy, reliability, and security of communications. Bear in mind that although accuracy, reliability, and security of communications are essential, our efforts are wasted unless all information and orders are handled so that action may be taken in ample time to be completely effective.

(U) The success of all EW operations depend on teamwork. What is teamwork? How do we achieve this coordinated action? It is accomplished by being able to exchange ideas, information, and orders, thus letting each other know what we are doing or planning to do. Without communications, the EW team is not really a team, but merely a group of men doing different jobs with individual skills, yet lacking the means for actually accomplishing the mission. Therefore, every member of the EW team must become an expert in voice communications.

### **TYPES OF INTERNAL COMMUNICATIONS**

(U) Nine types of shipboard internal communications are used. They are (1) voice

tubes, (2) ship's service telephones, (3) messengers, (4) teletypewriter, (5) television, (6) multichannel (MC) systems, (7) sound-powered telephone systems, (8) pneumatic tubes, and (9) target designation-systems. Not every ship's EW module has all of these means of communication. As our discussion progresses, we will examine each type of internal communication separately.

### **VOICE TUBES**

(U) Voice tubes provide important means of internal communications, although they are normally used only as a standby measure. This system is merely a network of metal tubes designed to carry the sound of the voice from one station to another. The major value of this system is that it is practically immune to mechanical failure. Consequently, it can be relied upon when casualties disrupt other systems.

### **SHIP'S SERVICE TELEPHONES**

(U) Although the ship's service phones are not part of the battle communication system, they prove invaluable when the regular systems fail. They are standard telephones powered by the ship's generators, and are intended for use in carrying out the normal administrative routine on ships. Two features expedite the telephone-calling process. They are the executive cut-in telephone and hunt-the-not-busy line.

(U) Executive cut-in telephones, clearly marked, are for emergency calls and for use of persons in authority. Operationally, these

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telephones are the same as a standard telephone, except they are limited in number and they can be used to call a station that is in use. Instead of returning a busy signal, the cut-in phone breaks into the circuit. The caller then can interrupt the conversation in progress to deliver important messages.

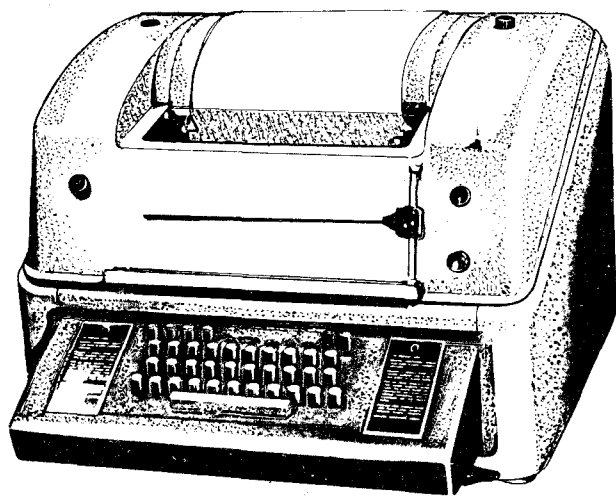
(U) The hunt-the-not-busy line feature can be utilized when calling an area that has a group of consecutively numbered telephone stations. By dialing the lowest numbered station, the switchboard connects the calling station to the lowest numbered idle telephone. When all the circuits of the group called are in use, a busy signal is returned to a standard telephone.

**MESSENGERS**

(U) Ships still use the oldest method of communication—the messenger. Messengers are a reliable means of sending a message, but they are not always as fast as the other methods discussed in this chapter. You'll be called on many times during your naval career to use your knowledge of the ship by serving as a messenger.

**TELETYPEWRITERS**

(U) The teletypewriter (fig. 11-1A) is another means of internal communication. It is



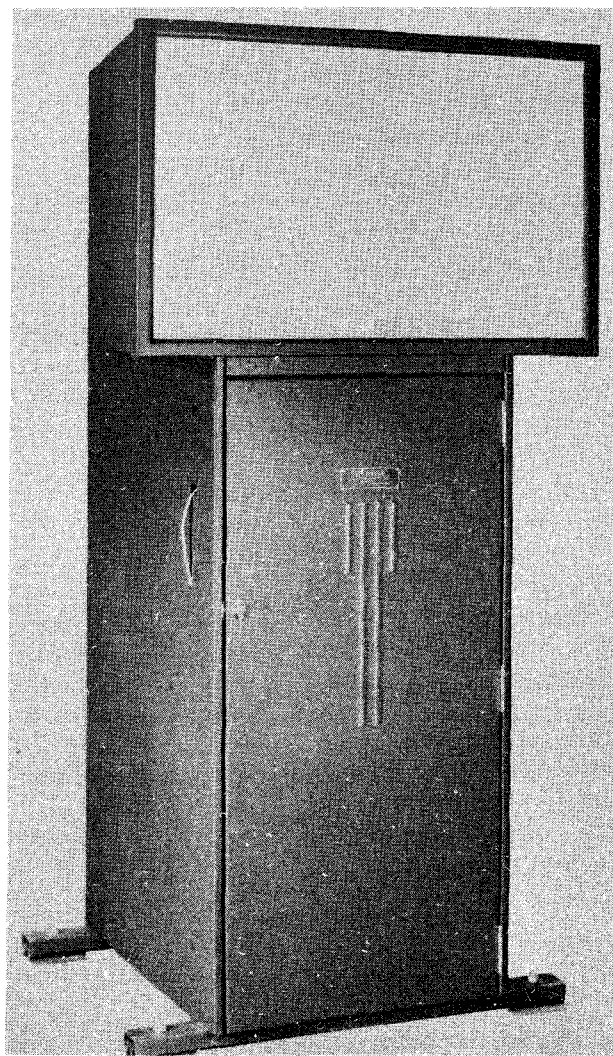
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Figure 11-1A.—(U) Teletypewriter (U).

found on most large ships. An advantage of the teletypewriter is that it can be used with a projector unit to enable the teletypewriter message to be read simultaneously by groups of persons. It is utilized in carrier readyrooms and in conference rooms on command ships. (See figure 11-1B.)

**TELEVISION SETS**

(U) Television sets show an up-to-date picture of a particular operation or evolution to



31.34

Figure 11-1B.—(U) Teletypewriter projection unit (U).

a group of people. The TV is used to relay the latest picture of the overall operation. It also is utilized for training personnel in large groups. In some instances, TV may be used to relay information between ships at close range.

### PNEUMATIC TUBES

(U) Pneumatic tubes are for the purpose of relaying written messages between communication stations in some ships. This system of internal communications has the advantage of routing a message quickly. Two disadvantages are that it needs ship's power for compressed air, and it is good for written messages only.

### TARGET DESIGNATION EQUIPMENT

(U) Target designation equipment is a rapid, silent, and effective means of communicating combat information. Inasmuch as CIC is the principal agent for collecting combat information, many ships have installed target designating equipment. This equipment allows CIC to provide to the weapons control stations, a signal that will assist in target acquisition.

(U) In some ships the radar target designation equipment is not located in CIC, but in a separate station. Its operation, however, is closely integrated with CIC. Target designating equipment normally is operated by weapons department personnel, as directed by the weapons officer, but you as an EW should understand the function, capabilities and limitations of the target designation systems.

### MULTICHANNEL SYSTEMS

(U) Multichannel systems (MC) aboard ship serve the general purpose of transmitting orders and information between stations within the ship. Transmission is by means of direct amplified voice communications. There are two types of MC equipment, one is the central amplifier system, the second is the intercommunication systems. Each has distinguishing features.

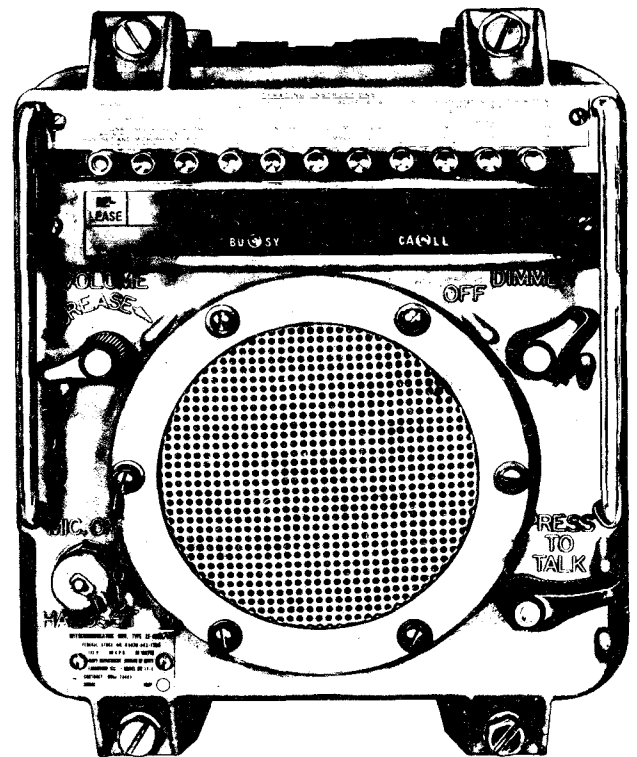
(U) The central amplifier system, such as the ship's general announcing system (1MC) is designed to broadcast orders or information, usually to a large number of stations simultaneously. A central amplifier is used, hence the system affords only one-way communication.

(U) Intercommunication (intercom) systems provide for two-way transmission of orders and information between stations. Each intercom unit contains its own amplifier.

### Intercommunicating Unit

(U) Intercommunicating units installed in naval vessels are of standard design (fig. 11-2). This standardization permits the units to be connected together electrically in a system.

(U) The intercommunicating unit (normally referred to as the MC unit) is housed in a steel cabinet designed for bulkhead mounting. It will



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Figure 11-2.—(U) Intercommunicating unit (U).

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withstand shock, vibration, and salt spray, and will perform under extremes of temperature and high humidity. The components consist essentially of a reproducer, controls, and amplifier.

(U) The reproducer serves as a microphone to transmit sound from the unit to other units in the system and as a loudspeaker to reproduce sound transmitted to the unit by any other unit. An incoming call can be heard through the loudspeaker because amplification is accomplished by the amplifier of the calling unit.

(U) The controls consist of the talk switch, pushbutton assembly, busy light, call light, volume control, and dimmer control.

(U) The TALK SWITCH serves to select the function of the reproducer. When the switch is depressed, the reproducer functions as a microphone and the output of the amplifier of the calling station is electrically connected to the reproducer of the call station. When the switch is released the reproducer functions as a loudspeaker. The talk switch is spring loaded and returns to the listen or standby position when released.

(U) A HANDSET can be used with the intercommunicating unit in place of the reproducer. The operation is the same as that of the reproducer except that the pushbutton in the handset is used as a talk switch in place of the regular talk switch on the front panel. Incoming calls will be heard simultaneously in the handset and in the reproducer. The volume control will control the level of the incoming call to the reproducer only.

(U) A PORTABLE MICROPHONE can also be used with the equipment. The operation is the same as that of the reproducer, except that the pushbutton on the microphone is used as a talk switch instead of the regular talk switch on the equipment.

(U) The PUSHBUTTON ASSEMBLY, or station selector buttons, are located at the top of the front panel. The locations or designations of the various units in the system are engraved in the station designation plate below the associated selector buttons. When the station selector buttons are depressed they will lock in the operated position until the release

pushbutton is depressed to return them to the nonoperated position.

(U) The BUSY lamp is lighted when a station button is depressed to call another station and the station being called is busy. Do not leave a station selector button depressed when the busy lamp is lighted. Depress the release pushbutton and call later.

(U) The DIMMER CONTROL controls all illumination of the unit. The busy/call lights are off when the control knob is in the extreme counter-clockwise position and are fully lighted for all other positions as the knob is turned clockwise. The station designation lights are lighted for all positions of the control knob and the illumination increases as the knob is turned clockwise.

(U) The VOLUME CONTROL varies the volume of incoming transmissions. This control has no effect on the volume of the outgoing sound from the unit. Thus, each unit in the system can control the incoming volume to the desired level.

(U) OPERATION.—To call a particular station, depress the station selector switch of the desired station, depress the talk switch, and speak directly into the grill. Release the talk switch to listen. When the conversation is completed, depress the release pushbutton to return the station selector switch to the nonoperative position.

(U) To accept a call from another station, listen to the incoming call through the loudspeaker. Do not operate any of the station selector switches. Depress the talk switch to reply to the incoming call. The call light illuminates to indicate that the station is being called by another station.

### System Nomenclature

(U) A few of the MC systems that you will see and use (some not located in EW) are described in the following subtopics.

(U) GENERAL ANNOUNCING SYSTEM (1MC).—The general announcing system, a

**CONFIDENTIAL**

one-way system, is found on practically all ships—large or small. The system's transmitter is not located in EW, but you may have occasion to use it while standing in-port quarterback watches. It is used for passing general orders and administrative information. Transmissions can be made from key stations such as bridge, quarterdeck, and damage control stations, to all stations or selected groups of compartments within the ship and all topside areas. The 1MC also provides a means for transmitting general alarm and chemical alarm signals to the same areas.

(U) **READY ROOM ANNOUNCING SYSTEM (19MC).**—The 19MC provides two-way communications for stations dealing with air operations on aircraft carriers. Stations on the circuit include CIC, readyrooms, flight deck control, hangar deck control stations, air intelligence, and wardroom.

(U) **COMBAT INFORMATION ANNOUNCING SYSTEM (20MC).**—The information passed over the 20MC, a two-way system, is mostly combat intelligence from each main plotting group in CIC to primary and secondary conning stations, captain's tactical plot, open bridge, main battery control stations, antiair warfare stations, main battery director stations, main and secondary battery plotting rooms, flag bridge, flag command and plotting stations, missile control stations, and electronic warfare (EW) stations.

(U) **CAPTAIN'S COMMAND ANNOUNCING SYSTEM (21MC).**—The 21MC system provides two-way transmission of ship control orders and information among key stations. Key stations include primary and secondary conning stations, signal bridge, main battery control stations, antiair warfare stations, Radio Central, damage control station, main engine control, CIC, primary flight control station, and captain's tactical plot. The 21MC is used by EW for sending the bridge initial contact reports or any emergency information. The signal bridge frequently transmits information received by flaghoist to bridge and EW at the same time on the 21MC.

(U) **RADIO ROOM ANNOUNCING SYSTEM (22MC).**—The 22MC looks exactly like the 21MC and 20MC units, but the station selector switches are marked with different stations. The system is used to pass information and orders concerning radio facilities, as well as data between radio rooms and certain other radio operating stations. In EW you may use the 22MC to call radio to request a frequency setup on a transmitter, or to check a radio receiver that may be drifting out of tune.

(U) **FLAG OFFICER'S COMMAND ANNOUNCING SYSTEM (24MC).**—The 24MC system provides two-way transmission of flag orders and information between such stations as flag bridge, signal bridge, flag plot, flag radio, Radio Central, open bridge, combat information center, captain's tactical plot, and electronic warfare.

(U) **SONAR INFORMATION ANNOUNCING SYSTEM (29MC).**—The 29MC system provides one-way communication from sonar operators to captain's tactical plot, open bridge, pilothouse, CIC, underwater battery plot, ASW attack stations, and electronic warfare.

(U) **CIC COORDINATION ANNOUNCING SYSTEM (42MC).**—The 42MC usually is found in CICs in larger ships, especially those having a modular CIC.

(U) Such an arrangement enables communications at any time between key personnel with CIC.

(U) **SAMID WARNING SYSTEM (59MC).**—The 59MC provides two-way communications between EW control, the evaluator, CIC, bridge, lookouts, and weapons stations. Primary information sent over this circuit is threats, disclosures, and early warning. All transmitting stations are connected to all speakers so that no stations are cut out.

#### **SOUND-POWERED TELEPHONE SYSTEM**

(U) When you studied Basic Military Requirements you learned about sound-powered

**CONFIDENTIAL**

(S/P) telephones. Sound-powered telephones are considered the "workhorse" of the shipboard internal communication system. Their use in EW is quite extensive; for this reason it is necessary to study them further in this text.

**Advantages of SP Telephones**

(U) Several advantages are afforded by sound-powered telephone equipment for internal communications. A few of them are:

1. Operation is simple.
2. The equipment is rugged, if given reasonable care.
3. Talker is not distracted by external noise, because his ears are muffled by the ear pads.
4. Security or privacy of communications as compared with MC equipment.
5. Transmissions do not contribute to station noise levels.
6. The talker is mobile within the limitations set by the length of the cord, and except while transmitting, is free to perform other tasks with his hands, such as radar operator or plotter.
7. The earphones may be used for emergency transmissions if the microphone becomes defective.
8. The system does not require an external source of power for operation.

(U) **CIRCUIT NOMENCLATURE.**—Each separate sound-powered telephone circuit is designed for a specific purpose. The groups linked by a sound-powered circuit may include the bridge, the underway and docking stations, and the damage control teams. Identification of separate circuits is dictated by their usage, and is characterized by a letter and number code. *Basic Military Requirements*, NAVPERS 10154-C, covers the nomenclature designation.

(U) **CIRCUIT REQUIREMENTS IN EW.**—The number of sound-powered circuits required in EW depends on the type of ship. Normally there are more circuits in larger ships than in smaller ones. All types, however, have certain minimum circuit requirements. These needs include a separate circuit—

1. Between each search radar and the plotters for that radar.
2. Between the EW room and other CIC stations.
3. Between the visual lookout stations, EW, and to other stations.
4. Linking radio central (communications) to EW and other stations.
5. Between EW, bridge, and other conning stations.
6. Direct communications between EW and flag plot (on flagships).
7. Between EW and each weapons control station, including sonar in sonar-equipped ships.
8. For anti-aircraft information in carriers.

(U) Large ships, in which there are a great many more sound-powered telephone circuits, use a more elaborate setup. The number of phones manned depends on what the ship is doing. More circuits are manned at general quarters than during normal steaming watches.

**TYPES OF EXTERNAL COMMUNICATIONS**

(U) Three types of external communications are discussed in this chapter. They are the messenger, visual, and radio systems. Messenger and visual communications, when accomplished properly, are more secure than radio systems.

**MESSENGERS**

(U) Although visual and radio communications are the important types of communications, messenger-type communications are available. Messenger communications

are used chiefly in port, but may also be utilized at sea by means of highline, boat, or helicopter transfer. Most external communications handled by messenger are of an administrative nature. This method is the most secure system of handling communications, material receipts are obtained, and it is employed in handling classified matter.

(U) The messenger system of communications is of value in relieving congestion over rapid communication circuits. This application is particularly true of long messages requiring no immediate action. When circuits are heavily loaded and distances are short, time often can be saved by messenger communications. This method especially applies to classified matter, which, if sent by other systems, ordinarily would have to be encrypted and decrypted.

### VISUAL COMMUNICATIONS

(U) Visual communications (signaling) consists of flaghoist, semaphore, flashing light (directional signal searchlights and nondirectional yardarm blinkers), and infra-red gear. NANCY is the code name for a system using infra-red light that is invisible to the naked eye. NANCY consists of either a special filter placed over the 12-inch searchlight or an omnidirectional infrared beacon mounted on a mast. The resulting signal is visible only to a signalman looking through a special NANCY receiver.

(U) During daylight hours the majority of tactical and maneuvering signals are accomplished by flaghoist, and are sent and received by the signal bridge. These signals are transmitted to CIC via sound-powered phones or the 21MC circuit.

### RADIO COMMUNICATIONS

(U) Radio communications are accomplished by means of radiotelegraph, radiotelephone, and radioteletypewriters. The number of nets assigned depends upon duties of the ship, mission of the force, group, or unit to which it is assigned, the operation order, and equipment available aboard ship.

#### Radiotelegraph

(U) Radiotelegraph messages, known as continuous wave (CW) transmissions, are sent and received by radio personnel. When of interest to CIC, they are written up and routed to CIC by messenger.

#### Radioteletypewriter

(U) The radioteletypewriter (RATT) automatically receives and prints messages. These messages can be reproduced by the master equipment and retransmitted to various ship control stations.

#### Radiotelephone

(U) Radiotelephone (RT) is used for voice tactical and administrative communications by ships and aircraft. Because of its convenience, speed, and simplicity of operation, it is the primary method of external communications for EW.

(U) Electronics Warfare Technicians are concerned chiefly with R/T, consequently the remainder of this chapter deals with information required for the most effective use of this type of communication system.

### EW COMMUNICATION EQUIPMENT

(U) Personnel in EW are not responsible for tuning and maintaining communication equipment. Radio equipment is installed in other spaces aboard ship and is tuned and maintained by authorized personnel. Electronics Warfare Technicians must, however, have some knowledge of the frequency coverage, power output, and purpose of each unit of equipment they control in EW; equipment operating manuals should be consulted for this purpose. Likewise, EWs must be familiar with operation and maintenance of control accessories installed in EW.

(U) Communication equipment used in EW is in MF, HF, VHF, and UHF bands. The VHF and UHF bands are for short-range ship-to-ship and ship-to-aircraft communications. Under normal conditions, surface-to-surface range with these frequencies is about 30 miles. Many times,



**CONFIDENTIAL**

though, because of atmospheric conditions and other weather effects, transmissions may be received at a much greater distance. Where VHF/UHF is unreliable, MF and HF are used for distances greater than 30 miles.

(U) As in radar, the more powerful the transmitter, the farther radio waves may be expected to travel. Power output, then, must be adjusted to fit the desired distance, utilizing the minimum power output that will furnish reliable communications; in other words, low power for short distances, medium power for medium distances, and high power for long distances.

(U) In any discussion of range capabilities of EW equipment, it must be noted that weather phenomena probably make up the greatest single factor affecting capability and limitation of communications. These phenomena may permit unusually great distance; but, on the other hand, they may limit communications.

(U) Effective communications depend on efficiency of equipment and how precisely it is tuned to the desired frequency. Constant checks must be made on all communication equipment

to ensure that transmitters and receivers do not drift off frequency. Although a Radioman normally performs these checks, EWs need to know whether frequency drift may be one cause of poor communications. The position of the selected antenna is a very important consideration during periods of poor communications.

**REMOTE CONTROL UNITS**

(U) A number of remote control units are used in EW. The number of units installed is governed by a ship's communication requirements.

(U) When frequencies to be guarded in EW are determined, the communication officer sees that they are set up on receivers and transmitters and patched to EW remote control units. (See figure 11-3.)

(U) Remote control units (fig. 11-3A) contain one 5-pronged receptacle for either a chestset or a handset. Besides start-stop switches, a remote control unit has only one control—an earphone level control. A red light

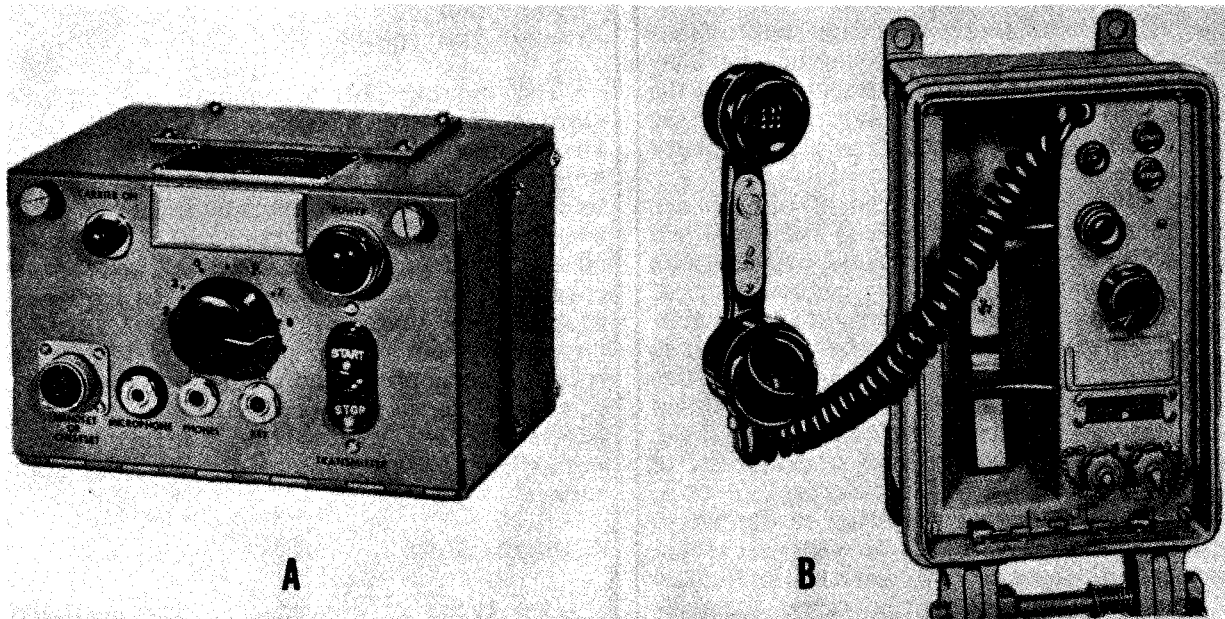


Figure 11-3.—(U) Remote radiotelephone units (U).

7.40(74)



on the unit indicates when the equipment is ready for operation. A small green light shows when a transmission is being made.

(U) The remote control unit is started by pushing the start button, at which time the red light shows. Usually the unit requires about 20 or 30 seconds to warm up before transmitting. When transmitting from the remote control unit, the transmitter is keyed by means of the small button on the handset in order to send the message. When the transmitter is keyed, the green light comes on if the proper carrier signal is emitted.

(U) Transmitters that are used frequently are placed in the ON position. For frequencies over which few transmissions are made, the transmitter may be left in the STOP position merely by pushing the STOP button.

(U) The remote phone unit in part B of figure 11-3 is an all-weather control apparatus. Its operating principles are the same as those described for other components of remote control units, except it contains one built-in handset and two 5-pronged receptacles.

### **RADIO NETS (CIRCUITS)**

(U) A radio set is the organization of two or more stations in direct communication on a common channel. Usually the senior station on the circuit is net control—normally the OTC on most circuits used in EW. To assist in accomplishing a mission, the OTC sometimes subdelegates net control duties to another unit. He also may assign a station as alternate net control. The station so designated would assume net control duties when the net control station is unable to perform the function.

### **RADIO WATCHES**

(U) Various types of radio watches are necessary to maintain communication circuits in EW. The type of watch required is specified in the OpPlan and OpOrder. Watches must be stood according to instructions for the particular type of watch. If instructions are not observed, the result will be missed messages or time delays

in receipt of messages. Following are the types of radio receiver watches.

- **Guard:** A continuous receiver watch is required with a transmitter ready for immediate use. A complete log must be kept.
- **Cover:** A continuous receiver watch is kept, with transmitter calibrated and available, but not necessarily for immediate use. A complete log is required.
- **Copy:** A continuous receiver watch is maintained, and a complete log is kept.
- **Listen:** A continuous receiver watch is maintained. A complete log of transmission is optional.

### **CLASSES OF CIC RADIO NETS**

(U) Radio nets are classified into three major classes according to their mission (purpose), as (1) command, (2) common, and (3) functional.

#### **Command Net**

(U) A command net links a commander with his immediate subordinates in the chain of command and with such other units as may be designated. A task force command net, for example, is activated by the task force commander, and is guarded by task group commanders.

#### **Common Net**

(U) A common net links all ships and/or troop units of the same task organization. A task group common net is activated by the task group commander, for instance, and is guarded by all ships and troop units in the task group.

#### **Functional Nets**

(U) A functional net normally is used to connect directly those personnel delegated control of a specified function for which the net is provided.

**CONFIDENTIAL****TYPES OF NETS**

(U) The type of net and method of operation is determined from consideration of operational factors involved.

**Free Net**

(U) In this type of net, the net control station (NCS) authorizes member stations to transmit traffic to other stations in the net without obtaining prior permission from the net control station. Free net operation does not relieve the control station of the responsibility for maintaining circuit discipline.

**Directed Net**

(U) In this type of net, stations obtain permission from the net control station prior to communicating with other stations in the net. Permission is not required for the transmission of FLASH messages, which shall be sent direct. Transmissions on a directed net may also be accomplished in accordance with predetermined schedules.

(U) A net is deemed to be a Free Net unless otherwise ordered. When it is required to change a Free Net to a Directed Net or vice versa, one of the following phrases "This is a Directed Net"/"This is a Free Net" shall be used by the NCS.

**COMMON RADIO CIRCUITS**

(U) FLEET TACTICAL (UHF).—For communications between forces meeting at sea. When supporting forces such as shore-based aircraft or additional surface forces do not hold the communications plan of the supported force, initial communications will be established on this circuit and then be shifted as directed by the OTC. Guarded by all U.S. ships underway singly and at least one ship of a group.

(U) TF/TG TACTICAL (UHF).—For maneuvering signals and urgent short tactical messages. This circuit is primarily limited to the OTC for tactical maneuvering signals but may be used for urgent warning, tactical alerts, initial contact reports by ships within the formation

and screening ships, and reports of vital information concerning the immediate safety of ships in company. Controlled by the OTC and guarded by all ships of the TG while in UHF range.

(U) TF/TG REPORTING (UHF).—For the exchange of radar and plot information on surface, subsurface, and air contacts. Pre-exercise messages are transmitted via this net. The TF/TG reporting net is guarded continuously by all ships of the TF/TG when underway regardless of the tactical situation. It should not be used for passing command orders or administrative traffic. This is a CIC to CIC net.

(U) SCREEN TACTICAL (UHF).—For use by the screen for maneuvering signals and urgent short tactical messages.

(U) EW COORDINATION (HF).—For the control of jamming-search, and DF organization, and for the alerting and steering of search and DF activity and the exchange of information.

(U) AIR COORDINATION (HF).—For the dissemination of information concerning aircraft control and to control and coordinate the function of air control ships. May be one to four nets (W, X, Y, Z) depending on the number of sectors established. Information transmitted includes stationing and relieving CAP; assignment of CAP to air control ships; progress of intercepts, intercepting instructions; CAP position reports; CAP missile coordination; tally-ho and splash reports; report of flight deck condition and status of airborne aircraft; coordination and direction of air phase of SAR; coordination of homing lost aircraft; reports of jamming and passive ESM intercepts of airborne radiation.

(U) AIR REPORTING (HF).—For air raid reporting between ships with an air defense capability.

(U) AAW WEAPON COORDINATION (HF).—For the coordination of gunfire, missiles, and fighter interceptions in defense of the

**CONFIDENTIAL**

formation and may be used for passing simplified air pictures to small ships.

(U) **NAVAL GUNFIRE CONTROL.**—Used between naval gunfire support ships and other authorities for control and coordination, including aircraft safety.

(U) **NAVAL GUNFIRE GROUND SPOTTING CONTROL.**—Used to control individual ship's gunfire support. Primary use is to call and adjust fire; secondary use is to exchange vital information between stations on the network. Provides communications between the naval gunfire spotter, the fire support ships, and the battalion naval gunfire liaison officer (NGLO) for conducting fire missions against enemy targets.

(U) **NAVAL GUNFIRE AIR SPOTTING.**—For air spotting of naval gunfire. Used to call for and adjust fire by the air spotter in the same manner as the ground spotting control net.

(U) **FIGHTER CONTROL (UHF).**—Used to control CAP aircraft within UHF range by the ships or aircraft allocated to control them.

(U) There are secondary circuits associated with many of the nets listed above. The secondary TF/TG tactical, TF/TG reporting, and screen tactical are usually HF circuits that are used when the distance between ships becomes too great for UHF communications.

(U) National and international distress circuits will be guarded in accordance with NWP 16 and the effective Operation Order.

(U) The air control and air reporting nets are the long range circuits used for aircraft coordination and reporting in an AAW environment. When the AAW area is divided into sectors, a single net, called the SNIP Net, can be used in place of the air control and air reporting nets.

### **OPERATING RULES**

(U) To utilize circuit time more efficiently, all messages or their substance should be written

down prior to transmission. Those messages which must be delivered by the receiving operator to another person or which are preceded by the proword "MESSAGE" shall be written down.

(U) Transmissions by radiotelephone shall be as short and concise as practicable consistent with clarity. The use of standard phraseology enhances brevity.

(U) Transmissions over radiotelephone should be clear with natural emphasis on each word except the prescribed pronunciation of a numeral, and should be spoken in natural phrases, not word by word.

(U) If it is technically practicable the operator shall, during the transmission of a message, pause after each natural phrase and interrupt his transmission (carrier), momentarily, to allow another station to break in if necessary.

(U) When it is necessary for a station to initiate test signals, either for the adjustment of a transmitter before making a call, or for the adjustment of a receiver, such signals will not continue for more than 10 seconds, and will be composed of spoken numerals (1,2,3, etc.) followed by the call sign of the station transmitting the signals.

### **ESTABLISHING COMMUNICATIONS**

(U) Abbreviated call signs shall not be used in establishing communications. Before conducting regular traffic over radiotelephone circuits, it may be necessary to make contact with the other stations involved to ascertain that communication is possible.

### **CALL SIGNS**

(U) Voice call signs are words or numbers or a combination of words and numbers that identify communication facilities, commands, authorities, or units. They are used principally for establishing and maintaining communications. A voice call sign assigned a ship is the primary means of identifying that ship on voice radio nets.

**CONFIDENTIAL**

(U) Individual ship voice call signs, together with all other joint armed forces voice call signs, are contained in JANAP 119.

(U) In addition to individual ship voice call signs, there are collective voice call signs, which include two or more ships, units, and the like; and command voice call signs, which are the voice call signs for the commander of a group of ships, units, and so on. To illustrate: In a task group consisting of several ships, whose collective call sign is Lampblack, the task group commander, whose command call sign is Bull Durham, wishes to send a message to the task force. His transmission would be:

LAMPBLACK—THIS IS BULL  
DURHAM—INTEND TO TRANSFER  
MAIL COMMENCING 0900—OVER

Each ship would receipt for the message in alphabetical order of call signs.

Full call signs are to be used:

- When first establishing a net.
- When reporting into a previously established net.
- In the transmission instructions and address components when a message is required to be relayed to a station on a different net.

(U) Provided no confusion can arise, call signs may be abbreviated when authorized by the NCS.

**SEQUENCE OF CALL SIGNS  
AND/OR ADDRESS GROUPS**

(U) The following rules govern the sequence of call signs and/or address groups in calling and answering and of those included in components of messages:

(U) Call signs and/or address groups in message headings will ordinarily be arranged in alphabetical order in the form in which they are to be transmitted, whether plain or encrypted. For this purpose, / (slant sign) and figures 1 through 0 will be considered the twenty-seventh

through thirty-seventh letters of the alphabet. Care must be exercised to avoid separating groups of related call signs and/or conjunctive address groups which are interdependent.

(U) When abbreviated call signs are used on a net, the sequence of answering a collective call is to be the same as if full call signs were in use, thus avoiding any confusion that may arise when changing from full to abbreviated call signs.

**RADIO CHECKS,  
SIGNAL STRENGTH  
AND READABILITY**

(U) A station is understood to have good signal strength and readability unless otherwise notified. Strength of signals and readability will not be exchanged unless one station cannot clearly hear another station.

(U) A station that wishes to inform another of his signal strength and readability will do so by means of a short and concise report of actual reception such as, "Weak, but readable," "Loud but distorted," "Weak with interference," etc.

(U) The prowords listed below are for use when initiating and answering queries concerning signal strength and readability:

## 1. General—

**RADIO CHECK**—What is my signal strength and readability, i.e., how do you hear me?

**ROGER**—I have received your last transmission satisfactorily. The omission of comment on signal strength and readability is understood to mean that reception is loud and clear. If reception is other than loud and clear it must be described with the prowords from subparagraphs (2) and (3) below.

**NOTHING HEARD**—To be used when no reply is received from a called station.

**CONFIDENTIAL**

## 2. Report of Signal Strength—

**LOUD**—Your signal is very strong.

**GOOD**—Your signal strength is good.

**WEAK**—Your signal strength is weak.

**VERY WEAK**—Your signal strength is very weak.

**FADING**—At times your signal strength fades to such an extent that continuous reception cannot be relied upon.

## 3. Report of readability—

**CLEAR**—Excellent quality.

**READABLE**—Quality is satisfactory.

**UNREADABLE**—The quality of your transmission is so bad that I cannot read you.

**DISTORTED**—Having trouble reading you because your signal is distorted.

**WITH INTERFERENCE**—Having trouble reading you due to interference.

**PRELIMINARY CALLS**

(U) When communication is difficult or when the calling station wishes to ascertain whether the station called is ready to receive a message, a preliminary call will be sent before transmitting a message.

**AUTHENTICATION**

Authentication is a security measure to establish the validity of a transmission suspected to be fraudulent. The degree of security of an authentication system decreases with its use, and the receipt of correct authentication cannot always be accepted as proof of validity. Accordingly, if an inordinate delay precedes a reply to a challenge, a second challenge must be transmitted. A message cannot be rejected arbitrarily if its transmission was not authenticated, inasmuch as authentication may not be required on all transmissions. Even

incorrectly authenticated transmissions may be genuine. In situations where authentication is required, messages received incorrectly authenticated or unauthenticated must be delivered locally without delay but without suitable notation for decision by the addressee regarding their authenticity. When a message must be relayed, the relaying station is required to advise the receiving station that the message was not authenticated or was incorrectly authenticated. Only approved authentication systems may be used.

## 1. Authentication is mandatory when—

a. Any station suspects imitative deception on any circuit.

b. Any station is challenged or requested to authenticate. This challenge must not be interpreted as requiring stations to break radio silence for the sole purpose of accomplishing authentication.

c. Directing radio silence or requiring a station to break an imposed radio silence.

d. An unclassified message canceling a classified message under the provisions of NWP 16.

e. Transmitting to a station that is under radio silence.

f. Making contact and amplifying reports in plain language or brevity code.

## 2. Authentication is advisable when—

a. Transmitting a plain language cancellation by radio.

b. Transmitting operating instructions that affect the military situation. (Examples: Closing down a station or watch, shifting frequency, or directing establishment of a special guard.)

c. Making initial radio contact or resuming contact after prolonged interruption. Authentication should be exchanged to prevent an unauthorized station from opening a circuit by asking a legitimate station to authenticate.

d. A station having, for any reason, failed to obtain an answer to its calls, if forced to transmit its messages blind (that is, without getting a receipt from the intended receiving station).

**CONFIDENTIAL****TRANSMITTING A MESSAGE**

(U) When communication reception is satisfactory, message parts need to be transmitted only once and preliminary calls are optional.

(U) When communication is difficult, call signs should be transmitted twice. Phrases, words, or groups may be transmitted twice and indicated by use of the proword "WORDS TWICE". Reception may be verified by use of the proword "READ BACK". Under such conditions preliminary calls are normally employed unless stations are on a directed net, in which case stations should have indicated they are ready to receive.

**RELAY**

(U) The proword "RELAY" used alone indicates that the station called is to relay the message to all addressees.

(U) The proword "RELAY TO" followed by an address designator, indicates that the station called is to relay the message to the stations indicated. When more than one station is called, the call sign of the station designated to perform the relay will precede the proword "RELAY TO." At times it is necessary to relay a message originated on a radio telephone circuit by some other means of communications. When such relay is necessary, it is the responsibility of the station relaying the message to place the message in the proper format for the means of communications employed for relay.

**REPETITIONS**

(U) When words are missed or are doubtful, repetitions will be requested by stations before receipting for the message. The proword "SAY AGAIN" used alone or in conjunction with "ALL BEFORE \_\_\_\_\_," "ALL AFTER \_\_\_\_\_," "\_\_\_\_ TO \_\_\_\_\_" will be used for this purpose. In complying with requests for repetitions, the transmitting station will identify that portion which is being repeated.

(U) When it is necessary to ask for repetitions after a message has been receipted, such requests and replies thereto must identify the message being queried as well as the portion required. Where used, the date-time-group or time group should be used for such identification.

**CHECKING THE GROUP COUNT**

(U) When a message consisting of coded groups is being received and the number of groups actually received does not correspond with the group count of the message, the receiving station requests a check by transmitting the phrase "Interrogative groups....", stating the number of groups actually received.

(U) When queried, the transmitting station will check and if the number of groups received is correct, will indicate this by use of the proword "CORRECT". The receiving station must then alter the group count accordingly.

**CORRECTION DURING TRANSMISSION**

(U) When an error is made by a transmitting operator, the proword "CORRECTION" will be transmitted followed by the last word, group, proword or phrase correctly transmitted. Transmission then continues.

(U) When an error in transmission is made but not discovered immediately, a correction may be made in the final instructions element provided that the ending sign has not been transmitted. When making such a correction, the word, group proword or phrase must be properly identified.

**CANCELLING MESSAGES**

(U) During the transmission of a message and prior to the transmission of the ending proword "OVER" or "OUT", the transmission may be cancelled by use of the proword "DISREGARD THIS TRANSMISSION-OUT".

**CONFIDENTIAL**

(U) A message which has been completely transmitted can only be cancelled by another message.

### **“DO NOT ANSWER” TRANSMISSIONS**

(U) When it is imperative that called stations do not answer a transmission, the proword “DO NOT ANSWER” will be transmitted immediately following the call and the complete transmission will be sent twice, the full transmission ending with the proword “OUT”.

### **“READ BACK”**

(U) If it is desired that a message or a portion thereof be read back, the proword “READ BACK” and identifying data will be transmitted immediately following the call.

Note: When “READ BACK” procedure is employed, the proword “ROGER” is not necessary to indicate receipt of the message.

(U) The proword “READ BACK” when not preceded by identifying call signs means that all stations are to read back. If a collective call is used, but only part of the stations represented in the call are required to read back, that station or those stations will be specified by transmitting the appropriate call signs preceding the proword “READ BACK.” When the order to read back is given, only those stations directed to do so will read back; remaining stations called will keep silent unless directed by the calling station to receipt.

### **RECEIPT**

(U) Receipt is employed in direct station-to-station traffic handling. No message is considered delivered until a receipt is obtained. A receipt may be effected as follows: The receiving station transmits a receipt after each message or string of messages by the proword “ROGER”. Example:

(U) When the transmitting station considers speed of handling a primary consideration, one station in the net may be directed to receipt for

the message and no other stations may answer until instructed to do so. This does not prohibit any station from requesting repetition. Security is enhanced if the same station is directed to receipt for all transmissions.

(U) Should either the transmitting or receiving station wish to indicate that he has further traffic to transmit to the station that he is working, this may be done by using the proword “MORE TO FOLLOW” in the message ending or receipt.

### **ACKNOWLEDGMENT OF MESSAGES**

(U) An acknowledgment should not be confused with a reply or receipt. A prompt reply referring to the message may serve in lieu of an acknowledgment. It is the prerogative of the originator to request an “acknowledgment” to a message from any or all addressees of that message. If an acknowledgment is desired for a message, the request for acknowledgment normally is included in the text of that message. If the message has been transmitted the request for acknowledgment will constitute a new message. Acknowledgments are originated only by the addressee to whom the request for acknowledgment was made.

### **VERIFICATION**

(U) When verification of a message or a portion thereof has been requested by an addressee, the originating station will verify with the originator and send the correct version.

(U) When a message to a number of addressees is queried by one station and found to be incorrect, the corrected version must be sent to all addressees.

### **EMERGENCY SILENCE**

(U) Emergency silence may be imposed or lifted only by competent authority. When an authentication system is in force, a station must always authenticate a transmission which:

- Imposes emergency silence.

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- Lifts emergency silence.
- Calls stations during a period of emergency silence.

(U) Transmissions imposing emergency silence will be made twice through and ended with the proword "OUT". Stations do not answer or receipt for such transmissions.

(U) "SILENCE", spoken three times means "Cease transmissions on this net immediately. Silence will be maintained until lifted."

1. After a call, use of the proword "SILENCE" (spoken three times) means, "Stations addressed cease all transmissions on this net immediately".

2. "SILENCE" (spoken three times) followed by a frequency or a frequency designator means, "Cease all transmissions immediately on frequency... (or that indicated by frequency designator)".

3. "SILENCE" (spoken three times) followed by "all nets", means, "Cease all transmissions immediately on all nets".

(U) When emergency silence is lifted after a prolonged period of silence, communications will be established with all stations just as if the net were being established for the first time.

**BREAK-IN PROCEDURE**

(U) A station having a message of higher precedence than the transmission in progress may break-in and thus suspend that transmission in the following circumstances:

1. Flash-Break-in at once and transmit the message.

2. Immediate—May break-in at once and pass message. A preliminary call may be made before transmitting the message if necessary. On a directed net NCS approval to transmit the message must be obtained.

3. Priority—As for Immediate except that only long Routine messages should be interrupted.

Note: Break-in procedure will not normally be employed during the transmission of tactical messages except to report enemy contact.

(U) The precedence spoken three times means "Cease transmissions immediately. Silence will be maintained until the station breaking in has passed his message."

(U) Break-in procedure for messages of precedence Flash on either a free net or a directed net should take the following form:

**EXECUTIVE METHOD**

(U) The executive method is used when it is desired to execute a tactical message at a given instant, e.g., to ensure that two or more units take action at the same moment.

(U) Abbreviated plaindress format is normally used for messages transmitted by the executive method. When communications are good, it is not necessary to have all stations called acknowledge receipt of tactical messages. In these circumstances only those stations whose call signs precede the proword "OVER" receipt for the message.

(U) Messages sent by Executive Method are never to have a time group included in the message ending.

There are two executive methods:

1. Delayed Executive Method.
2. Immediate Executive Method.

(U) DELAYED EXECUTIVE METHOD.—A tactical message sent by the Delayed Executive Method will carry the warning proword "EXECUTE TO FOLLOW" in the message instructions, immediately preceding the text. The executive signal will be sent later in the form "Standby-EXECUTE", the latter word being the instant of execution. The text of the message being executed shall be repeated prior to transmission of the proword "EXECUTE" when:

1. It is a portion of or one of several outstanding "EXECUTE TO FOLLOW" messages.

**CONFIDENTIAL**



2. A considerable time has elapsed between the transmission of an "EXECUTE TO FOLLOW" message and the transmission of the executive signal.

**(U) IMMEDIATE EXECUTIVE METHOD.**—In cases of urgency the executive signal may be transmitted in the final instructions element of the message to which it refers. To differentiate between this method and that laid down above, the transmission of the executive signal in the final instructions of the message to be executed is termed the "Immediate Executive Method". It should be noted that:

1. The use of the Immediate Executive Method does not allow stations to obtain verifications, repetitions, acknowledgments or cancellations before the message is executed.

2. Messages made by the Immediate Executive Method should be in plain language or should be limited to basic TURN, CORPEN, and SPEED signals.

#### **EXECUTION OF NON-EXECUTIVE METHOD MESSAGES**

(U) Tactical messages taken from a signal book which do not employ Delayed Executive Method or Immediate Executive Method should have a time group included in the message ending. The use of a time group on a tactical message ordering action indicates that action is to be taken on receipt unless otherwise indicated in the text of the message.

#### **CANCELLING TACTICAL MESSAGES**

(U) Tactical messages requiring cancellation will be cancelled as follows:

1. Messages not sent by the Executive Method will be cancelled in accordance with procedures previously explained.

2. Messages sent by the Delayed Executive Method and not yet executed shall be cancelled by use of the word "Negat". Such messages can be cancelled individually or as a group.

#### **ACKNOWLEDGMENT OF SIGNALS**

(U) Signals, the purport of which requires the accomplishment of a difficult maneuver, quite often require acknowledgment of not only the understanding of the signal but also the capabilities of the addressee to perform such a maneuver. In such cases, the originator adds the word, "Acknowledge," as the last word in the text. When the commanding officer or his authorized representative is in close proximity to the operator, and no delay in answering will result, the proword "WILCO" will be used in receipting in lieu of the proword "ROGER." However, when this situation does not exist, the operator shall receipt in the usual manner and send the proword "WILCO" later, when ordered.

#### **COMMUNICATIONS SECURITY**

(U) In the interest of security, transmission by radiotelephone will be as short and concise as possible consistent with clearness. Since personnel other than trained operators frequently operate radiotelephone equipment, all personnel must be cautioned that transmissions by radiotelephone are subject to enemy interception and therefore have no security.

(U) Adherence to prescribed procedure is mandatory. Unauthorized departures from or variations in prescribed procedure often create confusion, reduce reliability and speed, tend to nullify security precautions, and are prohibited. If the procedure prescribed herein does not cover a specific operating requirement, initiative and common sense should suffice.

(U) The following basic rules are essential to transmission security and will be strictly enforced on all military radiotelephone circuits.

1. No transmission will be made which has not been authorized by proper authority.

2. The following practices are specifically forbidden:

- Violation of radio silence.
- Unofficial conversation between operators.

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- Transmitting on a directed net without permission.
- Excessive tuning and testing.
- Transmitting the operator's personal sign or name.
- Unauthorized use of plain language.
- Use of other than authorized prowords.
- Unauthorized use of plain language in place of applicable prowords or operating signals.
- Linkage or compromise of classified call signs and address groups by plain language disclosures or association with unclassified call signs.
- Profane, indecent or obscene language.

3. The following practices are to be avoided:

- Use of excessive transmitting power.
- Excessive time consumed in tuning, changing frequency, or adjusting equipment.
- Transmitting at speeds beyond the capabilities of receiving operators.

**CIRCUIT LOGS**

(U) Circuit logs will be maintained, when practicable, on all radiotelephone nets or circuits. The log normally shows a complete and continuous record of all transmitted and received traffic and operating conditions which occur during the day. Logs are discussed in chapter 12.

**OPERATIONAL BREVITY CODE**

(C) The operational brevity codes are words and phrase vocabularies for use on radiotelephone nets and sound-powered telephone circuits manned by EW and other personnel familiar with the codes. They provide brevity and clarity to communications—a basic knowledge requirement for EWs.

(C) Operational Brevity Codes, ACP-165, is the basic operational brevity code book. It should be adhered to exactly, that is, according to the strict meaning of each word and phrase. From time to time, other publications listing code words are promulgated. Code words not listed in ACP-165 or other authoritative service publication are not authorized for use. Commonly used code words are given in the accompanying list.

ARTIC: Polarization of signal is \_\_\_\_\_.

BENT: Equipment indicated is unserviceable.

BLOOMER: Erase my last switch or report.

BLOTTER: ESM Receiver.

BRIDGE: Pulse width in microseconds.

BRUSH: Antenna sweep rate in revolutions per minute.

CANYON: Use electronic jamming on frequency indicated or in accordance with previous orders.

CHATTER: Communications jamming.

CLIFF: Jamming signal (hostile/unknown/friendly).

CONFETTI: Chaff lane or corridor.

CONTROL: This unit responsible for coordinating intercept search efforts.

CURVE: Deception signal (hostile/unknown/friendly).

DUFFER: DF equipped unit.

FAN TO: Left and right hand edges of jammed sector are \_\_\_\_\_ and \_\_\_\_\_.

FERRET: Airborne electronic reconnaissance activity or aircraft.

FLASH PHOTO: Ground fire control or missile guidance radar.

FORD: Assume intercept guard/watch on band or guard indicated.

FREAK: Frequency in megahertz.

MUSIC: Electronic jamming.

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**PROWLER:** ELINT configured merchant ship.

**RACKET:** Intercepted electronic emission which is unidentified but assumed to be enemy and which has been assigned a serial number.

**RENT:** Characteristics of intercepted radar signal are given in the following sequence, separated by the word TACK, frequency in megahertz, PRF in pulses per second, PW in microseconds, antenna rotation rate, type scan, bearing, and time. If any portion of the above are unknown you must indicate unknown for that portion. An example (3900/300/0.3/5A/310/unknown).

**REVERT:** Resume search on the previously assigned intercept guard.

**SCRUB:** Erase the contact indicated from all plots.

**SEARCHER:** Unit or units having electronic intercept search capability which has been assigned to search a specified frequency, or band of frequencies and report to CONTROL all electronic emissions intercepted.

**SEARCHLIGHT:** Train antenna specified on true bearing indicated.

**SLOPE:** Pulse repetition rate in pulses per second.

**SNEAKER:** ELINT configured trawler.

**SWITCH:** Stations maintaining watch in the band, shift search and DF watch to the frequency indicated, on which an enemy is transmitting.

**TROUT:** Take a DF bearing on transmission indicated.

**VOLCANO:** Guided missile signal (hostile/unknown/friendly).

**WATCH:** Continue to sweep as directed and concentrate on the contact designated, but do not report unless there is a material change in this contact.

### **METHOD OF SYNCHRONIZING TIME**

(U) If an accurate time check is desired it will be requested by using the phrase "Request time check". The time at which the check is required may be indicated by the addition of a four figure group, normally local zone time.

(U) Should the occasion arise when the NCS desires to give an accurate time check to all stations on the net, he will pause a sufficient period of time between his warning phrase and the commencement of his count-down to allow all receiving operators to prepare their watches. The NCS may announce his intention of transmitting a time check at a certain time, using the phrase "Time check at . . . ."

### **EW REPORTING**

(U) The objective of EW in support of fleet operations is to effect detection and permit timely reaction to an airborne, surface, or subsurface threat. Therefore, rapid and efficient reporting procedures are essential if EW information is to be useful on a force level.

### **COORDINATION DURING NAVAL WARFARE OPERATIONS**

(C) During naval actions the force commander has vital need to integrate and correlate EW information into the tactical situation. Although the majority of EW information will be transmitted on the EW coordination and control net it is further necessary that evaluated passive EW information be paralleled on appropriate tactical warfare nets. The EWC will transmit evaluated information (location and identification of emitter) on the following nets during the actions indicated:

<b>NET</b>	<b>ACTION</b>
AAWR (CID)/SNIP	AAW
SAU Tactical	ASW
Surface Raid Reporting	Surface

**CONFIDENTIAL****TACTICAL EW  
REPORTING CONTROL**

(C) The OTC/EWC is responsible for overall control of EW reporting on the EW coordination and control net. To aid in detection, identification, and quick reaction to the threat, the OTC will direct the use of ESM and ECM.

(C) The EWC shall:

Receive all reports of intercepted signals and take action on each intercept reported.

Identify and evaluate the intercept by ordering Rent reports.

Switch units with DF capabilities to the frequency of the intercept.

Plot all reported DF bearings to obtain position, course, and speed of the emitter platform.

Disseminate all information on the intercept to the OTC and other units without delay.

Take action to scrub an intercept when information is no longer required or the intercept is no longer active. Unless otherwise directed, ensure that all units resume previously assigned guard assignments.

(C) **BASIC REPORTING PROCEDURES.**—In many instances, the response time to react to a threat is so short that immediate action must be taken to neutralize or eliminate the threat. It is imperative that the OTC be made immediately aware of all intercepted signals evaluated nonfriendly for the purpose of quickly and effectively ordering appropriate countermeasures and placing ships in appropriate conditions of readiness. Basic reporting procedures are as follows:

(C) The EWC will clarify when needed all dual or incorrect designation of intercepted rackets, will clarify all incorrect evaluations and correlations, and will organize and order all Trout and order Rent reports if applicable.

(C) Initial reporting unit of a racket will issue a scrub report to all units when a reported racket has ceased for five minutes and the EWC has taken no action. If the EWC does not agree with this scrub order, the EWC will immediately clarify the situation.

(C) Individual units will continue to report as directed by the EWC and as outlined in table 11-1.

(C) **INITIAL INTERCEPT CLASSIFICATION.**—The following criteria is an aid to individual units in classifying initial intercepts as either a normal intercept or an emergency intercept.

(C) A normal intercept report shall be made when a unit passively detects a signal evaluated as nonfriendly. This intercepted signal may or may not be a threat emitter. Before reporting this intercept, a unit must attempt to correlate this intercept with radar contacts presently being reported.

(C) An emergency intercept report shall be made when an intercepted signal is evaluated capable of providing necessary target data input for weapons delivery of antishipping cruise missiles or any other weapons systems where minimum reaction time is paramount. An emergency report shall be made regardless of the silence condition in effect.

(C) **INITIAL PASSIVE INTERCEPT REPORT.**—Information contained in the initial passive intercept report will be as follows:

- Designation using own ship's normal or AAW call sign together with a numerical system on a 24-hour basis.

- Frequency in kHz so that all force units will know the exact frequency of the emitter prior to switching Duffers for Trout information, and true bearing in three digits.

- Evaluation by item number referring to DST-1730S-465-YR, line number referring to OTC threat emitter list, or plain language in

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Table 11-1.—(C) EW Reporting Procedures (C)

SITUATION	REPORT
<b>MISSILE EMERGENCY</b> 1. Any EMCON plan. 2. Signal evaluated as antiship missile. 3. Report NATO nickname, if known, and bearing.	THIS IS LIMA, VAMPIRE (NATO NICKNAME, IF KNOWN) 060, REPEAT THIS IS LIMA, VAMPIRE (SHADDOCK) 060, OUT.
<b>THREAT SIGNAL EMERGENCY</b> 1. Any EMCON plan. 2. Signal is evaluated capable of providing target data input for delivery of antiship missile or any other weapons system where minimum reaction time is paramount.	THIS IS LIMA, EMERGENCY RACKET LIMA ONE, (PAGE NUMBER, KEY NUMBER OR OTC LIST NUMBER) 060 REPEAT THIS IS LIMA, EMERGENCY RACKET LIMA ONE, PAGE NUMBER 178,060, OUT.
<b>STANDARD ESM REPORT</b> A. 1. Any EMCON plan. 2. No radar correlation. 3. Signal evaluated as a threat emitter. B. 1. Depending on communications restrictions in EMCON plan. 2. No radar correlation. 3. Unknown signal.	WHISKEY, THIS IS LIMA, RACKET LIMA TWO, FREAK 9600, (060). (PAGE 178, KEY 1800 OR OTC NUMBER) OUT.
<b>CORRELATED ESM REPORT</b> 1. Intercepted signal determined to be contact being reported by own or another unit using AAW reporting procedures.	WHISKEY, THIS IS LIMA, RACKET LIMA ONE CORRELATES BOGEY LIMA TWO, 060, (PAGE 178 OR KEY 1800) OUT. OR WHISKEY, THIS IS LIMA, RACKET LIMA ONE CORRELATES BOGEY DELTA TWO, 060. (PAGE 178 OR KEY 1800) OUT.
<b>RENT REPORT</b> 1. Reported only when requested by control. 2. Contains frequency, pulse repetition rate, pulse width, scan, bearing (optional), and time (4 digit) in that order. Frequency: 9120 MHz PRF: 1100 PPS PW: 0.5 $\mu$ S SCAN: Circular/10 SPR Bearing: 060 T Time: 1230Z	LIMA, THIS IS ALFA WHISKEY, RENT RACKET LIMA ONE, OVER. THIS IS LIMA, RACKET LIMA ONE 9120, TACK 1100, TACK 0.5, TACK ALFA 10, TACK BEARING 060, TIME 1230Z OUT.
Organizing a Trout — Control takes action to fix location of racket. Although not specifically named, the ship initially reporting the racket is included as a duffer.	DELTA, MIKE, THIS IS ALFA WHISKEY, SWITCH RACKET LIMA ONE, STAND BY TO TROUT, TIME 18, OUT.
Ordering the Trout — Time 18 control desires Trout.	THIS IS ALFA WHISKEY, TROUT RACKET ONE, OUT.
Reporting the Trout — Duffers report results of Trout, reporting in alphabetical sequence of voice calls (only the first duffer's report is given here as an example).	THIS IS DELTA, RACKET LIMA ONE, 180, OUT.
Reporting negative results — Duffer does not detect signal or obtain a bearing.	THIS IS MIKE, RACKET LIMA ONE, NEGATIVE REPORT, OUT. OR THIS IS LIMA, RACKET LIMA ONE, NEGATIVE TROUT, OUT.
Reporting racket position — Control reports racket position after plotting trout reports.	WHISKEY, THIS IS ALFA WHISKEY, RACKET LIMA ONE, BLUE 010 TACK 150, TIME 18, OUT.
Ordering further Trouts — Control desires subsequent Trout.	THIS IS ALFA WHISKEY, STANDBY TO TROUT RACKET LIMA ONE, OUT.
About 30 seconds after preceding transmission.	THIS IS ALFA WHISKEY, TROUT RACKET ONE, OUT.

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Table 11-1.—(C) EW Reporting Procedures—Continued (C)

SITUATION	REPORT
Duffers report Trout as before and may include class of bearing (see Table B-2, NWP 33).	THIS IS DELTA, RACKET LIMA ONE, 120, CLASS ALFA, OUT.
Racket ceased — Racket Lima One ceased time 26.	ALFA WHISKEY, THIS IS LIMA, RACKET LIMA ONE CEASED TIME 26, OUT.
Racket resumed — Racket Lima One resumed time 27.	ALFA WHISKEY, THIS IS LIMA, RACKET LIMA ONE RESUMED TIME 27, OUT.
Racket scrubbed — Racket has ceased for 5 minutes and the EWC has taken no action. The initial reporting unit will issue a scrub report to all units.	WHISKEY, THIS IS LIMA, SCRUB RACKET LIMA ONE, TIME 29, OUT.
Ordering continued watch on racket — Control decides that a particular racket is not an immediate threat but still needs watching.	DELTA, LIMA, MIKE, THIS IS ALFA WHISKEY, REVERT RACKET LIMA ONE, LIMA WATCH, LIMA OVER.
Incorrect freak — Duffer not on correct frequency. EWC tells duffer to check for a signal about 25 MHz above freak he is on.	DELTA, THIS IS ALFA WHISKEY, RACKET LIMA ONE, SPOT UP 25, OUT.

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emergency reports to lessen reaction time. Evaluation of an intercepted signal by line number refers to a current threat EOB originated by the OTC.

(C) The threat EOB is a condensed version of threat emitters geared to a geographical area and the general tactical situation in that area. Each threat emitter is listed on a separate line.

(C) Bearing and positive evaluation are optional and need not be contained in the initial emergency racket reports if they cannot be determined immediately. As soon as bearing or evaluation information is immediately ascertained, it must be reported. Bearing and positive evaluation may be omitted from normal intercept reports if they cannot be determined within 30 seconds of the intercept.

#### EW COORDINATION AND CONTROL NET INFORMATION

(C) The following information will be transmitted on this net:

- Assignment of intercept guards

- ESM reporting and evaluation
- Duffer assignments
- Scrub orders
- Orders to employ ECM
- EMCON control and coordination orders
- Casualty reports involving equipment
- Enemy use of jamming
- Enemy deception

(C) If the EWC or OTC desires to fix the position of the emitting platform, he may order a Trout by switching additional units to a particular racket. Units may also ask for Rent reports if the exact parameters of the intercepted signal are required.

(C) When units are instructed to take periodic bearings on a signal source to locate and track the enemy transmitter by triangulation, each unit reports the true bearing of the signal and exact time of the

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bearing. Bearings will be classified according to table 11-2.

(C) Information such as status, identity, and characteristics of contacts will be

Table 11-2.—(C) Classification of Bearings (C)

Classification	Bearing Limits
A	±2
B	±5
C	±10
D	> ±10
Q	SNAP

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recorded and displayed on status boards, status sheets, or summary plots.

### REPORTING OWN USE OF ECM

(C) When our forces use ECM or are directed to do so by the AAWC or EWC, the appropriate transmission sent over the EW coordination and control net will be in accordance with the appropriate order, NWP-33 () or ACP-165. The reports are listed in NWP-33 () and are duplicated in table 11-3.

Table 11-3.—(C) ECM Coordination Codes and Reporting Procedures—Own Use of ECM (C)

Round Stone THOMAS 2 4 6 8 10 12	ULQ-6/SLQ-19/SLQ-17 Blip enhance Inverse gain RGPO Swept audio RGPO/IG Wobulation (SLQ-17 only)
Round Stone ROSCOE	SLQ-12
Round Stone WILLIAM	Chaff projectiles or rockets (frequencies specified by frequency band designation from Appendix C)
Round Stone JOSEPH 1 2, and so forth	As stated in OPOD. Round Stone JOSEPH plus number will normally be used to designate airborne active ECM equipment
Round Stone HARRY	ALQ-98
SITUATION	REPORT
1. Unit with ULQ-6 is radiating equipment in inverse gain mode of operation against Bogey DELTA-1.	This is DELTA, Round Stone THOMAS Four Shining Bogey DELTA-1, out.
2. Unit having SLQ-12 equipment is directed by the OTC/EWC to use SLQ-12 against Bogey DELTA-1.	DELTA, this is ALFA WHISKEY, Round Stone ROSCOE Bogey DELTA-1, out.
3. Unit with ULQ-6 equipment radiating in inverse gain mode of operation against Bogey DELTA-1 evaluates DECM as ineffective.	This is DELTA, Round Stone THOMAS Four negative Bogey DELTA-1, out.
4. Unit fires chaff projectiles (frequencies designated by Appendix C, NWP 33).	This is DELTA, Round Stone WILLIAM INDIA Shining, out.
5. Aircraft uses noise jammer. Noise jammer listed as "JOSEPH Two" in operation order. Direction of jamming orientation should be given (degrees true).	This is ROBINSON 12, Round Stone JOSEPH Two Shining 180, out.

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Table 11-4.—(C) Reporting Enemy Use of ECM (C)

SITUATION	REPORT
1. Unit detects enemy use of ECM on ESM equipment and/or radar	<p>Make report using following format:</p> <ol style="list-style-type: none"> <li>1. CLIFF (jammer) CURVE (deception)</li> <li>2. FREAK (frequency in MHz)</li> <li>3. Bearing (degrees true)</li> <li>4. Time jamming first received</li> <li>5. Bogey/Skunk correlation</li> <li>6. BANDWIDTH (MHz)</li> <li>7. Does enemy ECM, even after using CCM, make it impossible for you to:               <ol style="list-style-type: none"> <li>a. Locate targets?</li> <li>b. Destruct targets?</li> </ol> </li> </ol> <p>Report Example:            "THIS IS DELTA CLIFF FREAK 5600/090/1105/BOGEY D3/20/7A NEGATIVE/7B AFFIRMATIVE/OUT."</p> <p>Items not known shall be indicated using the format number/letter plus word UNKNOWN, (that is, "5 UNKNOWN").</p> <p>If item 7 (a. and b.) are both answerable by either "yes" or "no" then the transmission would simply end: "NEGATIVE" or "AFFIRMATIVE"</p>

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### REPORTING THE ENEMY'S USE OF ECM

(C) When own forces encounter enemy use of ECM, the report over the EW coordination and control and the appropriate tactical net will be taken from table 11-4.

### Amplifying Scan Information

(C) The present Rent report format as described in ACP-165 makes no provisions for reporting intercepts other than those with circular scan. Units intercepting and identifying an emitter using a scan other than circular will include in the Rent report additional information using the single letter code and numerical value for the measurement. Table 11-5 gives the single letter indicator for the different types of scans.

Table 11-5.—(C) Scan Types (C)

Code	Basic Scan Type
A	Circular or rotating
B	Horizontal sector (bidirectional)
C	Vertical sector (bidirectional)
D	Steady
E	Irregular, unsteady, or manual
F	Conical tracking
G	Lobe switching
H	Tracking other than F or G
J	Raster
K	Spiral
L	Helical
N	Circular and conical
O	Sector and conical
Q	Helical and conical
R	Other combinations
S	Vertical sector (unidirectional)
T	Horizontal sector (unidirectional)
U	Unidirectional (plane undetermined)
V	Bidirectional (plane undetermined)
Z	Undetermined

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## **CHAPTER 12**

# **EW STATUS BOARDS, LOGS AND PLOTS**

(U) In the past, when the EW rating was new, shipboard EW procedures involving logs, status boards, and reports, etc., were dependent upon the requirements set forth by fleet or area commanders, type commanders, and in many cases the specific OPORDER under which your ship was assigned. While basically the procedures of all organizations were somewhat the same, the exact procedures used often changed when the operational control ship was changed from one organization to another.

(U) Subsequently, standardization of all EW procedures throughout the entire Navy has taken place. In many procedures such as reporting, this standardization applies not only to the Navy, it applies to all the military services, including friendly nations with whom we have military alliances.

(U) It must be emphasized that all EW personnel should be thoroughly familiar with the procedures and instructions found in the different publications such as those covered in chapter 9 of this training manual, and especially those found in OPORDERS and Instructions of cognizant fleet and force commanders.

### **LOGS**

(U) Logs are required to provide a complete permanent record of the use of intercept, jamming or deception against enemy electronics or to record EW exercises. Complete and up-to-date logs must be kept at all times.

### **OPERATOR'S INTERCEPT LOG**

(U) The operator's intercept log provides a permanent record of intercepted signals, their radiation characteristics, and the freely entered comments of the intercept operator or signal evaluator. This log is shown in figure 12-1. This is the standard intercept log to be used throughout the fleet. Procedures for filling out the intercept log are covered in chapter 14.

(U) Each ship, along with the operator's intercept log, should maintain an active signal diary to facilitate rapid reference by EW personnel to all signals previously intercepted. This signal diary, or file, should be locally prepared to meet the current operational conditions and requirements. Normally the file will be indexed by frequency and contains the following information:

1. The signal parameters required for quick identification, such as frequency, PRF, and PW.
2. All information contained in the operator's intercept log.
3. Date and time when a signal was intercepted and logged as to known type.
4. Special instructions concerning the signal from CIC or the watch supervisor.
5. As accurate list of own ship's radiations of spurious responses should be maintained. This will enable the operator to quickly identify a signal as a spurious response emanating from his own ship's electronic devices and eliminate the embarrassing situation of reporting his own ship's radiations as an unknown or enemy signal.

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OPERATOR'S INTERCEPT LOG										<b>CONFIDENTIAL</b> (When Filled In)	
S/N 0103-634-3001											
UNIT DESIGNATOR			MISSION NO./OP ORDER				OPERATOR				
INTERCEPT DATE			CHART NO.								
SIGNAL NO.			SIGNAL IDENTIFICATION								
SIGNAL PARAMETERS											
FIRST HEARD TIME (Z)	RF (MHZ)	PRF	PW (USEC)	SCAN TYPE	SCAN RATE	POL	SIG. STR.	REEL AND REC. NO.	PHOTO NOS.		
RECORDED FROM _____ Z TO _____ Z											
FREQUENCY CHECKS PERFORMED					FREQUENCIES CHECKED						
<input type="checkbox"/> IMAGE <input type="checkbox"/> HARMONIC											
STATUS OF OWN RADAR(S)					TYPE(S)						
<input type="checkbox"/> NOT RADIATING <input type="checkbox"/> RADIATING											
INTERCEPT EQUIPMENT USED (Indicate type of antenna, receiver, recorder and reference tone source)											
DF INFORMATION											
TIME (Z)	SIG. STR.	TRUE BRNG.	A ± 2	B ± 5	C ± 10	D ± 20	Q SNAP	INTERCEPT PLATFORM POSITION (Latitude/Longitude)			
SIGNAL NO LONGER HEARD AT _____ Z DUE TO _____											
OPERATOR'S REMARKS							SKETCHES				
EVALUATOR COMMENTS											
VISUAL CORRELATION					IDENTIFICATION						
<input type="checkbox"/> YES <input type="checkbox"/> NO											
PHOTOGRAPHIC CORRELATION					PHOTO NOS.						
<input type="checkbox"/> YES <input type="checkbox"/> NO											
PLATE NO. 22604			(USE REVERSE FOR ADDITIONAL REMARKS)								
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Figure 12-1.—(U) Operator's intercept log (U).

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(U) Photographs or sketches of the displayed pulse shape, if unusual or otherwise significant, should be included in the signal diary and operator's intercept log. Every attempt should be made to obtain a photograph of both the emitting vehicle and the emitting antenna system, or a silhouette drawing of the vehicle and antenna system, for inclusion in the log and diary. In any case, every attempt shall be made to identify and record the signal source.

deception and the position of the ship or aircraft using the ECM. Also included should be the forces in company, the tactical objective of the operation, the type of jamming or deception used, the frequency and setting used and the effects on the enemy and his equipment as observed by monitoring or other means. (See figure 12-2.)

**ECM LOG**

**EW EXERCISE LOG**

(C) All ships should have an ECM log containing the time, duration of jamming or

(U) A log of all EW exercises participated in should be kept. All information pertinent to the exercises should be recorded, including results and recommendations.

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DATE _____ 19____				SHIP OR A/C _____				FORCES IN COMPANY _____																																																																																								
RAK (1)	ON (2)	OFF (3)	TOT (4)	FREQ (5)	MOD (6)	EQPT (7)	PWR (8)	ANT (9)	POL (10)	POSIT (11)	ALT (12)	OBJ (13)	REMARKS (14)																																																																																			
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Figure 12-2.—(C) ECM log (C).

**CONFIDENTIAL****EW TRAINING LOG**

(U) Often combined with the exercise log, this log should be a record of any type of training, held or received, pertaining to EW or EW personnel.

**RADIOTELEPHONE LOG**

(U) At all times EW must have a complete picture of the tactical situation, and a lot of information is passed over the radiotelephone circuits used by EW personnel. NTP 4 states that complete logs must be maintained on the maneuvering net, task unit command net, and the combat information net; and that modified logs may be maintained on all other circuits and nets. Completeness of coverage and degree of textual detail vary with type of ship, availability of personnel, and category of information passing through a net or circuit. The decision concerning completeness of all logs on other circuits rests ultimately with the commanding officer.

(U) Radio logs can be kept in freehand or with a typewriter. If freehand is used, the log usually is written in a large notebook. Record all information heard on the circuit, even though a message is sent to another unit or if only part of the message was heard. Radio transmissions follow a set procedure, and were discussed in chapter 11. The more familiar recorders are with radiotelephone procedures, the easier it is for them to copy transmissions. If desired, prowords may be logged by CW equivalents (prosigns). Some of these prosigns appear in examples that follow.

(U) Although voice transmissions are spoken slowly and clearly to make sure a message gets through, it may be difficult for logkeepers to copy accurately, particularly if they are slow writers. To make the work easier, a number of abbreviations (besides prowords) have been adopted to enable shortcuts in writing voice transmission. Following are some of the more important prosigns and abbreviations. In the left column are the words heard on the circuit. Corresponding shortcuts to be used in writing a message appear in the right column.

(U) To avoid the possibility of confusing zero with capital letter O, zero is distinguished by a slant line through it; thus  $\bar{0}$ . For the same reason, capital letter Z is written with a small bar (as  $\bar{Z}$ ) to distinguish it from numeral 2.

Words Heard	Abbreviation
This is	DE
Message for you	M4U
Acknowledge	Ack
Break	BT
Roger (message received)	R
Wilco (will comply with the order received)	Wilco
Course	Cus
Corpen	Corp
Speed	Sp
Position	Posit
Starboard	Stbd
Distance	Dist
Bearing	Brg
Range	Rng
Emergency	Emerg
Affirmative	Affirm
Negative	Negat
Standby	Stdby
Say again (I say again)	$\bar{IM}$
Immediate execute	Immediate $\bar{IX}$
Execute (execute to follow)	$\bar{IX}$
Tack	/
Time of execution	TOX

(U) Table 12-1 gives a sample radiotelephone log. Note that each logkeeper signs in and out when relieving the watch and being relieved. The date is also entered at the start of a new day.

**EW WATCH LOG**

(U) The EW watch log should be a complete and accurate chronological account of both routine and unusual events pertaining to the EW watch. Normally this log is kept by the EW watch supervisor, but in some cases the EW watch officer may want to make all entries. The log may be printed or it may be written in

Table 12-1.—(C) Sample Radiotelephone Log (C)

CIRCUIT			EW COORDINATION		
TO	FM	TIME	TEXT	TOX	
M	AW	2230	EW3 G. C. MILLS Set EMCON condition one K	9-24-71	2230
AW	M	2231	R $\overline{AR}$  EW3 G. C. MILLS  EW2 J. P. JONES		
M	AW	2233	Rent racket Mike one, K		2233
AW	M	2234	Racket Mike one, 9220—1100-0.5-Alfa 10-060-2234, $\overline{AR}$		
D, E, M	AW	2236	Switch racket mike one STBY to trout time 38 $\overline{AR}$		
	AW	2238	Trout racket mike one, $\overline{AR}$		2238
	D	2239	Racket mike one, negat report time 39, $\overline{AR}$		
	E	2239	Racket mike one 120 class B time 40, $\overline{AR}$		2240
	M	2240	Racket mike one 113 class A time 2240, $\overline{AR}$  EW2 J. P. JONES		2240

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longhand; in format, EW log entries are made substantially as presented in the following topics denoted to entries.

(U) Initial Entry: Starting at 0000 local time, the EW watch supervisor should record the name of the EW watch officer at the top left side of a new page, his own name at the top right side, and the watch section under his name; then follows the equipment in use, or in standby status, equipment casualties and estimated time for repairs (ETR) of that equipment; also enter any pertinent tactical data such as radar guard intercept guard assignments, or any other

unusual or special data reported to him. An oncoming watch supervisor should read the entries for the preceding watch for any pertinent information and also should read the captain's night-order book and make reference to any unusual or important comments contained in the order book.

(U) On the midwatch, in addition to the normal running account of the watch, the initial entry should describe fully any activity in which the ship presently is engaged. This procedure provides valuable reference material. A sample entry on the 0000 to 0400 watch might read as

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follows: WO. LCDR GULLET SUPERVISOR,  
EW1 HALL

Watch Section #1

ØØ-Ø4 Steaming in company with Task Group 56.1 composed of CarDiv 9, CruDiv 7, and DesRon 21 plus *USS Floyd B. Parks* (DD 884) and *USS Taylor* (DD 468). OTC is CTG 56.1 in *USS Coral Sea* (CVA-43), enroute from Alameda, Calif. to Pearl Harbor, Hawaii. The ship is in readiness condition 3 and material condition yoke is set. EW control ship is *USS Coral Sea* (CVA-43). Radar guards are Alfa, *USS Taylor* (DD 468), Bravo; *USS Floyd B. Parks* (DD 884). Intercept guards are: 134, 135, and 136 *USS Coral Sea* (CVA-43); 132, and 133 *USS Taylor* (DD 468); 137 and 138 *USS Floyd B Parks* (DD 884). EMCON condition ECHO is in effect. All equipment is operating normally except the AN/SPS-43 is down for PMS ETR Ø33Ø.

Ø33Ø AN/SPS-43 is up and operating normally.

(U) On successive watches, the first entry is "Steaming as before," and additional entries are made as they occur.

(U) The EW watch log contains much of the information found in the Quartermaster's log; consequently, entries can be made in the same format. OPNAV INST 3100.7 (Revised procedures for keeping ship's Deck Logs) should be used as a reference for logkeeping.

### STATUS BOARDS

(U) Status boards provide a listing of current tactical information which, because of space

limitations, cannot be presented on plots but must be available immediately for proper evaluation of enemy threats. The size and number of status boards vary with the different types of ships. Most status boards, however, are edgelighted and have a 36-inch square writing area. The type of boards and information plotted on them should be summarized in the EW doctrine.

(U) Some common examples of status boards are discussed in ensuing subsections.

### EW CONTROL SHIP STATUS BOARDS

(U) Figure 12-3 shows a visual record of each intercept by fingerprints and visual plot of both the guard assignment, intercepts, and the enemy Radar Order of Battle. Space is also provided for duffer (DF equipped unit) casualties which affect the intercept guard assignments. The most logical ships to be switched to an intercept for triangulation will be immediately apparent by reference to this status board and coverage of the vacated section of the frequency spectrum can also be easily assigned.

### EW STATUS BOARD

(U) Figure 12-4, the EW status board, displays the fingerprints of all important enemy signals that may be intercepted, a complete and up-to-date record of the radiation characteristics of all signals within the force and a list of all friendly and enemy electronic equipment. Data is recorded during operations, and the results of the reported data are also recorded. The operational status of own equipment is shown, and on the control ship the status and capabilities of equipment of the force should also be posted. The status board should also show the EMCON condition in effect and time-sharing plans.

(U) Due to the amount of information that must be plotted on this status board, it can be divided into sections and each section may completely fill a status board.

INTERCEPT RECORD											
RACKET	1	2	3	4	5	6	7	8	9	∅	RACKET
FREQ.											FREQ.
SLOPE											SLOPE
BRIDGE											BRIDGE
BRUSH											BRUSH
TIME											TIME
IDENT.											IDENT.
MEMY.											MEMY.
INTERCEPT GUARD & R.O.B.											
GUARD											1
R.O.B.											
GUARD											2
R.O.B.											
GUARD											3
R.O.B.											
GUARD											4
R.O.B.											
GUARD											5
R.O.B.											
GUARD											6
R.O.B.											
GUARD											7
R.O.B.											
GUARD											8
R.O.B.											
GUARD											9
R.O.B.											
DUFFER STATUS											
SHIP											
STATUS											

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Figure 12-3.—(C) EW control ship status board (C).

(U) Figures 12-5, 12-6, and 12-7 show how some ships divide the EW status board to make it compatible to their area of operation. In figure 12-5, all the information from the EW status board shown in figure 12-4 is displayed

except for the probable intercept and known radiations. This information is displayed by the threat and friendly emitter boards. There is also a small area for recording ELINT information that should be readily available to the operator.

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INTERCEPT GUARDS _____		FREQ _____		TO _____		SECTOR _____																	
CONTROL _____		TUNER STATUS _____		ANT. STATUS _____																			
EMCON CONDITIONS						RADAR GUARDS																	
Comm						Station		Function		Freq		Sector											
Radar																							
NavAids																							
IFF																							
ECM																							
Acoustical																							
PROBABLE INTERCEPTS						KNOWN RADIATIONS																	
Freq		PRF		PW		Scan		Brg		Rmks		Freq		PRF		PW		Scan		Brg		Rmks	
INTERCEPT CONTACTS																							
Signal		Freq		PRF		PW		Ant. Info		Brg		From		Time		Remarks							

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Figure 12-4.—(C) EW status board (C).

**EQUIPMENT STATUS BOARD**

(U) The equipment status board is used to display all the electronic equipment in the force by ship and the type of equipment each ship has. The remarks column can be used to indicate whether the equipment is operational or not by an arrow indicating up or down (as indicated in figure 12-8). HF with the arrow pointing down means that the SPS-30 height-finding radar for that ship is inoperable. This board is used for assigning radar guards and time-sharing plans. It is also helpful when monitoring the EMCON condition in effect.

**COMMUNICATION STATUS BOARD**

(U) Because communication status boards differ from ship to ship, no attempt is made to describe one in detail. Regardless of the format used, the following information should be displayed:

1. Channel number, frequency, and title of each communication circuit used; also the number of each local control position including RPUs and speakers.
2. Radio voice calls of all ships in the formation; in addition, it gives the OTC, CTG, and TG calls for other formations. Figure 12-9 shows a sample communication status board.

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INTERCEPT GUARDS _____		FREQ. _____	TO _____	SECTOR _____				
CONTROL SHIP _____		TUNER STATUS _____	ANTENNA STATUS _____					
<b>EMCON CONDITION</b>		<b>RADAR GUARDS</b>						
COMM.	STATION	FUNCTION	FREQ.	SECTOR				
RADAR								
NAVAIDS								
IFF								
ECM								
ACOUSTICAL								
ELINT MISSION NR _____		PHOTO NR _____	RECORDING NR _____	REEL NR _____				
<b>RACKETS</b>								
SIGNAL	FREQ.	PRF	PW	ANT. INFO.	BRG.	FROM	TIME	EVALUATION

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Figure 12-5.—(C) EW status board (C).

THREAT EMITTERS								
FREQ	PRF	PW	SCAN TYPE	SCAN RATE	PLATFORM	THREAT	KEY NR	RMKS

189.104

Figure 12-6.—(U) Threat status board (U).

FRIENDLY EMITTERS						
FREQ.	PRF	PW	SCAN TYPE	SCAN RATE	KEY NR	RMKS

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Figure 12-7.—(U) Friendly status board (U).












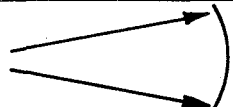


SUBJECT	DESCRIPTION	SYMBOL
1. BEARING	DRAW BEARING FROM DIRECTION OF INTERCEPTED SIGNAL.	
2. RAID AREA, (Rope, Chaff, and so forth).	LIMITS WELL DEFINED.	24  T 0920
	ONE SIDE UNDEFINED.	50  T 0948
	UNDEFINED.	10  T 1006
3. POSITION AREAS (Center and Radius).	ON GENERAL EW PLOT FULL CIRCLE.	
	ON DRT-SMALL CIRCLES AROUND FIGURE WHICH GIVES RADIUS IN MILES.	
	ON AIR PLOTS-AS IN TRIANGULATION FIXES AND RAID AREAS.	
4. MAXIMUM AND MINIMUM RANGES.	NO MINIMUM RANGE CAN BE GIVEN. DRAW BEARING FROM SHIP MAKING INTERCEPTION.	
	MINIMUM RANGE CAN BE DEDUCED. BEARING IS SHOWN.	
	MAXIMUM RANGE CAN BE DEDUCED.	
5. TRIANGULATION.	ARC OF JAMMING ORIGINATION.	
	NUMBER OF TRANSMITTERS.	
	TRIANGULATION FIX.	 T 0422

Figure 12-10.—(C) EW plotting symbols (C).

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**CONFIDENTIAL****PLOTS**

(U) There are several types of plots that can be useful to you as an EW watch stander. Only two of these will be covered in this section. Chapter 2 describes some of the various plots used by CIC personnel.

**STRATEGIC PLOT**

(U) The strategic plot is kept on a large area chart, and it shows a true display of movement, position, and strength of own and enemy sea, land, and air forces. It is based on OPLANS, OPORTERS, air reconnaissance, contact reporting, and intelligence information. On this chart should also be plotted the Electronic Order of Battle (EOB) showing location type of emitter and expected time your ship will enter into the range of the enemy's electronic equipment. This plot is a must for ELINT purposes to be discussed in a later chapter.

**FORMATION DIAGRAM**

(U) The formation diagram is a display, kept in terms of polar coordinates, on all stations in a formation of ships. On the formation diagram all

ships are shown relative to your ship in the center of the board and are normally kept on a maneuvering board. It can be used to see which units are in the best position to be switched for TROUT information.

**EW PLOTTING PROCEDURES**

(U) The plotting procedures used to coordinate ESM and ECM information depend to some degree upon the nature of the problem being encountered, and particularly on the tactical situation. ESM information that is plotted on the vertical plot in CIC should be early warning and identifying in nature. Do not try to confuse the vertical plot with information such as frequency, PRF, PW, and the like. However, time, bearings, triangulation fixes, and identification information on intercepted signals as well as bearing and location of jamming sources must be plotted. EW plotting symbols are shown in figure 12-10. Use them, because the plotting boards used by CIC are, in most cases, quite full of valuable information, and all of it must be correlated and evaluated in order to make the correct decision about any action to be taken.

## **CHAPTER 13**

### **EMCON**

(C) Emission Control (EMCON) is the effective management of all electromagnetic and electroacoustic emissions of a force or unit to obtain the maximum tactical advantage. The goal of EMCON is management of the electromagnetic and electroacoustic spectrum to provide the command with essential information, while presenting the enemy with a reduced probability of detecting, identifying, positioning, and homing. EMCON decreases own ship and force self-interference and provides for optimum exploitation of the electromagnetic spectrum. Information which is termed essential is determined by the tactical situation and will vary as the tactical situation varies.

(C) All emissions which occur in the electromagnetic spectrum and the electroacoustic environment must be included in emission control procedures. EMCON management must be integrated into the tactical command structure and must provide positive command decisions to use emitters as well as decisions to remain silent.

(C) Emissions are managed for tactical advantage in any engagement, and the situation must be under continuous review. The three basic reasons for EMCON are:

1. (C) Tactical evasion: In the era of reconnaissance satellites, it has become increasingly difficult to move a naval force of any size over vast ocean areas to within striking distance of an enemy coast line or naval force without disclosing its existence and location to the enemy. Concealing the existence, location, and composition of a naval force can be of the highest tactical value; however, this usually

requires electronic silence in all bands in which an enemy has an intercept capability during those times when surveillance by the enemy is being conducted or is most probable. The advantages and disadvantages of complete silence must be considered carefully before a decision is made. Continuous and effective ESM procedures must be employed to provide the tactical and local area information which emitters normally provide. The decision to maintain electronic silence must be under constant review. When it is obvious from ESM information that EMCON measures should be changed; selective, or full radiation freedom should be permitted.

2. (C) Preventing disclosure of intelligence or presenting false intelligence: Even though an enemy may be aware of the existence and general location of a force, considerable reconnaissance efforts may be required to determine force composition, disposition, and probable intentions. The judicious use of EMCON may magnify that problem and even require visual reconnaissance to obtain detailed information. Proper use of decoys and jammers, when combined with comprehensive deception effort, may cause sufficient confusion to an enemy that his reaction is delayed, his forces are deployed ineffectively, or his decision is incorrect as to which targets are most vulnerable. When special equipments with unique capabilities are employed, care must be taken to prevent premature disclosure of their deception capabilities.

3. (C) Avoiding interference: In order to prevent degradation of own force efforts, it is frequently necessary to restrict radiations.

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Effective ESM intercept search may require curtailment of radiations within certain limits. Radio frequency interference, hazardous electronic radiations to ordnance, and hazardous electronic radiations to personnel must all be considered in emission management.

(C) EMCON will also increase the effectiveness of our intercept search by minimizing the number of transmissions within our force, thereby reducing local or mutual interference on our own intercept search receivers. Conditions of silence also furnish an opportunity for the necessary maintenance work on the silenced equipment.

(C) The restrictions or limitations imposed upon the use of emitting equipment will range from complete silence to the unrestricted use of transmitting equipment. These restrictions will apply to the use of any type of emitting devices, including sonar, surface noisemakers, underwater telephone, fathometer, ECM devices or equipment, and meteorological devices.

**CONTROL OF EMCON (C)**

(C) Responsibility of the control and execution of EMCON is vested in the OTC. Except when the safety of the ship or the accomplishment of the mission requires, no transmission may be made unless specifically authorized by the OTC. Specific exceptions are usually stated in the OPORDERS concerned.

(C) Instructions and doctrine concerning EMCON can be found in: NWP-33, NWP 33-1, NWP 12-6, NWP 12-1, ACP-178 (A), ATP-1 series, NWP-31, and the OPORDER. This would include considerations in determining the degree of silence to be set, assignments of intercept search guards, control of the use of transmitting equipment, and the EMCON plan.

**EMCON ORDERS**

(C) EMCON orders are any orders that implement emission control used during a mission to authorize control or prohibit the use of electronic emission equipment by making effective, amplifying, or modifying EMCON.

(C) The signals provided in ATP-1, Vol. II, will be used for promulgating EMCON orders.

**BREAKING EMCON (C)**

(C) In a tactical emergency, the effective EMCON condition, regardless of its stringency may be broken by a single unit. Should a picket, for example, have indication of an approaching threat, he should not hesitate to provide warning to the force via a reporting net. A destroyer in the screen with detection of a submarine should make the threat known.

(C) Until the OTC relaxes or alters the EMCON in effect, however, only the concerned units will break down EMCON. Unless specified by the OTC, the breaking of EMCON by a single unit is not the signal for all units to activate communications and emitters.

(C) If a unit passively detects electromagnetic radiation and evaluates the emission as one from the list of specific threat emitters and the evaluator has determined that this is an immediate threat to the force, the unit may employ the radar that is best suited for the detection of the emitter platform for one minute or less, as determined by the evaluator, regardless of the EMCON condition in effect at the time.

(C) In all cases, units which detect a known or suspected Anti-Ship Cruise Missile (ASCM) will use whatever means necessary to provide warning to the force, regardless of the EMCON condition set.

**EW CONTROL SHIP (C)**

(C) The Electronic Warfare Control Ship (EWCS) plays an important role in the overall effectiveness of EW Readiness. The control ship must properly perform the required duties to insure optimum results. Specific duties of the EWCS are—

1. (C) Assignment of intercept search guards: There are two goals to attain when assigning intercept search guards. First, a sufficient number of searchers must be assigned

to the frequency spectrum of the expected threat. The threat may be air, sub-surface or surface forces. The OTC will normally inform EW Control of the primary threat expected. Several units of the force should be assigned to search this frequency spectrum for the highest probability of intercept. Second, full coverage of the frequency spectrum within the capabilities of the force is required. This provides the intercept capability from sources other than that of the primary threat.

(C) Factors that determine the assignment of intercept search guards are:

A. The type of intercept search equipment installed. (C)

B. Number of operators required to man the equipment. (C)

C. Type of D/F antennas installed, whenever possible a guard should be assigned within the D/F capability of the ship. This alerts the force to the general direction of the intercept without delay. (C)

D. Force or ship electromagnetic radiations: Whenever possible, assign a guard to a unit which will have the least interference from its own permitted radar operation. A copy of the emission control plan in effect will aid the control ship in meeting this requirement. (C)

E. Current status of ships EW equipment. (C)

2. (C) Coordination of the overall intercept effort: Successful EW intercept in any tactical situation requires the EWCS to:

A. Take action on each intercept reported. (C)

B. Switch three to four duffers to the frequency of the intercept. (C)

C. Identify and evaluate the intercept using the characteristics reported by the initial detecting ship. Amplifying reports from other units may be required for a complete evaluation. (C)

D. Plot all reported D/F bearings to obtain position, course, and speed of the platform from which the signal was radiated. (C)

E. Disseminate all information on the intercept to the OTC and other units without delay. (C)

F. Take action to scrub an intercept when information is no longer required or the intercept is no longer active. Unless otherwise directed, ensure all units resume normal guard assignments. (C)

3. (C) Monitor and enforce EMCON: The monitoring of emission control plans should be accomplished by the ship in the intercept guard assigned by the control ship. The procedures for locating an EMCON violator should be the same as that for coordination of the overall intercept effort. The EWCS should inform the OTC and violating ship of the violation.

4. (C) Ensure that all ships under control respond promptly to all control commands: The EWCS should be aggressive in determining that all units under control maintain surveillance of assigned intercept guard and report intercepts in accordance with current doctrine:

(C) Some common errors which require immediate corrective action are:

A. Incorrect R/T procedures. (C)

B. Incorrect reports of analysis information. (C)

C. Inaccurate bearing reports (C).

D. EMCON violations. (C)

#### **EMCON BILLS (C)**

(C) According to the tactical situation which dictates the requirements for use of active radiating devices, each ship must be able to effect rapidly and accurately an EMCON condition change. The integrity of the ship or task force can depend on the positive, rapid responses of each ship to emission control. To optimize the reaction to EMCON changes, each ship shall prepare an EMCON bill.

(C) The bill should set forth all of the ship's emitters including their frequencies and control

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locations. Care must be exercised to ensure that emitters installed for special purposes or operations are incorporated in the EMCON bill. It should reflect the specific duties and responsibilities of all personnel associated with the changing of ship's emission control status. Provisions should be made for an EMCON center (normally EW), and internal reporting checkoff, and monitoring procedures should be defined. The body of the bill should be based on that portion of the Standard Silence Policy Table set forth in ATP-1, Vol. I, applicable to your own ship. Appropriate excerpts from the EMCON bill should be posted at each transmitting equipment location.

**EMCON EXECUTION (C)**

(C) The control of electromagnetic and acoustic emissions is not only a vital tactical consideration but is a means of providing emitter compatibility, emission economy, and radiation efficiency. Individual ships must conform to EMCON conditions imposed by senior commanders and should establish more restrictive emission control with regard to own radiations when such a procedure is compatible with the tactical situation.

(C) When an EMCON order is received, the equipment affected should be determined and the EMCON status should be announced over the 1 MC. In addition, the EW watch officer should directly contact the personnel responsible for the affected equipment. He should notify them of the EMCON status change and their equipment affected. In turn the personnel responsible for the equipment should report to the EW watch officer when the new EMCON condition has been set. After all stations have been notified and reports have been received by the EMCON center that the new EMCON condition has been set, the actual operating status of every emitter should be verified by the EMCON center. Time-sharing plans may then be established and additional equipment put in standby or secured by the EW control officer as directed by the commanding officer.

(C) Personnel responsible for the appropriate equipment should report any ordered frequency

change to the EMCON center. This procedure ensures that the EMCON status display will be updated and that EMCON will not be violated. Activation of any radiating equipment should be cleared with the EMCON center to ensure that the current EMCON is not violated. This includes radiation of equipment into dummy loads since sufficient leakage exists to permit intercept equipment to detect such radiations at extended ranges.

**TIME-SHARING PLANS (C)**

(C) These plans are part of the EMCON plan and as such, are found in the EW annex of the OORDER. They provide for the operation of radar equipment on a preset time basis. Such plans provide a period of time, during which radars will be silent, to allow maximum effective use of your intercept search equipment without interference by friendly emissions. This is the only advantage of using a time-sharing plan (other than intermittent operation), since time-sharing plans provide very little protection from passive detection and tracking by an alert enemy intercept search station.

**INTERMITTENT OPERATION (C)**

(C) This is the delegation of authority to operate specified equipment, or equipment in a specified frequency band, on an "as required" basis. The "as required" basis is defined as the absolute necessity for the operation of the emitter involved. Intermittent operation is normally used for station-keeping and maneuvering, night operations or during low visibility.

(C) The operation of the emitting equipment should be as infrequent as possible, and emission time should be as short as possible. Intermittent operation is considered part of the time-sharing plan, but unlike the normal time-sharing plan it will limit the enemy's capability of tracking or evaluating your forces by passive means. It still permits passive detection by an alert enemy, but it will make the job harder.

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**TOTAL ELECTRONIC SILENCE (C)**

(C) There are measures available whereby the OTC can immediately set a condition of total electronic silence. When ordered, this will supersede any previous EMCON orders until cancelled by a releasing order. This order may be necessary under certain tactical conditions. It is a method to counter passive electronic homing weapons. It may be used to facilitate periods of intercept search.

**RADAR GUARD ASSIGNMENTS (C)**

(C) These assignments are included in the means by which the OTC controls his EMCON plan. These guard assignments, as generally

interpreted, indicate the ship that is responsible for the detection and tracking reports of radar targets to the OTC—all other ships running their own tracks using their own radars. Actually this is true, provided the OTC has authorized all ships to use their radar systems. Everyone concerned must realize that if the OTC has not authorized the general use of radar systems, then only those ships designated will transmit, and all other ships will remain in a silent condition. Radar guard ship assignments are a means of designating ships that will transmit.

**TYPICAL EMCON INSTRUCTION (C)**

(C) The remainder of this chapter gives a typical EMCON INSTRUCTION for a CVA, with the enclosures:

**Subj:** Emission Control (EMCON) (U)

**Ref:** (a) NWP-33 (Series)  
 (b) ATP-1A, Vol. I  
 (c) ATP-1A, Vol. II  
 (d) NWP 33-1  
 (e) NWP 12-6  
 (f) NWP 12-1

**Encl:** (1) Standard Silence Policy Table  
 (2) EMCON Bill  
 (3) EMCON Guide (Equipment Tag)

1. (C) Purpose. To promulgate Emission Control (EMCON) procedures aboard the CVA in accordance with reference (a).

2. (C) Cancellation. CVA INST. 03500.1C

3. (C) General. Emission Control (EMCON) is the effective management of all electromagnetic and electroacoustic emissions of a force or unit to obtain the maximum tactical advantage. The goal of EMCON is management of the electromagnetic spectrum to provide command with essential information while presenting an enemy only a controlled probability of detecting, identifying, positioning and homing.

4. (C) EMCON Orders. The OTC issues EMCON orders by OPORDERS, OPLANS, message, radio nets and visual signals. These orders will be implemented at the time designated or as soon as the EMCON center has decoded the signal and determined what equipment is effected. Tactical signals will normally be promulgated utilizing the Standard Silence Policy Table from reference (b), as depicted in enclosure (1). The OTC selects the plan best suited for the current tactical situation and by utilizing the Standard Silence Policy Table, has a flexible and rapid means of changing the EMCON plan in effect.

**CONFIDENTIAL**

5. (C) **Breaking EMCON.** In a tactical emergency, the effective EMCON condition may be broken by a single unit. Unless specified by the OTC, the breaking of EMCON by a single unit is not the signal for all units to activate communications and emitters.

6. (C) **EMCON Bill**

a. (C) The EMCON Bill, enclosure (2), is a listing of all the ships emitters including their frequency ranges, control locations and Intermediate Control Stations. Each piece of equipment is coupled with index numbers from Table E of reference (b). These index numbers are provided for rapid identification purposes in the event tactical signals are received which reference Table E.

b. (C) Excerpts from the EMCON Bill will be posted on, or in the vicinity of, each piece of equipment listed in the EMCON Bill. These tags can be reproduced locally or obtained from the EWO.

7. (C) **EMCON Plans.** A specific condition of EMCON, to be directed by the OTC, shall be in effect at all times. A ship's EMCON plan will be prepared by the Electronics Warfare officer to conform with each plan specified by the OTC. This plan will be promulgated by CVA NOTE C3500. The plan will include:

a. (C) All equipment capable of electromagnetic and acoustic radiations.

b. (C) The action required to place each piece of equipment in the prescribed emission status based on the plan ordered.

8. (C) **EMCON Organization and Responsibility.**

a. (C) **EMCON Center.** The Electronics Warfare module of CIC is designated as the EMCON center. The EW officer is designated as the EMCON officer. The EMCON center will be responsible for:

(1) Receiving, decoding, and promulgating the meaning of all EMCON orders.

(2) Monitoring own ship's and force EMCON as assigned.

(3) Maintaining a check list of departmental EMCON reports to the EMCON center.

b. (C) **Intermediate Control Stations.** Those organizations that have control over radiating equipment will be designated as Intermediate Control Stations. Those control stations with equipment list and reporting responsibility are listed on enclosure (2) and as follows:

(1) Air Department (including transient logistic A/C) (C)

(2) Air Operations (briefing of transient and ship's C1A crews) (C)

(3) Air Wing (C)

(4) Aircraft Intermediate Maintenance Department (C)

(5) Combat Information Center (CIC Officer) (C)

(6) Communications Department (C)

(7) Dental (C)

(8) Electronics Material Officer (C)

(9) Medical (C)

(10) Meteorology (OA Division) (C)

(11) Navigation Department (C)

(12) Ships Signal Exploitation Space (SSES) (OS Division) (C)

(13) Weapons Department (Weapons Control) (C)

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(C) These organizations assigned as Intermediate Control Stations will have an EMCON officer, watch officer or petty officer with a thorough knowledge of EMCON procedures and pertinent notices and instructions assigned to insure adequate internal communications for the setting of the appropriate EMCON condition at each individual control station, taking those reports and relaying them to the EMCON center. Aircraft, when on board, will comply with the ship's EMCON plan. When operating away from the ship, they may emit as briefed.

9. (C) EMCON Procedures. When an EMCON order is received the following procedures will apply:

a. (C) The Commanding Officer will direct the setting of a specific EMCON condition. The EW officer will determine the setting of EMCON conditions and make recommendations to the commanding officer.

b. (C) The OOD will pass the following to all stations over the 1MC (twice), "Set EMCON Condition \_\_\_\_\_ (From the Standard Policy Table or assigned EMCON Plan). Make EMCON reports to the EMCON Center, extension 605".

c. (C) Intermediate Control Stations will review the EMCON Plan and:

(1) Relay the required action to each equipment control station under his cognizance. (C)

(2) Report to the EMCON center (extension 605 or via the 22 or 24 MC) when the prescribed EMCON condition has been set. (C)

d. (C) Equipment Control Stations listed in enclosure (2) will:

(1) (C) Take necessary action to place equipment in the prescribed emission status

(2) (C) Indicate the emission status of the equipment of the EMCON guide (Equipment Tag), enclosure (3).

(3) (C) Report "EMCON Set" to the Intermediate Control Station.

e. (C) EMCON Center. The EMCON center will:

(1) Decode the EMCON order. (C)

(2) Make recommendations to the commanding officer via the OOD. (C)

(3) Complete the EMCON checkoff list. (C)

(4) Notify the OOD, evaluator, and operations officer when the specific condition is set. (C)

(5) Monitor own ships EMCON

10. (C) Radar Silence (Time-Sharing). Radar Silence (Time-Sharing) may be imposed by the OTC. This is accomplished by transmission of receipt of the appropriate signal from reference (b). The OOD will inform the CIC evaluator whenever this signal is received. The EW officer will coordinate with the evaluator in placing the ordered Radar Silence Diagram in effect. The EW officer shall keep the OOD informed whenever the radar's off/on status is to be changed.

W.L. McDONALD  
RADM. U.S. Navy  
Commanding Officer

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UEW 13- STANDARD SILENCE POLICY is in force as indicated:  
 (a) DESIG followed by first and second code letter  
 (b) Supplementary code numeral(s)  
 (c) Column number.

STANDARD SILENCE POLICY TABLE (C)

Column	20	21	22	23	24	25	26	27	28	29	Column	30	31	32	33	34	35	36	37	38	39	
First Code Letter	Below 50 MHz Ship and Aircraft Communications	Above 50 MHz							Sonar and Under-water Communications	Spare	Spare	Second Code Letter	Above 50 MHz							Spare	Spare	
		Ship Radio Communications	Ship Radar					Surface Search/Navigation Radars					Ship			Aircraft						
			Height Finding	Air Search	Gunfire Control	Missile Guidance	IFF						IFF	IFF	Radar	Air-to-Air Tacan						
																	Tacan	UHF Homer	CCA Radar			IFF
A	U	U	U	U	U	U	U	U			P	U	U	U	U	U	U	U	U	U		
B	S	U	U	U	U	U	U	U			Q	P	U	U	U	U	U	U	U	U		
C	P	P	P	P	P	P	P	P			R	S	P	P	P	P	P	P	P	S		
D	S	P	P	P	P	P	P	P			S	S	P	S	P	P	P	P	P	S		
E	S	P	S	P	P	P	P	P			T	S	S	S	P	P	P	P	P	S		
F	S	P	S	S	P	P	P	P			U	S	S	S	P	P	P	S	S			
G	S	P	S	S	S	S	P	P			V	S	S	S	S	P	S	S	S			
H	S	P	S	S	S	S	P	S			W	S	S	S	S	S	S	S	S			
I	S	P	S	S	S	S	S	P			X					Spare						
J	S	P	S	S	S	S	S	S			Y					Spare						
K	S	S	S	S	S	S	S	S			Z					Spare						
L						Spare																
M						Spare																
N						Spare																
O						Spare																

ALFA-ATDS/ADA/NTDS authorized.

CHARLIE-Middleman/AUTOCAT authorized.

DELTA-Intermittent operation during reduced visibility, minimum use.

GOLF-GUARDSHIP-The designated ship is to operate the equipment indicated or to maintain a guard on the circuits designated for the entire unit or force.

JULIETT-Operate as pre-briefed.

PAPA-POSITIVE CONTROL-Operation of the radar equipment indicated is under the direct control of the OTC or his representative. When directed, the radar equipment will be activated for no more than 30 seconds and then returned to a non-radiating state. Communications will be

limited to the absolute minimum, and automatic reporting shall not be employed except in the case of an enemy contact which is an immediate threat to the force. (Paragraph 401.b, ACP 178(A) refers.)

SIERRA-SILENCE-The equipment/circuits are not to be used except when under direct attack in the case of radars or when the STANDARD OCCASIONS FOR BREAKING SILENCE apply in the case of communication circuits. Equipment is to be put in a non-radiating standby condition when possible in order to be ready for instant use when required. (Paragraph 418, ACP 178(A), for naval surface forces and paragraph 204, NCCP for Maritime Air Forces refer.)

UNIFORM-UNRESTRICTED OPERATION-There are no restrictions on the use of the equipment/circuits indicated.

SUPPLEMENTARY CODE NUMERALS

1. Read key letter ALFA in column \_\_\_\_\_
2. Read key letter CHARLIE in column \_\_\_\_\_
3. Read key letter DELTA in column \_\_\_\_\_
4. Read key letter GOLF in column \_\_\_\_\_

5. Read key letter PAPA in column \_\_\_\_\_
6. Read key letter SIERRA in column \_\_\_\_\_
7. Read key letter UNIFORM in column \_\_\_\_\_
8. Read key letter JULIETT in column \_\_\_\_\_

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EMCON BILL (C)

Emmiting Equipment and Control Station	Frequency Range in MHZ	Operating Frequency	Index Numbers	Personnel to Notify (Intermediate Control Station)
<u>AIR DEPT</u>				
SPN-12	10,000-10,250		13,102 136	Air Department
SRC-22	138.66/149.07	138.66/ 149.07	5,90	Air Department
UHF	225-400		6,91	Air Department
VHF	30-225		4,89	Air Department
HF	3-30		4,89	Air Department
<u>AIR OPS</u>				
SPN-42	33,000-33,400		13,93,140	Air Operations
SPN-43	3550-3700		13,93,131	Air Operations
UHF	225-400		6,91	Air Operations
VHF	30-225		5,90	Air Operations
HF	3-30		4,89	Air Operations
MF	0.3-3		3,88	Air Operations
TACAN (URN-20)	962-1213		24,102	Air Operations
SRC-22	138.66/149.07	138.66/ 149.07	5,90	Air Operations
<u>AIMD</u>				
UHF	225-400		6,91	AIMD (IM 3)
VHF	30-225		5,90	AIMD (IM 3)
HF	3-30		4,89	AIMD (IM 3)
W/C 610	Misc. gear and test Equip. in various freq. ranges			AIMD (IM 3)
W/C 621	Misc. gear and test Equip. in various freq. ranges			AIMD (IM 3)
W/C 630	Misc. gear and test Equip. in various freq. ranges			AIMD (IM 3)
W/C 650	Misc. gear and test Equip. in various freq. ranges			AIMD (IM 3)
<u>CIC</u>				
SPS-10	5450-5825		10,133	EWO
SPS-30	3400-3600		12,131	EWO
SPS-43	205.5-224.5		11,122	EWO
UPX-11	1010-1040		14,128	EWO
UPX-12	1090-1110		14,128	EWO
UHF	225-400		6,91	EWO
VHF	30-225		5,90	EWO
HF	3-30		4,89	EWO
<u>COMM</u>				
MF	0.3-3		3,88	Communications Department
HF	3-30		4,89	Communications Department
VHF	30-225		5,90	Communications Department
UHF	225-400		6,91	Communications Department
NANCY	Infrared			Communications Department
<u>EMO</u>				
UHF	225-400		6,91	EWO
VHF	30-225		5,90	EWO
HF	3-30		4,89	EWO
SINS RF Transmitter	225-400		6,91	EWO

Radars (Local Control-Normally controlled remotely from CIC)

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## EMCON BILL (C)

Emitting Equipment and Control Station	Frequency Range in MHZ	Operating Frequency	Index Numbers	Personnel to Notify (Intermediate Control Station)
<b><u>METEOROLOGY</u></b>				
AN/AMT 11 Radiosonde	400-406	403	6,27,91	EWO
<b><u>NAVIGATION</u></b>				
CRP 1500-B	9345-9405		25,135	Navigation Department
AN/UQN-1D	12 kHz	12 kHz	15	"
TACAN (ARN-21)	1025-1150		24,102	"
UHF	225-400		6,91	"
VHF	30-225		5,90	"
HF	3-30		4,89	"
<b><u>SUPPLEMENTARY RADIO</u></b>				
UHF	225-400		225,400	EWO
HF	3-30		4,89	"
<b><u>WEAPONS</u></b>				
MK-25	8600-9500		20,135	Weapons Department
MK-35	8600-9500		20,135	"
SRC 22	138.66/149.07	138.66/ 149.07	5,190	"
<b><u>MEDICAL</u></b>				
X-RAY Diathermy				EWO
<b><u>DENTAL</u></b>				
X-RAY				EWO
<b><u>AIR WING</u></b>				
UHF	225-400		6,91	Air Wing Commander
VHF	30-225		5,90	(Duty Officer or EMCON
HF	3-30		4,89	Officer)
TACAN	1025-1150		24,102	"
Radar Altimeter	4200-4400		26,131	"
IFF	1070-1130		14,103	"
Radar	Variable		19	"
DECM	Variable			"
AN/APN 153	13,275-13,375		19,103	"
AN/APN 154	8800-9500		19,102	"
SRC-22	138.66/149.07	138.66/ 149.07	5,190	"
Survival Radio	243.0	243.0	225,400	"

Equipment not having a listing under "Operating Frequency" is selectable or variable and may be transmitted as briefed.

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**EMCON GUIDE**

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<b>EMCON GUIDE</b>						
<b>Equipment:</b>						
<b>EMCON Petty Officer:</b>						
After setting the required EMCON Condition, Report Status to _____ Officer, Ext. _____						
Line Number _____ (For reference to basic EMCON Plan)						
<b>EMCON</b>						
	<b>Alfa</b>	<b>Bravo</b>	<b>Charlie</b>	<b>Delta</b>	<b>Echo</b>	<b>Other</b>
<b>Action Required</b>						

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CVA and Airwing EMCON Plan IAW COMFIRSTFLT NOTE C3500 of 9 July 1971 (TACNOTE 3-71)		INDEX NO.	Ship's EMCON Plan:						INDEX NO.	Aircraft EMCON Plan:					
			A	B	C	D	E	F		A	B	C	D	E	F
EMCON Plan															
COMMUNICATIONS	All Radio Equipment	00	S	O				00	S	O					
	All Transmitters	10						10				O	O	O	
	WRT-1	11			O	S	S	G	11			O			
	CRT-3	12			O	S	S	G	12			O			
	URT-2, URC-32, SRC-23, CRT-3	13			O	S	S	G	13			O			
	Link 11, Link 14	14			S	S	S	G	14			O			
	URC-4, URT-7C, SRC-22	15			O	S	O	S	15			O			
	SRC-31, SRC-20, URC-9, SRC-21, URC-4	16			O	O	O	G	16			O			
Link 4, SINS, UHF link 11	17			S	S	O	G	17			O				
	18														
SEARCH/HF RADARS	All Radars	20	S	O			S	20	S	O	O	S*	O	O	
	SPS-43	21			V	V	S								
		22													
	SPS-30	23			S	V	S								
	SPS-10	24				V	S								
	CRP-15B	25			S	V	O								
	26														
CCA RADARS	All Radars	30	S	O	N	N	N	N							
	SPN-43	31													
	SPN-12	32													
	SPN-42	33													
FC/GM/GL RADARS	All Radars	40	S	O	P	P	S	P							
		41													
		42													
	Mk-25, Mk-35	43													
	44														
NAV AIDS ID AIDS	All Equipment	50	S	O					50	S	O			O	O
	UPX-11, Aircraft Interrogator	51			V	V	V	G	51			O	O		
	UPX-12, Aircraft Transponder	52			S	S	S	S	52			O	O		
	URN-20, ARN-21, Other Aircraft Tacan	53			S	S	N	N	53			O	S		
	LF Homer	54			S	S	S	N							
	UHF Homer	55			O	O	N	N							
	AMT-11	56			S	S	S	G							
	Radio/Radar Altimeter	57							57			O	O		
DECM ACOUSTICS	All Equipment	60	S		S	S	S	S	60	S	O	O	S	O	S
		61													
		62													
	UNQ-1D	63		O											
		64													
		65													
		66													
	All Equipment	70	S	S	P	P	S	S	70	S	S	P	P	S	S
	71														
ULQ-6	72														
**All Communication Jammers	80	S	S	S	S	S	S	80	S	S	S	S	S	S	
**All Radar Jammers	90	S	S	S	S	S	S	90	S	S	S	S	S	S	

\*AEW, VAQ use O vice S

\*\*All jamming ops will be as briefed by AIO

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## EMISSION STATUS INDICATORS

## LETTER INDICATOR

<b>GOLF</b>	Guardship. Only the designated unit is to operate the equipment indicated or maintain a guard on the circuits designated for the entire force. (For IFF guard, parent radar is silent.)
<b>NOVEMBER</b>	Operate only for safety.
<b>OSCAR</b>	Operate. Unrestricted operation.
<b>PAPA</b>	Equipment should be placed in the highest degree of readiness without actual radiation. (Disregard antenna leakage.)
<b>ROMEO</b>	Receiver only.
<b>SIERRA</b>	Silence. (No transmission is authorized. This includes radar antenna leakage. For aircraft, no emission is authorized within 150 NM of the CVA.)
<b>TANGO</b>	Operation is authorized for purposes of test/maintenance. (Missile guidance and fire control systems operate at the highest degree of elevation.)
<b>UNIFORM</b>	Intermittent operation is allowed in accordance with time sharing plans.
<b>VICTOR</b>	Air search radars and IFF interrogators may be used (Maximum of three sweeps) in reaction to ESM intercepts. Sonics may be used to verify passive sonar contacts.
<b>WHISKEY</b>	As assigned by the OTC.

## CHAPTER 14

# ELINT COLLECTION AND REPORTING PROCEDURES

(U) Electronic Intelligence (ELINT) is defined as the intelligence information product of activities engaged in the collection and processing for subsequent intelligence purposes of foreign, noncommunications, electromagnetic radiations emanating from other than nuclear detonations and radioactive sources.

(U) Every Navy unit, whether surface, subsurface, or airborne, having ESM capabilities is responsible for the collection and reporting phases of ELINT. If electronic warfare is to be waged effectively, it is vital to have good intelligence concerning all types of enemy electromagnetic emissions and their electronic warfare potential and activities.

(U) The processing activities furnish the various intelligence agencies with the pertinent information collected. This information is used to provide collection agencies/units with intelligence data bases contained in publications such as STICs, EOBs, and the Threat Emitter Evaluation Guide. The information is also used as a guide for designing our own EW equipment.

(U) This chapter will detail the collection and reporting of ELINT as it pertains to the EW operator aboard ship. The procedures discussed in this chapter will aid you in producing complete, accurate and informative reports for analysis at the processing activities.

### REQUIREMENTS

(U) An ELINT requirement may appear in many forms. It may be in the form of an OORDER or OPLAN or it may simply be a message from a processing activity requesting a

ship or ships be especially alert for certain types of emissions.

(U) A requirement may be placed on a unit by anyone in the chain of command that is senior to that unit. It may be a general requirement or one of a technical nature.

### GENERAL REQUIREMENTS

(U) General requirements are those that a unit attempts to intercept at all times. They cover a wide range of frequencies and are usually the day-to-day emissions that a unit encounters. It is important to record and report even the most apparently common signal because you never know when some minute change to a ship's electronic equipment suddenly becomes vital information.

(U) It is essential that all personnel who are responsible for planning ESM operations have an understanding of:

- Mission of own ship
- Enemy threat to assigned mission
- Own intercept equipment capabilities and status
- Force/Group disposition
- ELINT requirements
- The friendly EOB (To be determined as soon as practical after forces join).
- The effects on intercept search by interference from electromagnetic radiation of own ships equipment and other force units

**TECHNICAL REQUIREMENTS**

(U) Technical requirements may be imposed on a ship or group of ships when it is known that they may enter an area where electronic emissions have been previously reported. These technical requirements usually direct the unit to be especially alert for exact types of electronic emissions and are usually designated by NATO nickname, key number and/or item number as listed in DST-1730S-465(YR) (Radiation Characteristics of Electronic Equipment) or NWP 12-6-1, Vols 1 and 2 (Threat Emitter Evaluation Guide). Technical requirements may come from various sources. Some of these sources are:

- Specific Intelligence Collection Requirements (SICRs)
- EW annex to OPORDERS
- CINCPAC/CINCLANT Instructions S3430 (series)
- Fleet or Area Commander Instructions, i.e., COMFIRSTFLT or COMSECFLT
- Special ELINT operation orders, i.e., when a ship is ordered to operate near a certain coast for the purpose of collecting and reporting ELINT.

**COLLECTION**

(U) The intercept and recording of foreign emitters for subsequent intelligence purposes can be accomplished in different ways, but the primary method is intercept search conducted for the Department of Defense (DOD) by ships, aircraft, submarines, and any other means available. Other intelligence information is collected by intelligence agencies such as the Central Intelligence Agency and the Defense Intelligence Agency. Another method might be by talking to defectors to determine what the enemy has now and what he is developing.

**PROCESSING**

(U) Processing is the analytical procedures employed to determine emitter identification.

This is accomplished in three steps: preliminary by the collecting unit, intermediately by the ELINT centers, and finally by the National Security Agency (NSA).

**PLANNING AND PREPARATION**

(U) When a ship has been assigned an ELINT mission, there are some things that have to be done in order to ensure that the mission is successful and that the maximum intelligence is obtained. These include:

- Establishing ELINT requirements
- Plotting the search area for probable intercepts
- Briefing operators on signal priorities and equipment
- Reporting ELINT correctly and accurately
- Report training conducted in real and mock environments
- Recording ELINT intercepts
- Schedule briefings as appropriate with Technical Guidance Units (TGUs)

**ESTABLISH ELINT REQUIREMENTS**

(U) For the most part, these requirements will be previously determined and the ship will be tasked ahead of time. Sometimes, when personnel on the ship have previously operated in the same geographical location to this planned mission, personal experience may indicate that the probability of intercept for some signals (those not already listed in the OORDER) may be as great as, if not greater than, the established requirements.

(U) Know the area of operation, contact the Operations Specialist or Quartermaster for charts of the area, determine the applicable air defense districts and plot the boundaries of the air defense districts on the charts. When this is completed, determine the collection requirements that may be intercepted in addition to tasked requirements.

**CONFIDENTIAL****PLOTTING THE SEARCH AREA**

(U) Plot each ELINT requirement location, if possible; plot the estimated intercept range arcs using the radar range nomogram; also plot all friendly, active, suspect and suspense sites in the area.

(U) Most ELINT requirements, if not located by latitude and longitude in tasking letter, may be found in the EOB (Electronics Order of Battle) for that geographical area.

**OPERATOR BRIEFINGS**

(U) All of the ESM operators should be briefed as to the priority of signals, what equipment the enemy may be using and the estimated time of intercept. They should be briefed on collection procedures peculiar to the mission. An ELINT mission cannot be successful if the operators do not know what to expect and how to perform the required task. Technical Guidance Units (TGUs) should be used for ELINT briefings when and where available.

**REPORTS AND REPORTING PERIOD**

(U) Knowledge in advance of a mission of what reports are required and what constitutes a reporting period will help prevent confusion when the reports are due. There are two standard reports that should be discussed prior to each mission. These are

ELINT reports  
Training reports

**ELINT Reports**

(U) ELINT reports, consisting of compiled data from collecting units, are forwarded to the appropriate processing center at the completion of a mission or operation, or on a specified date. The reporting period is the interval between consecutive ELINT reports. The time period is not necessarily consecutive. It can be daily, weekly, monthly or any length of time. In normal operations, letter reports are to be submitted monthly or as soon as practicable

following an operation. Message reports are to be made as required. NWP-33, Appendix B explains when message reports are required.

**Training Reports**

(U) To train ESM operators in intercept and reporting procedures, practice intercept reports should be made using friendly electromagnetic signals. These reports are forwarded to a technical guidance unit for analysis, evaluation and the preparation of a feedback report. The feedback report provides information as to logging procedures, quality of the magnetic tape recording, quality of photographs taken and other remarks to help improve the proficiency of the ESM ELINT team on your ship.

**RECORDING ELINT INTERCEPTS**

(U) There are presently two methods of recording ELINT information for processing at analysis centers—magnetic tape recordings and photographs.

**Magnetic Tape Recordings**

(C) Magnetic tape recordings of intercepted signals are extremely valuable in ELINT analysis and every effort must be made to ensure that adequate recordings are obtained.

(U) The recording process and voice annotations will be discussed later in this chapter.

**ELINT Photographs**

(C) Analysis scope photographs are important since they permit analysts to view exactly what the operator saw at the time of the intercept. Photographs often record pulse shapes or complex forms of modulation not easily detectable by the operator, but which can be detected by a highly trained analyst.

(U) Further information on how to use photographic equipment to its best advantage appears in chapter 4, NWP-33, and details on photographic procedures appear later in this chapter.

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(U) Now that we have covered the basics of Planning and Preparation, we reach an important part of reporting procedures that is vital to provide complete and concise information to the analysis centers—preparing an Operator's Intercept Log.

### OPERATOR'S INTERCEPT LOG

(U) Operator's Intercept Log sheet entries are printed with pencil or pen; legibility is essential. Shipboard and airborne ESM Operator's Intercept Logs are available through the regular supply channels.

(U) To insure the consistency and accuracy of intercepted data and to facilitate processing by ELINT analysis personnel, shipborne operators should follow the instructions and procedures described below when completing ELINT log sheets. An Operator's Intercept Log is shown in figure 14-1.

- Classification

(U) The log must be classified **CONFIDENTIAL** unless a higher classification is deemed necessary.

- Unit Designator

Enter the name and hull number of the ship or unit in this space.

- Mission Title

(U) Enter the operation order number or special mission if assigned.

- Operator

(U) Enter the rate and last name of the operator in this space.

- Date of Intercept

(U) Enter the ZULU day, month, and year in this space.

- Chart Number

(U) Enter the hydrographic office chart number that is being used to plot DF bearings in this space.

- Signal Number

(U) The intercept signal number shall be entered in this space. Signal numbers are to begin with 001 (three digits) and run consecutively for the duration of the report.

- Signal Identification

(U) Enter the IBM code and nickname as found in the STIC publication *Radiation Characteristics of Electronic Equipment* (U).

- Time of Intercept

(U) Enter the six digit ZULU date-time group of intercept in this space.

- RF (Radio Frequency)

(U) Enter the receiver dial frequency in MHz suffixed with the letter "D" or the letter "C" for measured/calibrated frequency from the tuning head in use. For tactical or analysis purposes, radio frequency is one of the most important characteristics of an emitter. Since RF cannot be determined from magnetic tape recordings or photographs, care must be exercised in accurately measuring and logging the correct frequency.


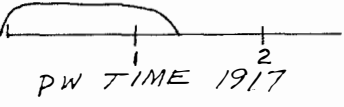
- PRF (Pulse Repetition Frequency)

(U) Enter the PRF in pulses per second. When the PRF is estimated from an analysis scope, enter the PRF followed by the suffix "E." When measured using an audio oscillator and electronic counter, enter the suffix "M." Any changes in the PRF should be noted in the Operator's Remarks section of the intercept log.

- PW (Pulse Width)

(U) Enter the PW in  $\mu$ sec, using a minimum of two digits to indicate the decimal

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OPERATOR'S INTERCEPT LOG						CONFIDENTIAL (When Filled In)				
S/N 0103-634-3001										
UNIT DESIGNATOR <i>USS SAMPSON (DDG10)</i>		MISSION NO./OP ORDER <i>9-72</i>		OPERATOR <i>EW3-HOOPFER</i>						
INTERCEPT DATE <i>28 SEPT 1972</i>		CHART NO. <i>HO-69</i>								
SIGNAL NO. <i>001</i>		SIGNAL IDENTIFICATION <i>HONKER-B301A</i>								
SIGNAL PARAMETERS										
FIRST HEARD TIME (Z)	RF (MHZ)	PRF	PW (USEC)	SCAN TYPE	SCAN RATE	POL	SIG. STR.	REEL AND REC. NO.	PHOTO NOS.	
<i>281915</i>	<i>5725D</i>	<i>642M</i>	<i>0.25</i>	<i>C</i>	<i>3.8</i>	<i>H</i>	<i>3</i>	<i>RO1/01</i>	<i>N/A</i>	
RECORDED FROM <i>1915</i> Z TO <i>1918</i> Z										
FREQUENCY CHECKS PERFORMED <input checked="" type="checkbox"/> IMAGE <input checked="" type="checkbox"/> HARMONIC				FREQUENCIES CHECKED <i>2826/1908</i>						
STATUS OF OWN RADAR(S) <input type="checkbox"/> NOT RADIATING <input checked="" type="checkbox"/> RADIATING				TYPE(S) <i>SPS-10</i>						
INTERCEPT EQUIPMENT USED (Indicate type of antenna, receiver, recorder and reference tone source) <i>AS-899/WLR-1/UNQ7D/SG465/USM207</i>										
DF INFORMATION										
TIME (Z)	SIG. STR.	TRUE BRNG.	A ±2	B ±5	C ±10	D ±20	Q SNAP	INTERCEPT PLATFORM POSITION (Latitude/Longitude)		
<i>1916</i>	<i>3</i>	<i>090</i>	<i>✓</i>					<i>19°01'N/77°30"E</i>		
<i>1921</i>	<i>3</i>	<i>105</i>	<i>✓</i>					<i>18°59'N/77°31"E</i>		
<i>1926</i>	<i>3</i>	<i>115</i>	<i>✓</i>					<i>18°57'N/77°31"E</i>		
<i>1933</i>	<i>2</i>	<i>145</i>	<i>✓</i>					<i>18°55'N/77°31"E</i>		
<i>1940</i>	<i>2</i>	<i>177</i>	<i>✓</i>					<i>18°53'N/77°30"E</i>		
SIGNAL NO LONGER HEARD AT <i>1944</i> Z DUE TO <i>CONTINUED SEARCH</i>										
OPERATOR'S REMARKS <i>THE SIGNAL CHANGED PULSE WIDTH TO 1.35 AT TIME 1917. RADAR CONTACT ON SAME BEARING AT 24 MILES. CONTACT ON COURSE 175, SPEED 12. UNABLE TO CLOSE CONTACT FOR VISUAL IDENTIFICATION DUE TO REFUELING OPERATIONS.</i>						SKETCHES 				
EVALUATOR COMMENTS <i>CONCUR EVALUATION. FROM INTELLIGENCE INFORMATION BELIEVE THIS CONTACT TO BE RUNAGROUND CLASS DESTROYER PENDANT NUMBER 025 KNOWN TO BE OPERATING IN THIS AREA.</i>						 (Draw scale in USEC)				
VISUAL CORRELATION <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO			IDENTIFICATION							
PHOTOGRAPHIC CORRELATION <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO			PHOTO NOS.							
PLATE NO. 22604			(USE REVERSE FOR ADDITIONAL REMARKS)							
								CONFIDENTIAL (When Filled In)		

0189.69

Figure 14-1.—(C) Sample operator's intercept log (C).

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position; e.g., 0.5, 1.0 and 10.0. The PW is measured between half amplitude points on the leading and trailing edges of the pulse. Multiple pulses or unusual shapes are measured and described in the Remarks section. If photographs are not taken, sketches of unusual pulse shapes should be entered in the space provided. The pulse sketch should be drawn to a scale in microseconds as indicated on the analysis scope to assist the analysts in determining pulse dimensions.

- Type of Scan

(U) Enter the type of scan, using the following designations:

<u>Code</u>	<u>Basic Scan Types</u>
A	Circular or Rotating
B	Horizontal Sector (bidirectional)
C	Vertical Sector (bidirectional)
D	Steady
E	Irregular, Unsteady or Manual
F	Conical
G	Lobe Switching
H	Tracking other than F or G
J	Raster
K	Spiral
L	Helical
N	Circular and Conical
O	Sector and Conical
R	Other combinations (including Phase or Frequency Scan, Stepped, Beam Broadening, Side Lobe Variation or Suppression, etc.) Explain in remarks.
S	Vertical Sector (unidirectional)

<u>Code</u>	<u>Basic Scan Types</u>
T	Horizontal Sector (unidirectional)
U	Unidirectional (Plane undetermined)
V	Bidirectional (Plane undetermined)
Z	Undetermined

- Scan Rate

(U) Scan rate is measured to the nearest 1/10 of a second and entered in the space provided, as indicated below:

<u>Type Scan</u>	<u>Unit of Measurement</u>
Circular . . . . .	SPR (Seconds per rotation)
Sector . . . . .	SPS (Seconds per sector)
Raster . . . . .	BPS/SPF (Bars per second/seconds per frame)
Irregular . . . . .	N.A.
Conical . . . . .	Hz (Cycles per second)
Palmer . . . . .	F T / H Z ( F r a m e time/cycles per second)
Lobe switching . . . .	Hz (Cycles per second)
Spiral . . . . .	Hz (Cycles per second)
Unidirectional Sector .	Hz (Cycles per second)
Steady . . . . .	N.A.
Unknown . . . . .	N.A.

If the scan type is known, but the rate is not known, enter UNK in this space.

- Polarization

(U) Indicate the type of polarization of intercepted signals, "H" for horizontal and "V" for vertical and "UNK" if unable to determine or unknown.

- Signal Strength

(U) The signal strength, compared to noise, is entered as a S/N (Signal-to-Noise) ratio.

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Operator procedures employed to determine a S/N ratio are: (1) adjust the IF gain for a maximum indication on the panoramic indicator **WITHOUT OVERDRIVING THE SIGNAL**; (2) approximate the ratio of signal-to-noise. Example: If the signal is five times greater than the noise, the S/N would be 5/1 and this figure would be entered in the log. The following are standard numerical values for determining and logging S/N ratios:

- 1/1 . . . signal weak and intermittent.
- 2/1 . . . signal weak, every sweep heard, unable to eliminate receiver noise.
- 3/1 . . . every sweep heard with no receiver noise.
- 4/1 . . . every sweep heard, side lobes present.
- 5/1 . . . signal saturated.

NOTE: Every example in the previous list is a ratio of some value compared to the figure 1. The SIG. STR. block of figure 14-1 shows only 3. This means that the recorded signal has a strength of 3 to 1. Since the block is so small and the comparison to 1 is always understood, only the strength of the recorded signal (compared to 1) is entered in this block.

- Reel and Recording Numbers

(U) Identifying numbers of reels and recordings are recorded in this space. The example listed below should be used.

- Reel #1 1st recording . . R0101 or R01/01
- Reel #1 3rd recording . . R0103 or R01/03
- Reel #2 1st recording . . R0201 or R02/01

(U) In the examples above, the "R" indicates reel, the first two digits indicate the reel number and the last two digits indicate the recording number on that reel.

- Photograph Numbers

(U) If a camera is used to photograph the analysis scope, the following numbering system should be used to identify the signal:

Photograph roll #1 Photograph #1 P01001

Photograph roll #2 Photograph #88 P02088

This number should then be entered in the Photo Nos. block of the Operator's Intercept Log. If more than one photograph is taken, enter all the numbers in this block unless there is insufficient space, in which case, mark the block "See Below," and enter the photo numbers in the Operator's Remarks block.

(U) Units submitting Polaroid prints will record the following data on the reverse side of the prints.

Unit and Mission Identity \_\_\_\_\_  
Date/Time Group \_\_\_\_\_  
Signal Number \_\_\_\_\_

- Recording Times

(U) Enter the ZULU time that the recorder was started and stopped.

- Frequency Checks Performed

(U) If "yes," enter the frequencies checked, or, in the case of image checks where the "rail" movement is normal, enter N.A.

- Status of Own Radars

(U) Check the appropriate block.

- Type(s)

(U) If the Radiating block is checked in the previous step, enter the types of radars that are actually radiating at the time.

- Intercept Equipment Used

(U) Enter all equipment used, including intercept receiver, antenna, recorder, reference tone source, frequency counter, audio oscillator or any other.

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- Time (Z), Signal Strength, and Bearings

(U) Ascertain that the correct ZULU time and signal-to-noise ratios are entered at the time the bearing is taken. True bearings are submitted. A minimum of five bearings are required to obtain accurate indication of target fix or motion. Time spacing between successive bearings will vary with aircraft or ship's speed. On bearing times that involve more than one day, enter a date/time group at the point where the signal is first recorded and again at the point where the signal is still observed on the second day in question.

- Classification of DF Bearings

(U) The classification of each DF bearing is the degree of accuracy with which each bearing is taken as determined by: the known accuracy of your ESM equipment, having obtained an ESM correlation from another ship, and/or having plotted the signals platform on radar. Enter a check mark in the appropriate block to correspond with the following list:

- A . . . . . plus or minus 2°
- B . . . . . plus or minus 5°
- C . . . . . plus or minus 10°
- D . . . . . plus or minus 20°
- Q . . . . . snap bearing (short duration signal, etc.)

- Intercept Platform Position

(U) The correct position of the intercept platform in latitude and longitude for each DF bearing is entered. If no DF is obtained, enter own ship's position at the time of intercept and the words "NO DF AVAIL." In the Remarks section give the reason why bearings were not obtained (e.g., short duration of signal or equipment failure).

- Visual Correlation

(U) If visual correlation is obtained, indicate type ship/aircraft, hull number and

other identifying features. An attempt should be made to photograph the radiating antenna. If no photographs are made, describe the antenna in the Remarks section, and indicate the reason for no photographs.

- Photo Number

(U) If a photograph of the antenna or platform is obtained, enter the photograph number in this space.

- Time Signal No Longer Heard

(U) It is neither necessary nor feasible from a tactical standpoint for the intercept operator to remain with any one signal; rather, he should resume search and return periodically to those targets he has previously located to obtain additional bearings and signal down time. If a signal remains active, it should never be completely abandoned until all collection requirements have been fulfilled.

- Operator Remarks

(U) Descriptive amplifying remarks regarding each intercept should be entered in this column. This information entered or recorded at the time of intercept may prove invaluable in post-analysis efforts. Remarks should be in the operator's own words and should include all pertinent data which might aid in establishing the identity and/or location of the source of the transmission, or in the analysis of the intercept. Information should include, but not be limited to the following:

1. Tentative identification of the signal, by nomenclature or function if possible.
2. Sketch of the pulse shape, in the appropriate position, if it is considered unusual or in any way significant.
3. Interference caused by local electronic equipment and/or weather condition.
4. Additional modes of operation.
5. Any additional information that may aid in the intermediate or final analysis of the intercepted signal.

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- Evaluator Comments

(U) Immediately below the operator remarks, the watch supervisor, watch officer, division officer or other appropriate evaluator enters comments regarding the results of preliminary analysis and/or evaluation of the intercepted signal. Evaluators should not change or erase the operator's comments even though obvious errors appear in his analysis. Evaluator's comments include the following:

- Concurrence or nonconcurrence with the operator.
- Suspected location of intercepted emitter.
- Any ships or aircraft in the immediate vicinity that may have been the source of the intercepted emission.
- Information obtained through own ship's radar, such as target course, speed, CPA and unusual tactics.
- Any amplifying information which may aid in the intermediate or final analysis of the intercepted signal.

**COMMON DISCREPANCIES**

(U) Listed below are some of the most common discrepancies or deviations from prescribed procedures which have been noted during analysis of Operator's Intercept Logs:

- Inadequate number of bearings.
- Illegible logs.
- Local and ZULU dates/times mixed on the same log.
- Accurate ship's position not logged while taking bearings.
- Ship's position not logged when no DF is obtained or available.

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- Failure to indicate whether frequency was taken from receiver dial or calibrated source.

(U) Now that you are familiar with how the Operator's Intercept Log is filled out, we come to another important phase of ELINT recording, the audio tape that should accompany each Operator's Intercept Log that is mailed to the analysis center.

(U) The following paragraphs will point out more specifically some operating procedures for the AN/UNQ-7D Audio Tape Recorder/Reproducer with which you became familiar in chapter 7. These procedures deal with the realistic day-to-day usage of the AN/UNQ-7D in ELINT recording and reporting.

**AN/UNQ-7 TAPE RECORDER PROCEDURES**

(U) Procedures discussed here are based on equipment currently in use by ESM teams and analysis centers. These may be expected to change as improved equipment becomes available.

**CONTROL SETTINGS**

(U) Before actually participating in an ELINT mission or operation, training tapes should be made by operators to determine the tape recorder control settings desired. This acquaints the operator with the equipment and procedures. The recorder gain controls should be adjusted in accordance with the instructions or technical manual provided with the recorder in use. Adjustments in signal strength should be made from the intercept receiver being used. Always insure that the tape recorder is set on the fastest recording speed available.

**REFERENCE TONE**

(U) A standard reference tone is recorded with each intercept. This permits analysts to note and compensate for any difference in tape

speed between interceptor and laboratory tape recorders. A VTTF (Vacuum Tube Tuning Fork) generating 1000 Hertz is preferred, but any other stable reference tone is acceptable. An actual measurement of the reference tone frequency should be made at least once a month, and more often when necessary.

### **DUAL TRACK PROCEDURES**

(U) The correct procedures for using the dual track recorder should be uniform from watch to watch, ship to ship, and fleet to fleet. To accomplish this, a standard procedure should be used. In normal operation of the dual track recorder, one track (Channel A) is used for voice annotations and the reference tone. The second track (Channel B) is for recording the intercepted signal.

(U) Before deploying on an ELINT mission or an operation, ensure that a sufficient quantity of magnetic tapes are available, either on hand or in the ship's supply department. Fleet or type commander instructions set the maximum or minimum number of tapes to have available.

#### **Information At The Beginning Of Each Reel (Recorded By Microphone On Channel A)**

1. A statement of the security classification. "The Classification of this Tape is \_\_\_\_\_." (Enter "Secret," "Confidential," or "Unclassified" as appropriate.)

2. The collector's designation, i.e., aircraft squadron, ship.

3. Channel allocation, e.g., "Channel ALFA contains a 1000 Hz reference tone (state its source) and voice annotations. Channel BRAVO contains the intercepted signal of interest."

4. Make the following statement: "Recording number one follows." Let the recorder run for 15 seconds and then stop. The tape is now ready for the first intercept.

#### **Annotations While Signal Is Being Recorded**

(U) The following information will be annotated on Channel ALFA while the signal of interest is being recorded on Channel BRAVO.

1. Recording number.
2. Signal number (same as Operator's Intercept Log), e.g., "This is signal number zero zero one."
3. Date/time recording was started (ZULU).
4. Frequency, pulse width, pulse repetition frequency.
5. Operator comments: Make annotations about varying the gain, rotating the antenna, or any change in signal characteristics. Add any information that the operator considers valuable for analysis and identification of the signal, e.g., "This is an airborne platform with a fast bearing drift rate and the DF antenna is being constantly rotated to stay on the signal. The gain is being decreased as the aircraft closes."

#### **Information At The End of Each Recording**

(U) The following information will be annotated at the end of each recording:

1. The statement "End of Recording Number \_\_\_\_\_."
2. The statement "Recording Number \_\_\_\_\_ follows."
3. Follow this with approximately 10 feet of blank tape.

#### **Information At The End Of Each Reel**

(U) The following information will be annotated at the end of each reel:

1. The statement "End of Reel Number \_\_\_\_\_."
2. The statement "The Classification of the Tape is \_\_\_\_\_." (Enter appropriate classification—must be the same as classification used at the beginning of the reel.)

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3. The statement "Nothing Follows, Nothing Follows."

(U) The following is an example of the beginning of a reel, an intercepted signal, and the end of a reel of the USS SAMPSON (DDG10).

"The classification of this tape is Confidential. Recorded on board USS SAMPSON (DDG ONE ZERO). Channel ALFA contains a one thousand Hertz reference tone from a vacuum tube tuning fork, model number four six five, and voice annotations, Channel BRAVO contains the signal of interest. Recording number one follows"

"This is recording number one."

"This is signal number one."

"The time is two eight one nine one five ZULU September 1972."

"The frequency is five seven two five megacycles."

"The pulse repetition frequency is six four two."

"The pulse width is zero decimal two five."

"The signal changed pulse width to one decimal three five at time one nine one seven ZULU."

"End of recording number one."

"Recording number two follows."

(Only placed on tape when operator is sure sufficient tape remains to record another signal.)

"End of reel number one. The classification of this tape is Confidential. Nothing follows, nothing follows."

(U) While recording an intercept, it is extremely helpful to monitor the signal. This

can be accomplished by plugging audio earphones into the output jack of the magnetic tape recorder. By listening to this output, the operator can hear exactly what is being recorded, and can adjust the gain on the intercept receiver to hear only the "main lobe" or "burst" from the intercepted signal.

**Information Required  
On The Side Of Each  
Reel Prior To Mailing  
To The Analysis Center**

(U) When a reel of magnetic tape has been completed, the following information is to be placed on the side of each reel:

1. Unit identification
2. Report identification.
3. Reel number.
4. Inclusive signal numbers
5. Classification (normally Confidential).

**Information Required  
On The Reel Container**

(U) Reel containers vary from manufacturer to manufacturer. Most of the common types of containers you will encounter will be either a cardboard box or a brown paper envelope (Kraft paper). As procedures get more standardized you will find the paper envelope the more common. This paper envelope comes preprinted with a chart on one side of it for filling in required information. The following information is recorded on the side of the reel container:

- Classification (normally Confidential).
- Collector's identification, mission title and reel number.
- Recording speed.
- Frequency of the reference tone.

(U) List every recording of the enclosed reel. Example: See figure 14-2 for an example of the proper method of listing recordings.

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<u>Reel #</u>	<u>Signal #</u>	<u>Frequency</u>	<u>Time Up</u>	<u>Time Down</u>	<u>Remarks</u>
1	001	9400 D	1414/17 Nov	1420/17 Nov	Emitter nickname
2	002	3450 C	1436/17 Nov	1550/17 Nov	Emitter nickname

**Figure 14-2.—(U) Example of recordings to be listed on reel containers (U).**

### **Antennas For Recording**

(U) An omnidirectional antenna should be used when recording a signal. If, however, a DF antenna is used for recording, it must be trained in the direction of the incoming signal.

### **Common Discrepancies**

(U) Listed below are the most common discrepancies or deviations found in recordings by the analysts at the ELINT centers.

- Improper, or absence of, voice annotations.
- Signal overdriven.
- No standard reference tone.
- DF antenna rotating during recording.
- Excessive noise on all channels (especially voice).
- Signals underdriven or completely blank recordings.
- Varying recorder speeds.

### **PHOTOGRAPHIC PROCEDURES**

(U) Analyzer scope photographs are important since they permit analysts to study the exact scope image of the signal observed by the operator at the time of intercept. Careful photography can record pulse shapes or complex forms of modulation not easily detectable by the operator but which can be detected by trained analysts. Only photographs of analyzer

scopes are desired. Before photographs are taken, ensure that the DF antenna is trained on the signal source. In most instances, using a DF antenna will result in higher quality photographs since an operator can observe his work and compensate for minor errors before the signal is lost.

### **COMMON DISCREPANCIES**

(U) Listed below are the most common discrepancies or deviations from photographic procedures that have been noted by analysts.

- Polaroid film and operator logs do not agree.
- Polaroid film overexposed/underexposed
- Polaroid film is old or of poor quality.
- Incorrect information on chamber or back of processed film.

### **COLLECTING ELINT DATA**

(U) The collection procedures are established to provide guidance to shipborne and airborne operators in the optimum methods of collecting ELINT data. The principal aims of establishing standard operating procedures are:

- To achieve a high degree of ESM operator proficiency in fleet ship and air units.
- To assist the ESM operator in providing command with accurate and valuable tactical ESM information.

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(U) To increase the scope, quantity, and accuracy of ELINT reports submitted by fleet ship and air units.

**STANDARD  
OPERATING SEQUENCE**

## 1. Receiver Tuning

(U) Receiver tuning techniques vary dependent upon many factors; however, basic techniques should include automatic frequency tuning interspersed with occasional manual frequency tuning at specific frequencies of interest.

## 2. Initial Signal Intercept

(U) Obtain the DF bearing of the signal and stop the antenna on the bearing acquired.

## 3. Center Tune the Signal

(U) The frequency of the signal must be determined accurately. To accomplish this, turn the fixed oscillator on and tune the receiver manually until the entire trace on the display scope blooms up. When the blooming is adjusted for maximum amplitude and the signal is properly centered, its frequency may be read from the indicator or directly from the tuning head in use. At this point, the image or harmonic frequency checks should be made.

## 4. Start Recording

(U) When the true frequency has been determined and the signal is properly center-tuned, begin recording. A minimum of two minutes or five sweeps of a slow scanning radar is desired. Unique recording requirements for signals of special interest are listed in collection requirement publications. Recordings of longer duration are required if the signal changes mode of operation or displays any peculiarities. **INSURE THAT THE DF ANTENNA IS STOPPED AND SWITCH TO OMNIDIRECTIONAL ANTENNA BEFORE STARTING THE RECORDER.**

## 5. Take Analysis Scope Photographs

(U) After starting the recording, take photographs of the signal presentation on the analysis scope.

## 6. Obtain Signal Characteristics

(U) While the signal is being recorded, determine the additional characteristics, i.e., PRF, PW, scan type-rate and visual correlation (if any). Enter all characteristics on the intercept log.

## 7. Continue Search

(U) Because time is critical in a tactical situation, **DO NOT** spend excessive time on any one signal.

**ELINT REPORTS**

(U) Complete ELINT reports are submitted by fleet units on all intercepts which cannot be identified as emanating from either United States or friendly sources. Letter reports are submitted as each mission, or phase of a mission, is completed. Negative reports are not required.

**PROCESSING**

(U) Each intercept report submitted undergoes analysis and evaluation at the ELINT center and the results obtained are provided to the originator. The ELINT center forwards intercepts of signals of interest such as those displaying new or unusual modes of operation to the NSA (National Security Agency) in the CARF (Consolidated Analysis Report Final) for technical analysis. Results of the final evaluation are provided cognizant agencies.

**Message Reports**

(U) In addition to subsequent inclusion in letter reports, unusual intercept data such as suspected submarine or missile signals, new enemy electronic weapons, devices, or techniques are forwarded in accordance with NWP-33 by a message report.

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**Letter Reports**

(U) Letter reports contain the following items as applicable:

- Operational summary.
- Individual operator intercept logs.
- Magnetic recordings of signals intercepted.
- Negatives (or photographs), if available, of analysis scope, and/or radarscope (for jamming or interference signals).

**Forwarding**

(U) The original report is submitted in single copy to the Commander, IPAC (Intelligence Center Pacific)/ILANT (Intelligence Center Atlantic). IPAC/ILANT prepares an analysis of the mission and forwards the results to the reporting unit, with copies to COMNAVSECGRU, CINCLANT,

CINCPACFLT, type commanders and operational commanders.

**Classification Policy**

(U) Administrative and historical matters which do not disclose ELINT search or reconnaissance information, or which disclose only the fact that the United States Navy is engaged in ELINT search operations, may be UNCLASSIFIED.

(U) Plans, orders and directives which reveal ELINT search information and reports of unevaluated ELINT intercept data are classified at least CONFIDENTIAL.

(U) Information and documents which reveal the scale of effort or the degree of success of ELINT search or reconnaissance and evaluated ELINT intercept data are classified at least SECRET.

(U) Any information or report which reveals the conduct of operations requiring a higher classification than is indicated above are classified accordingly.

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## CHAPTER 15

## MAINTENANCE AND TEST EQUIPMENT

The purpose of this chapter is to assist you in becoming a proficient technician. Proper maintenance of the ship's EW equipment is as important as the operational aspects of the rating. A ship which deploys on a mission with equipment in less than optimum condition presents itself as a vulnerable target in the event of attack. It is just as vital to the ship's mission that your EW equipment be maintained in as high a state of readiness as any other functional equipment on board ship.

This chapter will give you some insight toward the proper administrative procedures for preventive and corrective maintenance of your EW equipment. Information will also be provided on reference material for test equipment operating procedures, safety precautions, stowage and handling, repair and calibration, and general usage. To assist you in becoming a proficient EW technician we will begin by discussing the ship's Maintenance and Material Management (3-M) System and how you will use it on board ship.

## 3-M SYSTEM

The primary objective of the ship's 3-M System is to provide for managing maintenance and maintenance support in a manner which will ensure maximum equipment operational readiness. To this end, the intermediate objectives of the 3-M System are as follows:

- a. Achievement of uniform maintenance standards and criteria.
- b. Effective use of available manpower and material resources in maintenance and maintenance support efforts.

- c. Documenting information relating to maintenance and maintenance support actions.

- d. Improvement of maintainability and reliability of systems and equipment through analysis of documented maintenance information.

- e. Provision of the means for reporting ship configuration changes.

- f. Identification and reduction of the cost of maintenance and maintenance support in terms of manpower and material resources.

3-M is applicable to all ships, service craft, and small boats. It includes all equipments installed therein, except for medical equipment, fleet ballistic missiles and nuclear power plants, and associated test equipment. The 3-M System consists of two subsystems:

- a. PMS (Planned Maintenance Subsystem).
- b. MDCS (Maintenance Data Collection Subsystem).

The 3-M System is the nucleus for managing maintenance aboard all ships of the Navy. Its purpose is to provide all maintenance and material managers throughout the Navy with the means to plan, acquire, organize, direct, control, and evaluate manpower and material resources expended or planned for expenditure in support of maintenance. Thus, it is essential that all hands recognize the importance of the System, and understand the role it plays in assisting management to improve the material readiness of equipment in the fleet. In referring to "management," the term is used in its broadest sense, including the work center on the ship as well as Navy Headquarters in Washington.

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The guidelines for the 3-M System are contained in OPNAVINST 4790.4 which consists of three volumes that provide a user-orientated document directed to three specific areas of use:

- Volume I is directed to all users as an overall introduction to the 3-M organization including responsibilities, training, and reports available from the system. Volume I also deals specifically with the Planned Maintenance Subsystem (PMS).

- Volume II is also directed to all users and contains the Maintenance Data Collection Subsystem (MDCS). It is useful to all activities and deals with MDCS specifications, error corrections, and products available.

- Volume III of the manual covers intermediate maintenance activities procedures, and will be used principally by those organizations.

The IMMS (Intermediate Maintenance Activity Management Subsystem), as described in Volume III of the 3-M Manual, is comprised of computerized procedures used aboard tenders, repair ships, and repair bases/activities. These mechanized procedures are used to manage the planning, scheduling, production, and monitoring of the maintenance workloads of tended ships.

Now that you have an overview of the 3-M System, let's take a look at the two subsystems with which you will be most concerned—PMS and MDCS.

These two subsystems combine to assist you in preventive maintenance and to insure that corrective maintenance is properly recorded. A detailed description of the two subsystems follows.

### **PMS (PLANNED MAINTENANCE SUBSYSTEM)**

PMS provides each ship with a simple and standard means for planning, scheduling, controlling, and performing planned maintenance of all equipment. PMS is the most

efficient means developed to date for using available maintenance resources.

PMS maintenance actions are the minimum required to maintain the equipment in a fully operable condition, within design specifications. If performed according to schedule, these maintenance actions will provide the means to identify parts requiring replacement prior to failure. PMS procedures are, therefore, preventive in nature in that they are designed to prevent future equipment failures which might otherwise result in repeated maintenance actions.

These PMS procedures and the periodicity in which they are to be accomplished are developed for each piece of equipment based on good engineering practice, practical experience, and technical standards. These procedures are contained on cards designated MRCs (Maintenance Requirement Cards). MRCs provide the detailed procedures for performing the preventive maintenance and state exactly who, what, when, how, and with what resources a specific requirement is to be accomplished. Some MRCs have EGLs (Equipment Guide Lists) accompanying them to serve as location guides for identical equipments; such as motors, controllers, valves, life rafts, deck fittings, CO<sub>2</sub> bottles, test equipment, etc., which are impractical to schedule individually for routine, periodic preventive maintenance.

A MIP (Maintenance Index Page) contains a brief description of the requirements on the MRC(s) for each item of equipment including the periodicity code, the manhours involved, the minimum required skill level and, if applicable, the related maintenance requirements. The MIPs for all equipments in a department are contained in a Departmental Master PMS Record. This manual also contains an index of the effective MIPs, called a LOEP (List of Effective Pages), and a correction page to record changes made. The Department Master PMS Record is used by the department head as a scheduling tool when scheduling maintenance on the PMS schedule forms, and also as a cross-reference guide. Additionally, each work center has a Work Center PMS Record which is identical to the

Departmental Master PMS Record, except that it contains only those MIPs and LOEPs applicable to the work center. The division officers, work center supervisors, and maintenance personnel use these records for cross-reference purposes.

The planning and scheduling of maintenance requirements are accomplished on the cycle, quarterly, and weekly schedules. Transferring maintenance requirements from the MIPs for each work center contained in the Departmental Master PMS Record and scheduling them on the Cycle Schedule creates the ship's overhaul-to-overhaul maintenance schedule. Quarterly and Weekly Schedules are prepared using the Cycle Schedule as a guide. Maintenance requirements indicated on the Weekly Schedule are assigned to specific personnel for accomplishment. Scheduled maintenance actions are crossed over with an "X" when they are completed, and actions not completed are circled and arrowed to a new schedule date. Quarterly Schedules are updated in the same manner.

Changes to PMS are issued by the NMMFOs (Navy Maintenance Management Field Offices). More detailed information and procedures concerning PMS can be found in Chapter 5 of Volume I of the 3-M Manual. Procedures for verification and installation of PMS in new construction/major conversion ships and update overhauls are outlined in Chapter 7 of Volume I of the 3-M Manual. PMS procedures for ship activation, strike and transfer to a foreign navy are outlined in Chapter 8 of Volume I of the 3-M Manual.

The PMS FBR (Feedback Report) Form (OPNAV 4790/7B) provides fleet maintenance personnel with the means to report discrepancies and problems, and to request PMS software. All PMS FBRs are sent to NMMFOs or TYCOMs (Type Commanders), based on the category of the FBR. Chapter 5 of Volume I of the 3-M Manual addresses the categories of the PMS FBR forms and the details of PMS feedback reporting.

PMDO (Planned Maintenance During Overhaul) embodies PMS procedures modified

for maintenance of systems and equipment for which the ship has responsibility during shipyard overhaul. PMDO provides planned maintenance procedures for the deactivation and reactivation of entire systems (instead of routine maintenance requirements) during the overhaul period. PMDO also provides reduced planned maintenance requirements for other equipment which will be used during the overhaul period.

A PMDO package, consisting of separate layup and startup sections, is installed in a ship by the TYCOM 3-M Installation and Assistance Team prior to the commencement of overhaul. The layup portion of the package is completely self-contained and can be used without reference to other documentation. However, the startup portion makes extensive use of PMS MRCs (Maintenance Requirement Cards) and is, therefore, dependent upon adequate PMS coverage. The ship is responsible for determining exactly which shipboard systems will be scheduled for PMDO vice PMS and during what specific time period. Chapter 6 of Volume I of the 3-M Manual addresses the details of PMDO.

#### **MDCS (MAINTENANCE DATA COLLECTION SUBSYSTEM)**

The following qualifications apply to the scope of MDCS:

a. Maintenance Actions Deferred for Outside Assistance: All ships for all such maintenance actions.

b. Ships' Force Maintenance Actions on Certain Selected Equipment:

(1) All submarines.

(2) All cruisers.

(3) All other ships with an original commissioned date of less than 20 years.

c. Other Maintenance Actions:

Except as indicated in a and b above, no reporting is required for ships' force performed maintenance on all ships originally commissioned more than 20 years ago, unless otherwise directed by fleet CINCs/TYCOMs.

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MDCS includes the following:

a. Documentation provided by shipboard personnel incident to certain shipboard maintenance actions. This documentation describes what was done or needs to be done, why it was done or why it needs to be done, who did it or who needs to do it, and what resources were used or are needed.

b. The means for producing an automated ship's CSMP (Current Ships Maintenance Project).

c. The means for producing automated ship work requests for intermediate maintenance activity and shipyard use.

d. The means for producing automated PRE-INSURV (Pre-Inspection and Survey) deficiency listings.

e. The means to produce automated reports tailored to meet the unique needs for all the various types and levels of management throughout the Navy.

f. Provision of the tools necessary to effectively manage and control intermediate maintenance activity workloads.

g. Provision of the media for the fleet to report changes to the configuration of equipment installed in ships. Incident to such reporting is the development of the capability to automatically update a ship's PMS coverage.

h. Provision of the media for depot level activities to inform the fleet of estimated and actual resource expenditures.

MDCS is the means by which maintenance personnel report corrective maintenance actions on specific categories of equipments (except for submarines who report corrective maintenance experience on all equipments). Information is retrievable from the TYCOM and the MSO (Maintenance Support Office) data banks for analyzing maintenance and logistic support problems, for the development of the CSMP, and for generation of automated work requests for maintenance actions deferred for outside assistance.

It is a basic premise of the MDCS that the data collected by maintenance personnel will be recorded once and only once, and that the MDCS data bank (not the maintenance activity) will thereafter provide information to all who have need for it in such form as may be required. In this connection, the MSO data bank is designed to be the focal point for receipt and distribution of maintenance and material data. Direct requests to the fleet for data which is available from the MSO imposes an unnecessary burden on the operating forces. It is the policy of the CNM (Chief of Naval Material) that the Naval Material Command minimize requests to the fleet for special data. However, if some such requests are deemed essential, special requests for data will include a phrase "The MSO data bank has been queried and the data is not available."

From the 3-M central data bank maintained at MSO, numerous reports are already programmed and available upon request by any command. These reports yield data concerning equipment maintainability and reliability, manhour usage, equipment alteration status, material usage and costs, and fleet material condition. Many reports are produced periodically for users in both the Navy Shore Establishment and Operating Forces. Detailed information concerning MSO products is contained in Chapter 4 of Volume I of the 3-M Manual.

From the deferred maintenance that is reported, a CSMP file is developed by the ADP (Automatic Data Processing) facility servicing the TYCOM. From the CSMP file a series of computer reports is provided the ship and/or unit commander. These reports are also used by the TYCOM. The reports provide either a detailed or summary listing of deferred maintenance information in various format options. Chapter 9 of Volume I of the 3-M Manual discusses the CSMP in detail. By-products of the CSMP include automated work packages, PRE-INSURV packages etc. A package of AWRs (Automated Work Requests) is generated by the ADP facility for each ship prior to overhaul and availability periods. These packages contain work requests for CSMP items appropriate to the designated repair activity as

well as standard work requests for routine jobs performed during IMA (Intermediate Maintenance Activity) and shipyard availabilities. Chapter 9 of Volume II of the 3-M Manual addresses AWRs in detail.

Prior to an inspection by the Board of Inspection and Survey, a package of automated INSURV items is generated by the TYCOM from all deferrals listed in a ship's CSMP file. These items are in a format similar to AWRs. After the INSURV board has screened these items and assigned priority numbers, if appropriate, the package is used to update the CSMP. Chapter 9 of Volume II of the 3-M Manual discusses automated INSURV procedures.

The usefulness of MDCS is dependent upon the accuracy, adequacy and timeliness of the information reported into the system. It is a system in which potential benefits are directly proportional to the efforts applied. Present programs for improving reliability, maintainability, and logistic support of fleet equipment are dependent upon conscientious adherence to reporting procedures. Chapter 9 of Volume I of the 3-M Manual provides detailed MDCS information.

Much of the fleet support effort resulting from use of 3-M data is not always visible immediately to the fleet because of the time span required to test, evaluate, and implement engineering and design changes. Correction of malfunctioning equipments through improvements in design often occur subsequent to reassignment of personnel who provided the information which precipitated the corrective action.

### CORRECTIVE MAINTENANCE

There are many factors you should consider when conducting corrective maintenance on your EW equipment. To become a proficient technician, you must have a thorough knowledge of basic electronics. You must know how your equipment operates and the types of circuits that are used in the equipment. No matter how complex a particular equipment appears—it is

nothing more than a combination of basic circuits. Understanding these basic circuits—how they operate and what they do—is the key to becoming a proficient technician.

It is not possible to include all of the circuits with which you will work without a mass duplication of material that is already in print and available to every ship or station. The following list of source material is recommended for your study:

*BASIC ELECTRONICS*, NAVEDTRA 10087 (series).—This book, printed in two volumes, contains information on most of the basic circuits used throughout the Navy. Information is included on circuit analysis and troubleshooting hints that can be used as valuable tools for performing corrective maintenance. A two-part Nonresident Career Course; *NAVAL ELECTRONICS, PART 1A*, NAVEDTRA 10445-C and *NAVAL ELECTRONICS, PART 1B*, NAVEDTRA 10437-A1, is available through your Educational Services Office and is recommended to enhance your knowledge in the electronics field.

**TECHNICAL MANUALS.**—The technical manuals for the equipment on board your ship contain information on operating the equipment as well as maintenance and troubleshooting hints. Read your technical manuals. No matter how well you think you know your equipment, there is always more to be learned.

**EIMB** (Electronics Installation and Maintenance Book).—There are presently thirteen volumes of the EIMB. Each of these volumes may prove useful in varying degrees. The EIMB handbooks are useful as convenient reference books for three general categories of maintenance personnel:

1. **Experienced Technician.** The experienced technician has no great difficulty in coping with maintenance problems because of previous experience and well developed maintenance skills. This person will use the EIMB as reference or review material. He will increase his knowledge of electronics maintenance as new concepts and procedures are added to the EIMB.

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2. Technician Out-of-School. This category of technician is representative of the individual who has completed Navy training courses, but has limited experience with the fleet. His experience will probably be limited to equipments covered in training courses and to equipments he has encountered in his brief tour of duty with the fleet. Consequently, the EIMB will prove extremely valuable to him, especially as new equipments are confronted. The maintenance concepts in the EIMB will help familiarize him with the new techniques involved in maintaining modern equipments.

3. Trainee. The trainee will find the information contained in the handbook to be useful as a reference while in training. Later, he will find that it serves as a source of review as well as reference. As a training aid, the individual sections might be recommended for suggested reading.

Information contained in the EIMB is of lasting interest to all naval personnel engaged in the maintenance of electronic equipment.

**ELECTRONICS INFORMATION BULLETIN (EIB).**—EIBs are published every 2 weeks and contain information on all types of electronics equipment. When your leading EW routes the EIB to you—read it. Determine what items contained in the EIB pertain to the EW equipment and study them.

**TEST EQUIPMENT**

Shipboard test equipment represents standards against which the performance of other systems, equipments, circuits, and components are measured. Equipment allowances are based upon providing each ship with test instrumentation capable of measuring those parameters which fall within the maintenance capability of that type ship.

To properly maintain your EW equipment you must have a working knowledge of your test equipment. Section I of the Test Equipment EIMB contains information on test equipment safety precautions, handling and stowage, repair and calibration, and general usage instructions. Information on operating instructions as well as capabilities and limitations for a particular piece of test equipment may be found in the technical manual for that equipment.

Nothing can supplant on-the-job training in terms of learning how to use test equipment properly. Use your test equipment MRC to compile a list of those items with which you are not completely familiar. Locate the technical manual for each of these equipments and spend some time reading the operating instructions and studying the capabilities and limitations. Then get together with your leading PO and discuss setting up a schedule for him to teach you more about how to operate these equipments.

## APPENDIX I

### GLOSSARY

#### A

(U) Acknowledgement—A message from the addressee informing the originator that his communication has been received and is understood.

(U) ACP—Allied Communication Publication.

(U) Adapter, Homing—A device which, when used with an aircraft radio receiver, produces aural and/or visual signals which indicate the direction of a transmitting radio station with respect to the heading of the aircraft.

(U) Adapter, Panoramic—An attachment designed to operate with a search receiver to provide a visual presentation on an oscilloscope screen of a band of frequencies extending above and below the center frequency to which the search receiver is tuned.

(U) Address Designator—A plain language name (full or abbreviated), routing indicator, call sign, or address group of a unit, activity, or other authority used to indicate the originator and/or addressee(s).

(C) Affirmative Grid—Transmitted to Duffers when Control ship desires to have Duffers include their position along with their reports. The position is usually transmitted in geographic reference.

(U) AI—(Airborne Intercept). Intercept radar equipment installed in fighter aircraft and providing a solution for attacking other aircraft.

(C) Air Surveillance—The systematic observation of air space by electronic, visual, or other means, primarily for the purpose of identifying and determining the movements of all aircraft and large missiles, friendly or enemy, in the air space under observation.

(U) Airborne Early Warning Set (AEW)—Airborne radar equipment providing long range detection and identification and relaying of the radar signals to ground or shipborne stations.

(U) Aircraft Control and Warning System—A system established to control and report the movement of aircraft. It consists of observation facilities (radar, passive electronic, visual, or other means), control centers and necessary communications.

(U) Amplification—The process of increasing the amplitude (either current or voltage or both) of an electrical signal.

(U) Amplifier—A device used to increase the strength of a signal without appreciably altering its characteristic waveform.

(U) Amplitude—The maximum instantaneous value of an alternating voltage or current, measured in either the positive or negative direction. Also used in regard to the height of a pulse.

(U) Amplitude Modulation (AM)—An operation in which the amplitude of a radio wave is made to vary in accordance with the signal containing the intelligence to be transmitted; the frequency and phase angle of the radio wave remain constant.

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(C) Amplifying Report—Report which may be made by a Duffer at any time and which contains data that will assist other operators in finding the target on their equipment.

(U) Analysis—In Electronic Warfare. A study of electromagnetic radiations to determine their technical characteristics and their tactical or strategic use. (See "Signal Analysis.")

(U) Anomalous Propagation (AP)—The transmission of electromagnetic radiation along other than the normally expected path, usually tending to follow the Earth's curvatures, because of refractive effects such as ducting, unusual reflections or unusual scattering of energy from discontinuities in the path.

(U) Antenna/Aerial—A device used to radiate or collect radio waves.

(U) Antenna Array—Antenna elements assembled in such a manner that the resulting radiation is concentrated in one or more directions.

(U) Antenna Matching Device—A device which matches the antenna to its transmission line by introducing an impedance which together with the impedance of the antenna equals the characteristic impedance of the line.

(U) Antenna Reflector—That portion of a directional array, frequently indirectly excited, which reduces the field intensity behind the array and increases it in the forward direction.

(C) Anti-Aircraft Fire Control Radar—Equipment for precision long-range fire control, and for defense against low-flying planes such as dive bombers and ground attack planes.

(C) Anti-Jamming (AJ)—(1) The art of minimizing the effect of enemy countermeasures in order to permit the echoes from targets detected by the radar to be visible on the indicator. (2) The controls of circuit features incorporated to minimize jamming.

(U) Aperture (of an antenna)—The diameter of the reflector (dish), usually measured in terms of wavelengths.

(C) Area Radar Prediction Analysis—Radar target intelligence study designed to provide radar significant data for use in the preparation of radar target predictions.

(U) Array—A number of antenna elements arranged so as to produce a concentration of energy in a desired direction.

(U) Astigmatism—Variation of focus along trace of CRT.

(U) Atmospherics—Irregular pulses of radio energy generated by atmospheric electrical discharges. Often called "Static".

(U) Audio Frequency—A frequency which can be detected as a sound by the human ear. The range of audio frequencies extends from approximately 20 to 20,000 hertz.

(U) Automatic Frequency Control (AFC)—A circuit or device which maintains a receiver or transmitter on a desired frequency.

(U) Automatic Gain Control (AGC)—A circuit or device which regulates the gain of a receiver or amplifier so that the output tends to remain constant though the incoming signal may vary in strength.

(C) Automatic Search Jammer (Search Lock Jammer)—A system comprising a search receiver and a jamming transmitter which first searches for signals having specific characteristics and then automatically jams them.

(U) Automatic Tracking—Tracking in which the servo mechanism follows a signal or target automatically.

(U) Automatic Volume Control (AVC)—See "Automatic Gain Control (AGC)."

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(U) Azimuth—(1) A direction expressed as a horizontal angle, usually in degrees or mils, and measured clockwise from north. Thus, azimuth will be true azimuth, grid azimuth, or magnetic azimuth depending upon which north is used. (2) The angle at the zenith between the observer's celestial meridian and the vertical circle through a heavenly body.

## B

(C) Bagpipes—A jamming method in which the carrier is modulated by several sinusoidal audio tones in rapid sequence. This method of jamming is extremely effective against voice circuits.

(C) Balloon Reflector—In Electronic Warfare, balloon-supported confusion reflector to produce fraudulent echoes.

(C) Barrage Jamming—Simultaneous electronic jamming over a broad band of frequencies.

(U) Base Line—The horizontal line formed by the movement of the sweep on a cathode-ray tube.

(U) Battery—An apparatus which may comprise a group of two or more cells used for the conversion of chemical energy into electrical energy.

(U) Battle Short—A switch for short-circuiting the safety interlocks and lighting a red warning light.

(U) Beacon—A light or electronic source which emits a distinctive or characteristic signal used for the determination of bearings, courses, or location.

(U) Beacon, Radar—A radio navigation transponder which transmits, in response to a specific received signal, a pulsed radio signal with specific characteristics whereby the bearing and/or range of the transponder from the interrogator may be determined, and which, in some cases, may also be used to identify the transponder.

(U) Beacon, Radio—A radio transmitter which emits a distinctive or characteristic signal used for the determination of bearings, courses, or location.

(U) Beam (Radio)—A radio transmission concentrated into a sector narrow in either azimuth or elevation, or in both.

(U) Beam Lobe Switching—A method of determining the direction of a remote objective by comparison of the signals corresponding to two or more successive beam angles, differing slightly from the direction of the object. Beam switching may be either: (1) continuous and periodic or (2) discontinuous.

(U) Beam Rider—A missile guided by a radar or radio beam.

(U) Beam Width—The angle between the directions, on either side of the axis, at which the intensity of the radio frequency field drops to one-half the value it has on the axis.

(U) Bearing, Class "A"—A bearing which a direction finding operator may reasonably consider to be accurate to within plus or minus two degrees.

(U) Bearing, Class "B"—A bearing which a direction finding operator may reasonably consider to be accurate to within plus or minus five degrees.

(U) Bearing, Class "C"—A bearing which a direction finding operator may reasonably consider to be accurate to within plus or minus ten degrees.

(U) Beat Frequency—A frequency resulting from the combination of two different frequencies in a non-linear device, such as a vacuum tube or a crystal. It is numerically equal to the sum or difference of these two frequencies.

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(U) Beat Frequency Oscillator—A device incorporated in super-heterodyne receivers for the reception of continuous wave signals. It generates a signal which is mixed with the received signal at the second detector, thus producing an audible beat frequency.

(C) Bird Nesting—Clustering of chaff strips causing them not to separate and disperse after dispensed from an aircraft.

(U) Blind Zones—Areas in which echoes cannot be received.

(U) Blip—The display of a received pulse on a cathode-ray tube.

(U) Blip/Scan Ratio—The ratio of the number of observed echo pulses from a target to the number of radar sweeps during the period in which the target is in the antenna beam.

(C) Blooming—In Electronic Warfare.  
 (1) The dispersal of window after launching.  
 (2) The expansion of the echo on a radar display due to the dispersal of window after launching.

(C) Bridge—Pulse width in microseconds.

(C) Brush—Antenna rotation rate in seconds per revolution (SPR).

(U) Burn Through Range—That range at which a radar target, until then masked by jamming, becomes detectable to the radar.

**C**

(U) Call Sign—Any combination of characters or pronounceable word(s) which identify(ies) a communication facility(ies), command(s), authority(ies), activity(ies), or unit(s); used primarily for establishing and maintaining communications.

(U) Call Sign, Collective—Any call sign which represents two or more facilities, commands, authorities, or units. The collective call sign for any of these includes the commander thereof and all subordinate commanders therein.

(U) Call Sign, Encrypted—A call sign which has been derived from other types of four-character call signs by means of an appropriate encryption system. Encrypted call signs are suffixed with an appropriate discriminant to identify the particular system in which the call sign is encrypted.

(C) Canyon—A brevity codeword meaning “Use electronic jamming on frequency indicated or in accordance with previous orders.”

(C) Chaff—Lightweight strips of foil, metallized paper or wire dropped from aircraft to clutter up radar scopes and confuse the AAW picture. May also be dispersed from ships by bursting shells or rockets. Cut to 1/2 wavelength of radar to be employed against.

(C) Chatter—Communications jamming.

(U) Circular Scan—Method of scanning of lobe of antenna radiation through 360° in a single plane.

(C) Cliff—A brevity codeword meaning “Jamming signal” (hostile/unknown/friendly).

(U) Clutter—The obliteration of targets on the screen of a radar indicator due to atmospheric conditions or other targets. Ground, cloud, or sea clutter.

(U) Coaxial Cable—A transmission line consisting of one conductor, usually a small copper tube or wire, within and insulated from another conductor of larger diameter, usually copper tubing or copper braid. The outer conductor may or may not be grounded. Coaxial cable is sometimes called concentric line, or coaxial line.

(U) Code, Brevity—A code which provides no security, but which has as its sole purpose the shortening of messages rather than the concealment of their content.

(C) Communications Countermeasures—All electronic countermeasures taken against communications.

(C) Communications Deception—The deliberate introduction of deceptive emissions into friendly or enemy radio communications channels with the intention of misleading the enemy.

(C) Communications Intelligence (COMINT)—That technical material and intelligence information derived from electromagnetic communications systems by other than the intended recipients or users.

(C) Communications Jamming (COMJAM)—That portion of electronic jamming directed against communication circuits.

(U) Cone of Silence—An inverted cone-shaped space directly over the aerial towers of some forms of radio beacons in which signals are unheard or greatly reduced in volume.

(C) Confetti—Chaff lane or corridor.

(C) Confusion Reflector—A reflector of electromagnetic radiations used to create echoes for confusion purposes. Radar confusion reflectors include such devices as chaff, rope and corner reflectors.

(U) Conical Scanning—A type of antenna beam scanning in which the tilt angle is fixed so that the axis of the RF beam generates a cone whose vertex angle is usually from 3 to 10 degrees.

(C) Contact Report—A report (visual, radio, sonar, or radar) of contact with the enemy. The first report, giving the information immediately available when the contact is first made, is known as an initial contact report. Subsequent reports containing additional information are referred to as amplifying reports.

(U) Continuous Wave (CW)—A continuous signal, not pulsed on and off. A CW signal may be amplitude, phase or frequency modulated.

(C) Control—That ship or unit designated by the OTC to take responsibilities for coordinating intercept search.

(U) Corner Reflector—Three mutually perpendicular metallic planes designed to reflect a large amount of radar energy, thereby making the radar echo resemble a much larger target.

(U) Correlate—To associate radar data with target position in active or passive tracking. To coherently compare jamming signals from two receivers to obtain a time delay and thus a line of target position.

(C) Correlation Techniques—In Electronic Warfare, the comparison of two or more signals emanating from a single source, but separated by transmission path or time, for the purpose of differentiating between real targets and clutter or jamming.

(C) Countermeasures—Steps taken to obtain information about enemy weapons, and to counteract their effectiveness.

(U) Counterpoise—A conductor or system of conductors used as a substitute for ground in an antenna system.

(U) Cover (Radio Communication)—To maintain a continuous receiver watch with transmitter calibrated and available to use but not necessarily available for immediate use.

(U) Cross Modulation—The modulation of the carrier of the desired signal by an undesired signal.

(U) Cross Talk—The unwanted transfer of energy from one circuit called the “disturbing” circuit, to another circuit called the “disturbed” circuit.

(U) Crossover Range (Point)—In Electronic Warfare. See “Burn Through Range.”

(U) Cursor—Part of an indicating instrument or display that may be moved to establish a reference line. Its most common use is on RHI displays for height finding purposes.

(C) Curve—A brevity codeword meaning “Deception Signal”—Hostile/Unknown/Friendly.

**CONFIDENTIAL****D**

(U) Data Processing, Automatic (ADP)—The recording, filing, computing, and production of data by means of electronic computers and associated auxiliary equipment.

(U) Dead Space—The area or zone which is within range of a radio transmitter, but in which a signal is not received.

(C) Deception—In Electronic Warfare. The deliberate radiation, re-radiation, alteration, or reflection of electromagnetic energy in a manner intended to mislead an enemy in the interpretation or use of information received by his electronic systems. There are two categories of deception: (1) manipulative and (2) imitative.

(C) Deception, Meaconing—See "Meadoning."

(C) Deception Jammer—A specialized type of jammer used to induce false indications in the system or systems being jammed.

(C) Deception Repeater—A device that receives a signal, amplifies, delays or otherwise manipulates and retransmits the signal for the purpose of deception.

(U) Decibel (dB)—A standard unit of comparison between two quantities of electrical or acoustical power.

(U) Decoy—A reflecting object used in radar deception, such as a spar buoy that looks like a periscope, a group of streamers hung from a captive balloon, etc.

(U) DF—Generally refers to radio direction finders. It is also sometimes used by the British for radar instead of RDF. It is sometimes written D/F.

(U) Diffraction—Deviation of rays of a wave motion from a straight course when partially cut off by an obstacle or passing near the edges of an opening, or through a small hole. Its effect is more marked as wavelength increases.

(U) Dipole Antenna—An antenna consisting of two elements each approximately one-fourth wavelength in length and fed with radio-frequency energy of opposing polarity at adjacent ends of the elements.

(C) Direct Amplified Noise (DINA)—A jamming technique that uses Direct Amplified Noise without a carrier frequency for the purpose of saturating a radio receiver with noise. This jamming technique is also called GAUSSIAN or WHITE NOISE. DINA is also effective against radars.

(U) Direction Wave—The component of the ground wave that is transmitted directly from transmitter to receiver.

(U) Directional Antenna—Any antenna system or array which either receives or radiates r-f energy more efficiently in one direction than in any other.

(U) Director—A parasitic element which reinforces radiation on a line pointing to it from the antenna.

(U) Discriminator—A vacuum-tube circuit whose output voltage varies in amplitude and polarity in accordance with the frequency of the applied signal. Its principal uses are as a detector in a frequency-modulation receiver and as an automatic frequency-controlling device.

(U) Dish—A paraboloidal antenna reflector.

(U) Display Scope/Display—A cathode-ray tube used to display a variety of information or data as follows:

A-Scope/Display—Horizontal or vertical sweep depicting range only.

B-Scope/Display—Horizontal sweep depicting azimuth, vertical sweep depicting range.

C-Scope/Display—Horizontal sweep depicting azimuth, vertical sweep depicting elevation.

**CONFIDENTIAL**

D-Scope/Display—Basic C-Scope/Display, but broken into horizontal strips in which trace (or pip) position roughly depicts range.

E-Scope/Display—Horizontal sweep depicting range, vertical sweep depicting elevation.

E-PPI-Scope/Display—A double gun cathode-ray tube that presents a normal PPI display from which a circular center section has been blanked out. In the center section, a dot moving in azimuth with the rotating sweep line indicates present elevation by its distance from the scope/display center.

F-Scope/Display—Horizontal displacement of spot (fated signal) depicting azimuth error angle or relative bearing, vertical sweep depicting elevation.

G-Scope/Display—Basic C-Scope/Display, with wings on the target trace which grow as range decreases.

H-Scope/Display—Horizontal sweep depicting azimuth, vertical sweep depicting range, and signal trace is bright line whose slope is proportional to line of elevation angle.

I-Scope/Display—Radial sweep synchronized with antenna conical scan. Trace appears as variable diameter circle whose radius indicates range and whose circumference brightens most at axial angle of maximum response. When “on target”, the entire circumference is brightened.

J-Scope/Display—Circular sweep depicting range only with radial deflection of video signal. Basic A-Scope/Display.

K-Scope/Display—Double target trace representing lobe signal strengths and hence error by relative amplitudes of trace. Basic A-Scope/Display with horizontal displacement of alternate scans for lobe switching.

L-Scope/Display—Same as K-Scope/Display with video response on alternate sweeps placed back to back, forming an envelope.

M-Scope/Display—Vertical deflection of horizontal range sweep. Basic A-Scope/Display with movable range “step” or “notch” for rematching an accurate range reading.

N-Scope/Display—Combination of K- and M-Scope/Displays.

PPI-Scope/Display (Plan Position Indicator)—Revolving radial sweep depicting azimuth and range.

R-Scope/Display—Expansion of small portion of range sweep of A-Scope/Display.

RHI-Scope/Display (Range Height Indicator)—Expansion of one dimension of polar display with horizontal sweep depicting range and expanded vertical sweep depicting height.

(U) Distortion—The amount by which the output wave form differs from the input wave form. Distortion may exist in amplitude, frequency, or phase modulation.

(U) Doppler Effect—The phenomenon evidenced by the change in the observed frequency of a wave caused by a time rate of change in the effective length of the path of travel between the source and the point of observation.

(U) Doppler Radar—Any form of radar which detects radial motion of a distant object relative to a radar apparatus by means of the Doppler Effect.

(C) Double Moding—Frequency jumping (changing abruptly from one frequency to another at irregular intervals.

(U) Ducting—Trapping and refraction of radiated electromagnetic energy caused by abnormal change of the refractive index with altitude. (See “Anomalous Propagation (AP).”)

**CONFIDENTIAL**

(C) Duffer—A unit assigned D/F duties.

(U) Duty Cycle—The ratio of pulse length to pulse interval. It is usually expressed as a percentage.

**E**

(U) Early Warning (EW)—The radar technique and equipment for long range detection of enemy aircraft and/or surface vessels.

(U) Echo—The signal reflected by a distant target to a radar set. Also the deflection or indication on the screen of a cathode-ray tube representing a target.

(U) Electric Field Intensity—Property of a radio wave measured in terms of the e.m.f. it produces, e.g., if 20 microvolts are generated between the ends of a conductor 1 meter long when the radio wave cuts across it, the field intensity is said to be 20 microvolts per meter.

(U) Electrolyte—A water solution of a substance which is capable of conducting electricity. An electrolyte may be in the form of either a liquid or a paste.

(C) Electromagnetic Emission Control (EMCOM)—See "Emission Control (EMCON)."

(U) Electromagnetic Energy—Forms of radiant energy found, for example, in radio waves, heat waves, light waves, X-rays, gamma rays, and cosmic rays.

(U) Electromagnetic Field—The portion of space in which the energy radiated in a radio wave can be detected. The field of energy always consists of a moving magnetic field and a moving electric field that act at right angles to each other. The direction in which the field moves is perpendicular to the line of action of both components of the field.

(C) Electronic Camouflage—The use of electronic means, or exploitation of electronic characteristics, to reduce, submerge, or eliminate the radio echoing properties of a target.

(C) Electronic Counter-Countermeasures (ECCM)—That division of EW involving actions taken to ensure friendly effective use of the electromagnetic spectrum despite the enemy's use of EW.

(C) Electronic Countermeasures (ECM)—That division of EW involving actions taken to prevent or reduce an enemy's effective use of the electromagnetic spectrum. Electronic countermeasures include: (1) jamming and (2) deception.

(C) Electronic Countermeasures Target List—A compilation of enemy electromagnetically dependent surveillance, weapons control and communications devices which should be temporarily nullified by ECM actions in support of a commander's battle plans.

(C) Electronic Deception—The deliberate radiation, re-radiation, alteration, absorption, or reflection of electromagnetic energy in a manner intended to mislead an enemy in his interpretation or use of information received by his electronic systems. There are two categories of electronic deception:

Manipulative—The alteration or simulation of friendly electromagnetic radiations to accomplish deception.

Imitative—The introduction of radiations into enemy channels which imitate his own emissions.

(U) Electronic Emission Security—Those measures taken to protect all transmissions from interception and electronic analysis.

(C) Electronic Intelligence—That technical and intelligence information derived from foreign electromagnetic non-communications transmissions by other than the intended recipients. (Also called ELINT.)

(C) Electronic Jamming—The deliberate radiation, re-radiation, or reflection of electromagnetic energy with the object of impairing the use of electronic devices, equipment, or systems being used by an enemy.

(U) Electronic Search—An investigation of the electromagnetic spectrum, or portions thereof, in order to determine the existence, sources, and pertinent characteristics of electromagnetic radiations.

(U) Electronic Security—The protection resulting from all measures designed to deny to unauthorized persons information of value which might be derived from their interception and study of non-communications electromagnetic radiations, e.g., radar.

(U) Electronic Warfare (EW)—The military action involving the use of electromagnetic energy to determine, exploit, reduce or prevent hostile use of the electromagnetic spectrum and action which retains friendly use of the electromagnetic spectrum.

(C) Electronic Warfare Support Measures (ESM)—That division of EW involving actions taken to search for, intercept, locate, record, and analyze radiated electromagnetic energy for the purpose of exploiting such radiations in support of military operations. Thus, ESM provides a source of EW information required to conduct electronic countermeasures (ECM), electronic counter-countermeasures (ECCM), threat detection, warning, avoidance, target acquisition, and homing.

(C) Emergency—Report of an intercepted emission that is considered to be from a dangerously close source.

(C) Emission Control (EMCON)—Implementation of the Emission Policy formulated by a commander to obtain the maximum tactical advantage in a particular situation. This is achieved by the management of the emissions of friendly units in accordance with operation orders or EMCON Plans which may authorize, restrict, or prohibit the operation of equipment by type, or unit, or both. Emission Control covers all emissions in the radio, sonic, and infrared spectrums.

(U) EMO (Electronic Material Officer)—That officer assigned the billet responsible to the command in all matters pertaining to upkeep, installation and maintenance of all electronic equipments aboard ship.

(U) End-fire Array—A directional antenna system designed to give the maximum radiation in a single direction laying in the plane of the array, e.g., Yagi array.

(C) EOB (Electronic Order of Battle)—A listing of emitters of the operating theater. Used to correlate intercepted emissions with those previously documented or to identify those not previously recorded. May be a “Friendly EOB”, an “Enemy EOB” or a combination of both.

(C) Evasion—In Electronics Warfare, tactics that are designed to take advantage of the limitations of radar to prevent or postpone radar detection, or to avoid revealing the true position of an attacking force.

(C) EWCS—Electronic Warfare Control Ship.

(C) EWO (Electronic Warfare Officer)—That officer assigned the billet and responsible to the command in all matters pertaining to electronic warfare.

## F

(C) FAAWC—Force Anti-Air Warfare Coordinator.

(U) Fading—A variation in strength of received signals due to variation with time in the conditions of propagation.

(U) Feedback—A transfer of energy from the output circuit of a device back to its input.

(C) FEWC—Force Electronic Warfare Coordinator.

(C) FEWO—Force Electronic Warfare Officer.

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(U) Filter, Band Pass—A filter so designed that it tends to pass a band of frequencies and attenuates all frequencies outside of the band.

(U) Filter, High Pass—A filter so designed that it tends to pass all frequencies above a certain frequency and attenuates all frequencies below the frequency.

(U) Filter, Low Pass—A filter so designed that it tends to pass all frequencies below a certain value and attenuates all frequencies above a certain value.

(U) Fire Control Radar—A radar for the continuous tracking of a selected target to provide accurate positional data for the purpose of directing weapons.

(C) Flares—In Electronic Warfare, an infrared decoy device used to deceive infrared homing weapons.

(C) Ford—Assume intercept guard/watch on band or guard indicated.

(U) Forward Scatter—The reflected radiation of electromagnetic energy away from the emitting source.

(C) Freak—Frequency in MHz.

(U) Frequency Agility—The ability of a radar to change frequency within its operating band on a pulse-to-pulse basis.

(U) Frequency Converter—A circuit or device which changes the frequency of an alternating current. (See "Mixer.")

(U) Frequency Deviation—In frequency modulation, the number of cycles by which the modulated carrier frequency differs from the resting frequency.

(U) Frequency Evasion—An electronic counter-countermeasure which consists of changing frequency to avoid jamming.

(U) Frequency Modulation—A system of modulation in which the deviation in frequency above and below the mean, or carrier frequency, is at each instant proportional to the amplitude of the signal being transmitted, and the number of complete deviations per second above and below the mean, or carrier frequency, is equal to the frequency of the signal being transmitted.

(U) Frequency, Radio (RF)—The nomenclature of radio frequency is as follows:

<u>Frequency Subdivision</u>	<u>Frequency Range</u>	<u>Metric Subdivision</u>
Very low frequency (VLF)	3-30 kHz	Myriametric waves
Low frequency (LF)	30-300 kHz	Kilometric waves
Medium frequency (MF)	300-3000 kHz	Hectometric waves
High frequency (HF)	3-30 MHz	Decametric waves
Very high frequency (VHF)	30-300 MHz	Metric waves
Ultra high frequency (UHF)	300-3000 MHz	Decimetric waves
Super high frequency (SHF)	3-30 GHz	Centrimetric waves
Extremely high frequency (EHF)	30-300 GHz	Millimetric waves
	300-3000 GHz or 3 THz	Decimillimetric waves

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(U) Frequency Scanning—A type of system in which the output or input frequency is made to vary at a mechanical rate over a desired frequency band. (1) Conducting an electronic search over a frequency band by means of an automatically-tuned receiver, the tuning rate being fixed or variable, and mechanical (low speed) or electronic (high speed). (2) A technique used to enable a radar to transmit on a clear frequency by searching a frequency band and then turning the system to a clear portion of that band.

(U) Frequency Shift Keying (FSK)—A form of frequency modulation where the carrier is shifted between two frequencies in accordance with a predetermined tone. In multiple FSK the carrier is shifted to more than two frequencies. FSK is used principally with teletype communications.

(U) Fundamental—The lowest frequency component of a complex vibration, tone or electrical signal. It is sometimes referred to as the fundamental harmonic or first harmonic.

## G

(C) Gadget—Radar or emitter equipment (type of equipment may be indicated by a letter as listed in operations orders). May be followed by a color to indicate state of jamming. Colors will be used as follows:

GREEN—Clear of jamming

AMBER—Sector partially jammed

WHITE—Noise jamming

RED—Sector completely jammed

BLUE—Completely jammed

BLACK—CW jamming

PINK—Partially jammed through 360 degrees

(U) Gain—The ratio of the output power, voltage, or current to the input power, voltage, or current.

(U) Ghost Signals—Signals appearing on the screen of the radar indicator, the cause of which cannot be readily determined.

(U) Grass—Random signals characteristic of atmospheric disturbances and of noise voltages internally generated in a radar receiver. So named because of their appearance on an A-scan display.

(C) Gridiron—A brevity codeword meaning “Jamming signal appears on my PPI scope or jamming prevents determination of range and bearing \_\_\_\_\_ percent of the time.”

(U) Ground Clutter—An area of heavy returns extending for a few miles in all directions from a radar site, caused by radar reflections from the Earth's surface. The pattern on a PPI scope is relatively circular and constant.

(U) Ground Controlled Approach (GCA) System—A ground radar system providing information by which aircraft approaches may be directed from the ground by radio telephony.

(U) Ground Controlled Interception (GCI)—A system employing radar techniques which will permit ground control of friendly aircraft or guided missiles for the purpose of effecting physical interception.

(U) Ground/Earth—The term applied to any conductor common to a number of circuits and which serves to maintain a constant potential, or to provide a bond of very small impedance between the points of connection to it. In many cases, the EARTH itself is used as the conductor.

(U) Ground/Earth/Return—(1) In wire/line communications, the circuit arrangement whereby one line conductor is replaced by the Earth plates and the soil or waters between them. (2) In radar. Ground/Sea/Return—The signal reflected from the surface of the Earth/sea.

(U) Ground Wave—In propagation, that portion of the transmitted radio wave that travels near the surface of the Earth.

**CONFIDENTIAL**

(C) Guarded Frequency—In Electronic Warfare, an enemy frequency used as a source of intelligence.

(C) Gulls—A line rigged with foil streamers or light corner reflectors attached between a balloon and a sea anchor. Used to give false target information. Relatively ineffective when used alone.

**H**

(U) Harmonic—An integral multiple of a fundamental frequency.

(U) Heading (Direction)—The direction in which a ship, aircraft, or other mobile object is pointed with reference to a true, magnetic, compass, or grid north.

(U) Heaviside Layers—Layers of ionized gas, believed to exist in the region between 50 and 400 miles above the surface of the Earth, which bend radio waves back to Earth under certain conditions. Also called the Kennelly-Heaviside layer.

(U) Helical Scan—The scanning motion in which a point on the RF beam describes a distorted helix. The antenna rotates in azimuth while the elevation angle changes from horizontal to vertical.

(U) Heterodyne Reception—Reception by combining received radio frequency with locally generated oscillations. Beat frequency may be audible or may be IF which is further amplified and demodulated. (See "Superheterodyne.")

(C) Home-on-Jam (HOJ)—An adaptation of active or semi-active radar guidance systems to give them a homing guidance system capability when their normal radar guidance capability is disrupted by jamming.

(U) Homing—A process whereby a mobile station is directed (or directs itself) towards a source of radio energy, whether primary or reflected.

(U) Homing Station (Homer)—A radio aid to navigation incorporating DF facilities.

(C) Hooter—Jammer.

(U) Horizontal Polarization—Electric field (E vector) parallel to the horizon. An antenna in which the dipoles are horizontal is horizontally polarized.

(U) Horn Radiator—An antenna shaped like a horn—normally used with microwave transmission and reception.

(U) Hyperbolic Navigation System—Any of a number of radio navigational aids such as loran, Gee, and Decca, which employ lines of position on the Earth's surface that appear as the small end of a hyperbola.

**I**

(U) Identification—The indication by any act or means of your own friendly character, or of an individual among several.

(U) Identification, Friend or Foe—Personal Identifier (IFF-PI)—The discrete IFF code assigned to a particular aircraft, ship, or other vehicle for identification by electronic means.

(U) Image Frequency—An undesired signal capable of beating with the local oscillator signal of a superheterodyne receiver which produces a difference frequency within the bandwidth of the IF channel.

(C) Imitative Communication Deception—The transmission of messages in the enemy's radio communication channels by our operators with the intention of deceiving the enemy.

(C) Imitative Deception—Introducing radiations into enemy channels which imitate his own emissions.

(U) Intensity Modulation—In a cathode-ray tube, causing the intensity of the light generated to vary in accordance with the modulating signal.

(C) Intercept Guard—Frequency band or portion of frequency spectrum to be searched by designated unit when conducting electronic intercept search.

(U) Intercept Receiver—A receiver designed to detect and provide visual and/or aural indication of electromagnetic emissions occurring within the particular portion of the electromagnetic spectrum to which it is tuned.

(U) Interference—In contrast to meaconing, intrusion and jamming, interference is usually caused by another authorized emitter on the same frequency. Interference is more common on communications circuits than on non-communication frequencies such as radar or IFF channels. Interference may be generated by on-board emitters, or in the HF spectrum by emitters thousands of miles away. Ducting may cause interference between widely separated emitters which normally experience no interference. Willful and deliberate interference is classified as jamming, and is reported as such.

(U) Intermediate Frequency (IF)—The fixed frequency to which all radio-frequency carrier waves are converted in a super-heterodyne receiver.

(U) Intermittent Pulsing—Transmission of short bursts of radiation at irregular intervals.

(U) Intermittent Scanning—One or two 360° scans of antenna beam at irregular intervals to increase difficulty of detection by intercept receiver.

(C) Intrusion—Intrusion is an attempt by the enemy to enter a friendly communication net. Intrusion attempts are usually directed against low-level communications channels. The purpose of the intrusion is to gain intelligence of immediate tactical value and to introduce confusion. Intrusions are generally attempted by linguists trained in the operations and terms used in military communication nets. The linguists masquerade as legitimate net operators and try to obtain details of flight plans of aircraft, timing and routes of surface operations, and call sign information. A completely successful intrusion effort may not be recognized as such. Intrusion is most likely on clear voice transmission links. The simple equipment required, the wide usage of English language terms in communication procedures, and the simple identification procedures all favor intrusion tactics. Intrusion attempts can usually be thwarted if all operators in a communication net insist that authentication procedures be rigidly followed. Successful intrusion into covered voice or teletype systems is much more difficult, but cannot be ruled out entirely. These systems are much more likely to

be subjected to jamming or intentional interference. In using simple codes it must be remembered that they may be saturated in less than a 24-hour period. Under these conditions the enemy can produce a reasonable facsimile of the codes being used on a particular day.

(U) Isotropic Radiator—A radiator which sends out energy equally in all directions.

## J

(U) Jamming—Intentional interference with normal operation of radio communication or radar equipment.

(C) Jamming, Self-Screening—Jamming conducted by a force for the purpose of screening itself from enemy electronic detection is termed “self-screening” jamming. This technique can be employed by either aircraft or ships. Self-screening jamming is the most efficient method of radar masking when ships are involved because supporting units are not required.

(C) Jamming, Standoff—The term standoff jamming (SOJ) refers to jamming that is used to support or screen units (ships or aircraft) that are potential targets of enemy electronic detection devices when the jamming platform (ship, aircraft, or expendable unit) is not the immediate target. Standoff jamming is sometimes referred to as off-target jamming.

Standoff jamming is used primarily to support air operations. An airborne jamming platform supports, at a standoff distance, attack/reconnaissance aircraft just prior to entry into and while within the weapons/radar surveillance envelope.

(U) Jamming-to-Signal (J/S) Ratio—The ratio, at a designated point in space or in the circuits of an electronic system, of jamming power to signal power.

## L

(U) Lissajous Figures—Patterns produced on the screen of a CRT by combination of sine wave signal voltages (of various amplitude and phase relations) on horizontal and vertical deflection plates.

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(U) Lobe—Refers to the two or three dimensional polar representation used to indicate the distribution in space of antenna field strength intensities. The curve shows points of equal field strength, power, or voltage as desired.

(U) Lobe Duration—The time a signal from the main lobe of a rotating antenna is detectable. It is normally measured in seconds or parts of a second. (See "Beamwidth.")

(U) Lobe Switching—Any method (electrical or mechanical) of alternately shifting the lobe of an antenna system from one direction to another.

(U) Local Oscillator (LO)—An adjustable-frequency oscillator used in a superheterodyne receiver. The output of this oscillator is mixed with a desired RF carrier to form a signal of lower, or intermediate, frequency.

(U) Long Persistence Screen—A fluorescent screen in which the light intensity of its spots does not immediately die out after the beam has moved on. (See "Persistence.")

(C) Look-Through—A manual or automatic procedure consisting of periodic monitoring of a signal being jammed.

(U) Loop Antenna—An antenna consisting of one or more complete turns of wire, designed for directional transmission or reception.

(U) Loran—Long-range navigation. A hyperbolic navigation system permitting accurate determination of lines of position.

**M**

(U) Magnetic Field—The space in which a magnetic force exists.

(U) Magnetic Focusing—A method of focusing an electron stream by which the electrons are brought to a point through the action of a magnetic field.

(C) Manipulative Communication Deception—Regulated insertion of misleading material into our own communications channels for the purpose of presenting a false traffic picture to the enemy.

(C) Manipulative Deception—The alteration or simulation of friendly electromagnetic radiation or the re-radiation, absorption, or reflection of enemy electromagnetic radiation to accomplish deception.

(U) Maskings—The use of additional transmitters to hide a particular electromagnetic radiation as to location of source and/or purpose of the radiation.

(C) Meaconing—A system of receiving beacon signals and rebroadcasting them on the same frequency to confuse navigation. The meaconing stations cause inaccurate bearings to be obtained by aircraft or ground stations.

(U) Microwave—A subclassification of the electromagnetic spectrum. Generally covers the wavelength region from VHF to EHF (3 meters to .3 cm).

(C) MIJI—Mecaconing, Intrusion, Jamming and Interference. (See individual listing for definitions.)

(U) Minimum Discernible Signal (MDS)—The lower limit of useful signal input to a radar receiver, as determined by the signal-to-noise ratio at the output. (See "Radar Sensitivity.")

(U) Minimum Jamming Range (Cross-Over Point)—See "Burn Through Range."

(U) Modulation—The process in which the amplitude, frequency, or phase of a carrier wave is varied with time in accordance with the wave form of superimposed intelligence.

(U) Moving Target Indicator (MTI)—A radar presentation which shows only targets which are in motion. Signals from stationary targets are subtracted out of the return signal by the output of a suitable memory circuit.

(C) Multipurpose Jammer (MPJ)—An electronic equipment capable of (1) jamming multiple frequencies throughout a very broad band of frequencies simultaneously, or (2) combining two or more jamming roles, e.g., barrage plus reception, etc.

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(C) Music—Electronic Jamming (Hostile, Friendly, or Unknown).

(C) Mutual Screening—In Electronic Warfare the protection of a unit not having a jamming capability by a unit which does have a jamming capability.

## N

(C) Negative Grid—A brevity codeword transmitted to Duffers to cancel the requirement to report position along with contact reports.

(C) Negative Report—A brevity codeword transmitted to control when the racket to which a Duffer has been assigned is not detected.

(C) Negative Trout—A brevity codeword transmitted to control when the racket to which a Duffer has been assigned is detected but a bearing cannot be obtained.

(C) Noise Jamming—Electronic jamming in which the carrier wave is modulated by noise, or in which noise at the desired output frequencies is amplified and radiated without a carrier.

## O

(U) Omnidirectional—The term applied to antennas which receive or transmit equally in any angle of azimuth.

(U) OTC—Officer Tactical Command.

## P

(U) Palmer Scan—A complex scan consisting of a combination of conical and any other scan.

(U) Panoramic Indicator—A special oscilloscope used with a search receiver to assist the ESM/ECM operator in interpreting the signals that are detected.

(U) Parabolic Antenna—An antenna provided with a reflector having the characteristic that radio frequency waves emitted from a focal point will be reflected into space along parallel paths thus creating a narrow beam.

(U) Parabolic Reflector—A metallic sheet formed so that its cross section is in the shape of a cylindrical parabola. The antenna elements are placed along the line that runs through the focal point of the parabola, parallel to the leading edge of the reflecting sheet. (See "Paraboloid.")

(U) Paraboloid—A reflecting surface formed by rotating a parabola about its axis of symmetry. A paraboloidal reflector or dish.

(U) Parasitic Antenna—An antenna that is excited by radiation from other antennas rather than by electrical connection with them.

(U) Parasitic Oscillations—Oscillations which occur at other than the desired frequency in oscillators, or random oscillations in audio and radio frequency circuits. These oscillations are always undesirable.

(U) Parasitic Reflector—A parasitic antenna so placed that the radiation from the driven antenna is reduced in one direction and reinforced in the opposite direction. (See also, "Director" and "Reflector.")

(U) Passive Detection—In Electronic Warfare, the process of detecting an electromagnetic emitter by using the energy emitted.

(U) Persistence—The measure of the length of time during which phosphorescent light is emitted from the screen of a cathode-ray tube.

(U) Phase Angle—The time difference, expressed in electrical degrees, between the occurrence of the positive peaks of two sine waves of the same frequency.

(U) Phase Detector—A circuit which detects both the magnitude and the sign of the phase angle between two sine wave voltages or currents.

(U) Phase Distortion—A condition that exists in an amplifier when the relative phases of the various frequency components in a complex input voltage are not preserved in the output voltage.

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(U) Polarization—The direction of the electrical field component of radiated energy.

(U) Polarization Diversity—The use or availability of various polarizations such as horizontal, vertical, cross, circular or elliptical either simultaneously or singly.

(U) Pulse—A variation in the value of an electrical quantity as a function of time such that the value departs from a given datum for a time interval and then returns to this datum for a much longer time interval.

(U) Pulse, RF—A train of radio frequency oscillations whose envelope has the form of a pulse.

(U) Pulse Analyzer—An equipment used for analyzing pulses in order to determine their time, amplitude, duration, shape, and other characteristics.

(U) Pulse Length/Width/Duration—The nominal duration of a standard pulse which is the time interval between the half amplitude points on the rise and decay points of the curve. For pulses of other shapes, the points on the curve must be stated.

(U) Pulse Repetition Frequency/Rate (PRF/PRR)—The number of pulses per second.

(U) Pulse Rise Time—The interval required for the instantaneous amplitude of a pulse to rise from 10% to 90% of its peak value.

(U) Pulse Shape—The figure produced by the outline of a pulse as viewed on a cathode-ray tube.

**R**

(C) Racket—An intercepted electronic emission which is unidentified but assumed to be enemy and which has been assigned a serial number.

(C) Racket Ceased—Announcement that the intercepted signal source has ceased or paused in emitting.

(C) Racket Number—Number assigned to an intercept emission to be used as a reference to the emission in the future.

(C) Racket Report—Report made by a Duffer to Control and containing best bearings and other pertinent data.

(U) Radar—Radio detection and ranging equipment that determines the distance and usually the direction of objects by transmission and return of electromagnetic energy.

(C) Radar Countermeasures (RADCM)—The means employed to obtain information about enemy forces from his use of radar, and to prevent him from obtaining any accurate or useful information about our forces through the use of his radar. Countermeasure methods are of four types; interception, jamming, deception, and evasion.

(U) Radar Nautical Mile—The time interval, approximately 12.367 microseconds, required for radio energy to travel one nautical mile and return, or a total of two nautical miles.

(U) Radar, Navigational—Radar equipment used to assist in navigation and pilotage.

(U) Radiation Pattern—A two or three dimensional plot showing the gain of an antenna in all directions.

(U) Radar Height Finder—A radar intended to display the height of a target by measurement of its slant range and elevation angle.

(U) Radar Horizon—The locus of points at which the rays from a radar antenna become tangential to the Earth's surface. On the open sea this locus is horizontal, but on land it varies according to the topographical features of the terrain.

(U) Radar Sensitivity—The degree of response of a radar receiver to signals on its frequency. A measure of the ability of the receiver to amplify and make usable very weak signals.

(U) Radiation (in radio communication)—(1) The outward flow of radio frequency energy from a source. (2) Energy flowing in a medium in the form of radio waves.

(U) Radiation Characteristics—In Electronic Warfare, features of a radiated signal such as frequency, pulse width, pulse repetition frequency, beamwidth and polarization.

(U) Railings—Radar pulse jamming at high recurrences rates (50 to 150 kHz). It results in an image on a radar indicator resembling fence railings.

(C) Random Drop—In Electronic Warfare, non-uniformity of intervals between drops in window dispensing.

(C) Random Saw—A jamming method similar to saw modulation except that frequency of the random saw varies in discontinuous jumps as compared with the steady frequency change of saw.

(U) Random Keying—A communication method in which the carrier is modulated by a series of pulses which are negative or positive, depending on the type of equipment being used. The rate at which these pulses occur is variable to simulate keying speeds from a few words per minute to about 30 to 40 words per minute.

(U) Raster Scan—A complex scan consisting of horizontal sector scans which change in elevations. Each change in elevation is called a bar. Each bar may be composed of one or more lines.

(U) Reflector—A metallic object placed behind a radiating antenna to prevent radiation in an undesired direction and to reinforce radiation in a desired direction.

(U) Refraction—The bending, or change in the direction, of a radio wave in passing into the ionosphere. Refraction also at times occurs in the troposphere.

(C) Rent Report—The report of characteristics of the intercepted signal, given in the following sequence: (1) frequency, (2) pulse repetition rate, (3) pulse width, and (4) antenna rotation rate in SPR. These parameters are separated by the word “tack”. Any unknown portion of the sequence must be represented by the word “unknown”.

(U) Repeater Jammer—A receiver-transmitter device which amplifies, multiplies, and retransmits the signals received, for purposes of deception or jamming.

(U) Repetition Rate (PRR)—The number of pulses sent out by the transmitter per second.

(U) Resolution—The ability of a system to distinguish between two adjacent objects and display them as separate images.

(C) Revert—Resume search on the previous intercept guard (watch).

(C) ROB—(Radar Order of Battle) a listing of radars of friendly forces within the operating theater. Used to assist in rapid identification of intercepted emissions.

(C) Rope—An element of chaff consisting of a long roll of metallic foil or wire which is designed for broad-band, low-frequency response. Usually, rope is about 400 feet long and effective for jamming from 50 to 350 MHz.

## S

(C) Saw—A jamming method in which the carrier is modulated by an audio-frequency voltage wave from which varies in frequency. At any particular time the frequency varies over a fixed range; for example, from 0 to 500 hertz or from 500 to 1,500 hertz with the variation cycle generally taking place about once or twice per second, thus producing a distinctive warble.

(C) Scrub—A brevity codeword meaning “Erase racket specified from all plots. Duffers automatically revert to last guard assigned without further order.”

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(C) Searcher—Unit having intercept equipment without DF capability. All references to Duffers are applicable to searches within their capabilities.

(U) Search Receiver—A receiver which can be tuned over a relatively wide frequency range in order to detect and measure electromagnetic signals.

(U) Sector Scan—A type of scanning in which the antenna pattern is made to scan back and forth through a sector of a circle.

(U) Selectivity—That characteristic of a radio receiver which determines its ability to discriminate between a desired signal and coexistent undesired signals at other frequencies.

(C) Self-Screening—In Electronic Warfare, concealing a target by means of radiating jamming energy (from self-contained jammers) at sufficient power levels to make the target radar echo indiscernible from the jamming.

(C) Self-Screening Range—In Electronic Warfare, that range at which a target has a certain specified probability of avoiding detection by the use of its jamming mask.

(U) Sensitivity—That characteristic of a radio receiver which determines the minimum strength of signal input capable of producing a desired strength of signal output.

(U) Sensor—A technical means of extending man's natural senses; an equipment which detects and indicates terrain configuration, the presence of military targets, and other natural and man-made objects and activities by means of energy emitted or reflected by such targets or objects. The energy may be nuclear, electromagnetic, including the visible and invisible portions of the spectrum, chemical, biological, thermal, or mechanical, including sound, blast, and Earth vibration.

(U) Servo System—A complete electromechanical system for amplifying and transmitting.

(U) Side Lobe—A portion of the beam from a radar antenna, other than the main lobe, and usually much smaller.

(C) Side Lobe Jamming—Jamming through a side lobe of the receiving antenna in an attempt to obliterate the desired signal received through the main lobe of the receiving antenna or to confuse the operator as to the true azimuth of the jammer by the injection of multiple strobes.

(U) Signal Analysis—The study of complex electromagnetic radiations to determine their technical characteristics and their tactical or strategic use. (See "Analysis.")

(C) Signal Intelligence (SIGINT)—A generic term which includes both "Communication Intelligence (COMINT)" and "Electronic Intelligence (ELINT)."

(U) Signal-to-Noise Ratio—The ratio, at a selected point in the circuit, of signal power to total circuit-noise power.

(U) Skip Distance—The minimum distance between the transmitting station and the point of return to the Earth of the transmitted wave reflected from the ionosphere.

(U) Skip Zone—The space or region wherein a transmission is not received between the farthest point reached by the ground wave and the nearest point at which the refracted sky waves come back to Earth.

(U) Sky Wave—That portion of a radiated wave which travels in space and is returned to Earth by refraction in the ionosphere.

(C) Slope—The pulse repetition rate in pulses per second.

(C) Spike—A brevity codeword meaning "bearing of a single jamming transmission is \_\_\_\_\_ degrees T." (Spike \_\_\_\_\_°T)

(C) Spot—A brevity codeword used in conjunction with prearranged code numbers designating spot frequencies to direct stations on the intercept frequency with the use of UP and DOWN \_\_\_\_\_, MHz. (Spot \_\_\_\_\_ MHz)

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(C) Spot Jamming—Jamming on a particular frequency being used by enemy electronics.

(U) Spiral Scan—The scan used for search by gun-aiming radars. It is similar to conical scan, but the vertex angle of the cone is varied slowly.

(U) Square Wave Modulation—A jamming method in which the carrier is a square wave modulated at a slow rate (2-10 Hz). Superimposed on the square wave is frequency modulation (FM) in the 400 to 1000 hertz range and amplitude modulation (AM) up to 100% of the FM products. This technique is effective against voice transmissions and achieves very high effectivity when the jamming carrier is tuned to within a few hundred hertz of the victim carrier. Accurate tuning of the jamming carrier reduces jamming power requirements to achieve effectiveness since the jamming carrier and modulation products beat directly with the victim carrier and create modulation products within the voice fundamental frequency range (400-1000 hertz).

(U) Stagger Tuning—The method of aligning the IF stages of a superheterodyne receiver in order to produce wide bandwidth. This is accomplished by peaking alternate IF transformers at slightly different frequencies.

(U) Standing Wave—The resulting wave from the electric variation in a circuit caused by periodic exchange of energy between current and voltage forms without transmission of energy. In a radar set, a wave passing down the transmission line and striking an obstruction or meeting a mismatch is reflected and returns up the line. The reflected wave combines with the initial radiant wave to form the standing wave. Such standing waves result in increased losses, and should be kept to a minimum.

(U) Superheterodyne—A receiver in which the incoming signal is mixed with a locally generated signal to produce an intermediate frequency which is then amplified and detected to produce the audio frequency.

(U) Surveillance Radar/Warning Search Radar—A radar with the normal functions of:  
(1) Maintaining continuous watch or search in

its area of employment. (2) Supplying information on all targets with sufficient accuracy to permit acquisition by more accurate radars or by weapon systems in sufficient time to allow effective engagements of the targets.

(U) Sweep—The pattern of light or marking on the face of a cathode-ray tube caused by the predetermined deflection and modulation of the electron beam.

(C) Sweep Jammer—A transmitter that emits a jamming signal consisting of a carrier wave (unmodulated or modulated), the frequency of which is continuously varied within a given bandwidth.

(C) Sweep Jamming—A narrow band of jamming that is swept back and forth over a relatively wide operating band of frequencies.

(C) Switch—A brevity codeword telling the designated ship or ships to cease general searching and shift to the frequency of the specified racket, whether or not the racket is within the duffer's intercept search responsibility.

## T

(U) Tank Circuit—A tuned circuit used in connection with a vacuum tube. It is so called because of its ability to store energy temporarily.

(U) Thermal Agitation—The term applied to noise caused by random motion of free electrons in a conductor, which produces minute voltages across the terminals.

(U) Time Base—The voltage generated by the sweep circuit or circuits in the CRT indicator. The waveshapes of the voltage generated is such as to cause to be described on the screen of the cathode-ray tube a trace which is either linear with respect to time, or, if nonlinear is still at a known timing rate.

(U) Time Sharing—A division of search time between radar and intercept search.

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(U) Tone Modulation—A type of transmission obtained by causing the radio frequency carrier amplitude to vary at a fixed audio frequency.

(C) Track-While-Scan—The process whereby a radar system produces tracking data on a target or targets while simultaneously being used for surveillance or control.

(U) Trapping—A type of radio wave propagation in which the radiated rays are bent excessively by refraction in the lower layers of the atmosphere. This bending creates an effect much as if a duct or waveguide has been formed in the atmosphere. The duct, which may be either elevated or ground based, is able to guide part of the radiated energy over distances far beyond the normal radar range.

(C) Trout—A brevity codeword meaning "Take a DF bearing on the transmission indicated."

(C) Trout Racket—An order for indicated Duffers to take a bearing on the indicated racket. (Trout Racket \_\_\_\_\_ .)

(U) Trigger Pulse—A pulse that starts a cycle of operations.

(U) Troposphere—That part of the Earth's atmosphere below the stratosphere in which temperature generally decreases with altitude, clouds form and convection is active. This region causes a refraction and trapping.

(U) TWT (Traveling Wave Tube)—A high gain, broad band voltage amplifier for the microwave region which can be used as an oscillator. It is capable of covering a wide spectrum, such as the entire "S" or "X" band. It functions particularly well in repeater type jammers which must be responsive to signals emanating from radars at any point within a given band.

**V**

(U) Vertical Polarization—The electric field (E vector) perpendicular to the horizon. An antenna in which the dipoles are vertical is vertically polarized.

(U) Video—(1) A term used to include a wide band of frequencies extending from approximately 60 or 100 cycles per second out to several megacycles per second. (2) The output voltage of a detector, or the signal voltage applied to a cathode-ray indicator.

**W**

(C) Watch—A brevity codeword that is an order to a Duffer (not necessarily the one originally intercepting a signal) to continue search in the assigned intercept guard but to check bearing and characteristics of designated racket when passing its frequency and report any significant changes.

(U) Wave Trap—A device used to exclude unwanted radio signals or interference from a receiver. Wave traps are usually tunable to enable selection of the interfering signal which is to be rejected or to determine the true frequency of a received signal.

(C) Window—Metal foil strips dispersed by rocket, shell, or aircraft for the purpose of jamming by creation of multiple false targets.

**X**

(U) X Axis—The horizontal axis of a CRT, as distinguished from the vertical, or Y axis, and the intensity modulation, or Z axis. It is usually an adjustable linear time base of the tube.

**Y**

(U) Y Axis—The vertical axis of a CRT used to describe deflection of the electron beam in the vertical direction in cathode-ray oscilloscope tubes, as opposed to deflection on the X, or horizontal axis.

(U) Yagi Antenna—A type of directional antenna array usually consisting of one driven 1/2-wavelength dipole section, one parasitically excited reflector and one or more parasitically excited directors.

(U) Yoke—A group of coils placed around the neck of an electromagnetic cathode-ray tube for the purpose of deflection.

**Z**

(U) Z axis—An attempt to show a third dimension on the two-dimensional screen surface of a cathode-ray tube by applying the

third variable to the control grid of the tube; this is variable showing up as a change in intensity.

(U) Zero Beat—The condition in which a given circuit is oscillating at the exact frequency of an external radio wave so that no beat tone is heard when the combined waves are demodulated.

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## INDEX

## A

Active duty advancement requirements, 4  
 Advancement system, enlisted, 3-9  
     how to prepare for advancement, 6-9  
     who will be advanced, 3-6  
 Analysis and identification, 185-200  
     analysis of a signal, 195-200  
     common evaluation criteria, 192-194  
     identification, 200  
     modulation, 185-188  
     signal recognition, 194  
     types of scan, 188-192  
 AN/SLA-10, 119-122  
 AN/SLA-10A, 122-127  
 Antennas and control unit, ESM, 109-118  
     AS-571, 109  
     AS-616A, 110  
     AS-899 series, 110-114  
     AS-1096, 114  
     AS-1173, AS-1174, and AS-1175, 115  
     AS-2918/S, 116  
     control unit, 116-118  
     NT-66131, 116  
     NT-66132, 116  
 AN/UNQ-7 tape recorder procedures, 258-261  
 AN/UNQ-7D, 135-140  
     accessories, 136  
     cabinet assembly, 135  
     operating controls and indicators, 136  
     operation, 136-140  
     sound control, 136  
     tape transport, 135  
 AN/UNQ-7E, 141-145  
     accessories, 142  
     auxiliary switches, 145  
     cabinet assembly, 141  
     controls and indicators, 141  
     functional operation, 142

AN/UNQ-7E—Continued  
     Remote Control Unit (RCU), 142  
     tape transports, 142

## B

Bibliography for Advancement Study, 7  
 Binder color code, security, 180  
 Blanker-video mixer group, 119-127  
 Blankers and preamplifiers, 119-134  
     antenna selection, 133  
     blanker-video mixer group, 119-127  
     preamplifiers, 127-133

## C

Call signs, 211-218  
     acknowledgment of messages, 215  
     acknowledgment of signals, 217  
     authentication, 213  
     break-in procedure, 216  
     cancelling messages, 214  
     cancelling tactical messages, 217  
     checking the group count, 214  
     communications security, 217  
     correction during transmission, 214  
     “do not answer” transmission, 215  
     emergency silence, 215  
     execution of non-executive method  
         messages, 217  
     executive method, 216  
     preliminary calls, 213  
     radio checks, signal strength and  
         readability, 212  
     “read back,” 215  
     receipt, 215  
     relay, 214  
     repetitions, 214

**UNCLASSIFIED**

- Call signs—Continued
    - sequence of call signs and/or address groups, 212
    - transmitting a message, 214
    - verification, 215
  - Cameras, 145
  - CIC, mission and function of, 11-22
    - CIC doctrine, 13
    - CIC organization in NTDS, 17-22
    - control and assist functions, 12
    - displaying information, 11
    - disseminating information, 12
    - evaluating information, 12
    - gathering information, 11
    - operations department organization, 13-17
    - processing information, 11
  - Circuit logs, 218
  - Collecting ELINT data, 261
  - Communications, 201-224
    - call signs, 211-218
    - circuit logs, 218
    - EW reporting, 219-224
    - method of synchronizing time, 219
    - operating rules, 211
    - operational brevity code, 218
    - radio nets (circuits), 209-211
    - types of external communications, 206-209
    - types of internal communications, 201-206
  - Corrective maintenance, 269
  - Countermeasures set, ECM systems, 147-176
    - control-indicator (unit 3), 176
    - overall operation, 149
    - RF amplifier (unit 1), 149-165
    - RF amplifier (unit 2), 165-175
- D**
- Deception ECM (DECM), 43-45
- E**
- ECM systems, 147-178
    - antenna group, 176-178
    - countermeasures set, 147-176
  - Electronic warfare support measures (ESM), 31-39
    - equipment, 35-39
    - intercept guards, 35
    - phases, 33-35
  - Electronics Warfare Technician, 1-10
    - enlisted advancement system, 3-9
    - enlisted rating structure, 1
    - EW rating, 1-3
    - sources of information, 9
      - publications you should know, 10
      - training films, 10
  - ELINT collection and reporting procedures, 250-263
    - AN/UNQ-7 tape recorder procedures, 258-261
    - collecting ELINT data, 261
    - collection, 251
    - Operator's Intercept Log, 253-258
    - photographic procedures, 261
    - planning and preparation, 251-253
    - processing, 251
    - reports, 261
    - requirements, 250
  - EMCON, 237-249
    - bills, 239, 245
    - breaking, 238
    - control of, 238
    - control ship, 238
    - emission status indicators, 249
    - execution, 240
    - intermittent operation, 240
    - orders, 238
    - radar guard assignments, 241
    - standard silence policy table, 244
    - time-sharing plans, 240
    - total electronic silence, 241
    - typical EMCON instruction, 241-243
  - ESM antennas and control unit, 109-118
  - ESM systems, 49-108
    - intercept receivers, 49
    - narrowband receivers, 49-95
    - wideband receivers, 95-108
  - Evaluation criteria, radar emissions, 192-194
  - EW, basic concepts of, 23-48
    - electronic counter-countermeasures, 45-48
      - radar guardship, 48
    - electronic-countermeasures, 39-45
      - deception ECM, 43-45
      - jamming ECM (JECM), 39-43
    - objective of, 23-31
      - control, 27-31
      - policy, 24-27

EW, basic concepts of,—Continued  
 support measures, 31-39  
     ESM equipment, 35-39  
     intercept guards, 35  
     phases of ESM, 33-35  
 EW publications and instructions, 179-184  
 EW reporting, 219-224  
     coordination during naval warfare  
     operations, 219  
     EW coordination and control net  
     information, 222  
     reporting own use of ECM, 223  
     reporting the enemy's use of ECM,  
     224  
     tactical EW reporting control, 220-222  
 EW status boards, logs, and plots, 225-236  
     logs, 225-230  
     plots, 236  
     status boards, 230-235  
 External communications, 206-209  
     EW communication equipment, 207  
     messengers, 206  
     radio communications, 207  
     remote control units, 208  
     visual communications, 207

**G**

Glossary of terms, 271-291

**H**

Helical omnidirectional antennas, 115

**I**

Identification of signals, 200  
 Inactive duty advancement requirements, 5  
 Instructions, EW, 181  
 Intercept receivers, 49  
 Internal communications, 201-206  
     messengers, 202  
     multichannel systems, 203-205  
     pneumatic tubes, 203  
     ship's service telephones, 201  
     sound-powered telephone system, 205  
     target designated equipment, 203  
     teletypewriters, 202  
     television sets, 202  
     voice tubes, 201  
 Inventory of EW publications, 183

**L**

Logs, 225-230  
     ECM log, 227  
     EW exercise log, 227  
     operator's intercept log, 225  
     radiotelephone log, 228  
     training log, 228  
     watch log, 228-230

**M**

Maintenance and test equipment, 265-270  
     corrective maintenance, 269  
     test equipment, 270  
     3-M System, 265-269  
 MDCS (Maintenance Data Collection  
 Subsystem), 267-269  
 Metric system, 10  
 Modulation, 185-188

**N**

Narrowband receivers, 49-95  
     AN/WLR-1, 50-81  
     AN/WLR-8(V), 87-92  
     AN/WLR-11A, 92-95  
     CV-3292/WLR-1G, 81-87  
 NTDS in CIC organization, 17-22  
     combat systems concept in NTDS, 19  
     detection and tracking (D & T)  
     supervisor, 19  
     detection and tracking team, 19  
     electronic warfare (EW) and intercept  
     control (IC), 19  
     evaluator/ship's weapons coordinator  
     (SWC), 18  
     track supervisor (TRK SUP), 18  
     weapons control, 19

**O**

Occupational Standards, 6  
 Operating rules, communications, 211  
 Operational brevity code, 218  
 Operations department organization, 13-17  
 Operator's Intercept Log, 253-258  
 OPLANs and OPORDERS, 179

**UNCLASSIFIED****P**

Personnel Advancement Requirement (PAR)  
 Program, 7  
 Plots, 236  
 PMS (Planned Maintenance Subsystem), 266  
 Preamplifiers, 127-133  
   AMPL mode, 133  
   assembly, 133  
   blanking, 133  
   description of units, 127-130  
   detailed functional description, 130  
   DF select, 133  
   DIR mode, 133  
   general description, 127  
   indicator and dimmer circuits, 131-133  
   OMNI select, 133  
   overall functional description, 130  
   +28 VDC power supply, 131  
 Publications and instructions, EW, 179-184  
   changes and corrections, 182  
   EW publications, 180  
   instructions, 181  
   inventory, 183  
   OPLANs and OPORDERs, 179  
   tactical warfare publications, 179

**R**

Radio nets (circuits), 209-211  
   classes of CIC radio nets, 209  
   common radio circuits, 210  
   radio watches, 209  
   types of nets, 210  
 Rate training manuals, 8  
 Receivers, 49-108  
   intercept, 49  
   narrowband, 49-95  
   wideband, 95-108  
 Recording devices, EW, 135-146  
   cameras, 145  
   recorder-reproducer set, AN/UNQ-7D,  
     135-140  
   recorder-reproducer AN/UNQ-7E, 141-145

**S**

Scan, types of, 188-192  
   circular, 188  
   conical, 189  
   helical, 191  
   horizontal/vertical, 189  
   lobe switching, 189  
   monopulse, 191  
   palmer, 189  
   sector, 188  
   spiral, 189  
   V-beam, 191  
 Signal analysis, 195-200  
 Signal recognition, 194  
 Silence policy table, EMCON, 244  
 Status boards, 230-235  
   communication status board, 232  
   equipment status board, 232  
   EW control ship status boards, 230  
   EW status board, 230-232  
   friendly status board, 233  
   plotting symbols, 235  
   threat status board, 233  
 Status indicators, emission, 249  
 Synchronizing time, method of, 219

**T**

Tactical warfare publications, 179  
 Test equipment, 270  
 3-M System, 265-269  
 Time-sharing plans, 240  
 Training films, 10

**W**

Wideband receivers, 95-108  
   AM-4255, 99-102  
   AN/WLR-3, 96-99  
   SLR-12, 102-108

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# ELECTRONICS WARFARE TECHNICIAN 3 & 2

## NAVEDTRA 10127-A

Prepared by the Naval Education and Training Program Development Center, Pensacola, Florida

Your NRCC contains a set of assignments and self-scoring answer sheets (packaged separately). The Rate Training Manual, ELECTRONICS WARFARE TECHNICIAN 3&2, NAVEDTRA 10127-A, is your textbook for the NRCC. If an errata sheet comes with the NRCC, make all indicated changes or corrections. Do not change or correct the textbook or assignments in any other way.

### HOW TO COMPLETE THIS COURSE SUCCESSFULLY

Study the textbook pages given at the beginning of each assignment before trying to answer the items. Pay attention to tables and illustrations as they contain a lot of information. Making your own drawings can help you understand the subject matter. Also, read the learning objectives that precede the sets of items. The learning objectives and items are based on the subject matter or study material in the textbook. The objectives tell you what you should be able to do by studying assigned textual material and answering the items.

At this point you should be ready to answer the items in the assignment. Read each item carefully. Select the BEST ANSWER for each item, consulting your textbook when necessary. Be sure to select the BEST ANSWER from the subject matter in the textbook. You may discuss difficult points in the course with others. However, the answer you select must be your own. Use only the self-scoring answer sheet designated for your assignment. Follow the scoring directions given on the answer sheet itself and elsewhere in this course.

Your NRCC will be administered by your command or, in the case of small commands, by the Naval Education and Training Program Development Center. No matter who administers your course you can complete it successfully by earning grades that average 3.2 or

higher. If you are on active duty, the average of your grades in all assignments must be at least 3.2. If you are NOT on active duty, the average of your grades in all assignments of each creditable unit must be at least 3.2. The unit breakdown of the course, if any, is shown later under Naval Reserve Retirement Credit.

### WHEN YOUR COURSE IS ADMINISTERED BY LOCAL COMMAND

As soon as you have finished an assignment, submit the completed self-scoring answer sheet to the officer designated to administer it. He will check the accuracy of your score and discuss with you the items that you do not understand. You may wish to record your score on the assignment itself since the self-scoring answer sheet is not returned.

If you are completing this NRCC to become eligible to take the fleetwide advancement examination, follow a schedule that will enable you to complete all assignments in time. Your schedule should call for the completion of at least one assignment per month.

Although you complete the course successfully, the Naval Education and Training Program Development Center will not issue you a letter of satisfactory completion. Your command will make a note in your service record, giving you credit for your work.

### WHEN YOUR COURSE IS ADMINISTERED BY THE NAVAL EDUCATION AND TRAINING PROGRAM DEVELOPMENT CENTER

After finishing an assignment, go on to the next. Retain each completed self-scoring answer sheet until you finish all the assignments in a unit (or in the course if it is not divided into units). Using the envelopes provided,

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mail your self-scored answer sheets to the Naval Education and Training Program Development Center where the scores will be verified and recorded. Make sure all blanks at the top of each answer sheet are filled in. Unless you furnish all the information required, it will be impossible to give you credit for your work. You may wish to record your scores on the assignments since the self-scoring answer sheets are not returned.

The Naval Education and Training Program Development Center will issue a letter of satisfactory completion to certify successful completion of the course (or a creditable unit of the course). To receive a course-completion letter, follow the directions given on the course-completion form in the back of this NRCC.

Return the text and course booklét to the appropriate officer in your command for proper disposition of CONFIDENTIAL material. Directions for returning the textbook and assignments are given on the book-return form in the back of this NRCC.

**PREPARING FOR YOUR ADVANCEMENT EXAMINATION**

Your examination for advancement is based on the Manual of Navy Enlisted Manpower and Personnel Classification and Occupational Standards (NAVPERS 18068-D). The sources of questions in this examination are given in the Bibliography for Advancement Study (NAVEDTRA 10052). Since your NRCC and textbook are among the sources listed in this bibliography, be sure to study both in preparing to take your advancement examination. The standards for your rating may have changed since your course and textbook were printed, so refer to the latest editions of NAVPERS 18068-D and NAVEDTRA 10052.

**NAVAL RESERVE RETIREMENT CREDIT**

This course is evaluated at 12 Naval Reserve retirement points. These points are creditable to personnel eligible to receive them under current directives governing retirement of Naval Reserve personnel. Points will be credited upon satisfactory completion of the entire course.

**COURSE OBJECTIVE**

Upon completion of this NRCC, you will demonstrate a knowledge of the subject matter by correctly answering items on the following: background and history of the EW rate; the advancement process in the Navy; concepts of EW and where it applies to the operation of CIC; ESM and ECM systems, antennas and control-indicators; blanking and preamplifying equipment; recording devices used in EW; EW publications and instructions; analysis and identification of electromagnetic emissions; collection of ELINT and reporting procedures used; EW communications; EMCON; EW status boards, logs and plots used in a day-to-day environment; maintenance of EW equipment and the test equipment used.

While working on this nonresident career course, you may refer freely to the text. You may seek advice and instruction from others on problems arising in the course, but the solutions submitted must be the result of your own work and decisions. You are prohibited from referring to or copying the solutions of others, or giving completed solutions to anyone else taking the same course.

Naval nonresident career courses may include a variety of items -- multiple-choice, true-false, matching, etc. The items are not grouped by type; regardless of type, they are presented in the same general sequence as the textbook material upon which they are based. This presentation is designed to preserve continuity of thought, permitting step-by-step development of ideas. Some courses use many types of items, others only a few. The student can readily identify the type of each item (and the action required of him) through inspection of the samples given below.

MULTIPLE-CHOICE ITEMS

Each item contains several alternatives, one of which provides the best answer to the item. Select the best alternative and erase the appropriate box on the answer sheet.

SAMPLE

- s-1. The first person to be appointed Secretary of Defense under the National Security Act of 1947 was
1. George Marshall
  2. James Forrestal
  3. Chester Nimitz
  4. William Halsey

The erasure of a correct answer is indicated in this way on the answer sheet:

	1	2	3	4	
	T	F			
s-1		C			

TRUE-FALSE ITEMS

Determine if the statement is true or false. If any part of the statement is false the statement is to be considered false. Erase the appropriate box on the answer sheet as indicated below.

SAMPLE

- s-2. Any naval officer is authorized to correspond officially with a bureau of the Navy Department without his commanding officer's endorsement.

The erasure of a correct answer is also indicated in this way on the answer sheet:

	1	2	3	4	
	T	F			
s-2		CC			

MATCHING ITEMS

Each set of items consists of two columns, each listing words, phrases or sentences. The task is to select the item in column B which is the best match for the item in column A that is being considered. Items in column B may be used once, more than once, or not at all. Specific instructions are given with each set of items. Select the numbers identifying the answers and erase the appropriate boxes on the answer sheet.

SAMPLE

In items s-3 through s-6, match the name of the shipboard officer in column A by selecting from column B the name of the department in which the officer functions.

A. Officers

B. Departments

- |                               |                           |
|-------------------------------|---------------------------|
| s-3. Damage Control Assistant | 1. Operations Department  |
| s-4. CIC Officer              | 2. Engineering Department |
| s-5. Assistant for Disbursing | 3. Supply Department      |
| s-6. Communications Officer   |                           |

The erasure of a correct answer is indicated in this way on the answer sheet:

	1	2	3	4	
	T	F			
s-3		C			
s-4	C				
s-5			C		
s-6	C				

How To Score Your Immediate Knowledge of Results (IKOR) Answer Sheets

	1	2	3	4	
	T	F			
1		C	6		1
2	C	9		9	2
3			C		
4	CC	12			1

Total the number of incorrect erasures (those that show page numbers) for each item and place in the blank space at the end of each item.

Number of boxes erased incorrectly	0-2	3-7	8-
Your score	4.0	3.9	3.8

Now TOTAL the column(s) of incorrect erasures and find your score in the Table at the bottom of EACH answer sheet.

NOTICE: If, on erasing, a page number appears, review text (starting on that page) and erase again until "C", "CC", or "CCC" appears. For courses administered by the Center, the maximum number of points (or incorrect erasures) will be deducted from each item which does NOT have a "C", "CC", or "CCC" uncovered (i.e., 3 pts. for four choice items, 2 pts. for three choice items, and 1 pt. for T/F items).

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iv

## Assignment 1

The Electronics Warfare Technician; Missions and Functions of CIC; Basic Concepts of Electronics Warfare

Textbook Assignment: EW 3&2, NAVEDTRA 10127-A, pages 1 - 48

In this course you will demonstrate that learning has taken place by correctly answering training items. The mere physical act of indicating a choice on an answer sheet is not in itself important; it is the mental achievement, in whatever form it may take, prior to the physical act that is important and toward which course learning objectives are directed. The selection of the correct choice for a course training item indicates that you have fulfilled, at least in part, the stated objective(s).

The accomplishment of certain objectives, for example, a physical act such as drafting a memo, cannot readily be determined by means of objective type course items; however, you can demonstrate by means of answers to training items that you have acquired the requisite knowledge to perform the physical act. The accomplishment of certain other learning objectives, for example, the mental acts of comparing, recognizing, evaluating, choosing, selecting, etc., may be readily demonstrated in a course by indicating the correct answers to training items.

The comprehensive objective for this course has already been given. It states the purpose of the course in terms of what you will be able to do as you complete the course.

The detailed objectives in each assignment state what you should accomplish as you progress through the course. They may appear singly or in clusters of closely related objectives, as appropriate; they are followed by items which will enable you to indicate your accomplishment.

All objectives in this course are learning objectives and items are teaching items. They point out important things, they assist in learning, and they should enable you to do a better job for the Navy.

This self-study course is only one part of the total Navy training program; by its very nature it can take you only part of the way to a training goal. Practical experience, schools, selected reading, and the desire to accomplish are also necessary to round out a fully meaningful training program.

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Learning Objective: Determine the classification of the Electronics Warfare Technician rating in the rating structure.

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- Question 1-1 is to be judged True or False.
- 1-1. An Electronics Warfare Technician is required to be a technical specialist in his rating as well as a training specialist responsible for training personnel to carry out their assigned tasks and to qualify for advancement.
- 1-2. A general rating is one which reflects qualifications in
  1. civilian skills identified with a peacetime Navy
  2. civilian skills identified with a wartime Navy
  3. broad occupational field of related duties and functions
  4. subdivisions or specialties within broad occupational fields

- 1-3. In the naval rating structure, the Electronics Warfare Technician rating is identified as a/an
  1. general rating
  2. service rating
  3. emergency rating
  4. general service rating
- 1-4. SN SPAIN realizes that he must be concerned with military duties as he advances in rate. He therefore includes in his reading program the reference of
  1. Navy Department General Order 21
  2. Manual of Qualifications for Advancement, NAVPERS 18068
  3. Military Requirements for Petty Officer 3&2, NAVPERS 10056
  4. Bibliography for Advancement Study, NAVEDTRA 10052

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Learning Objective: Identify the requirements or qualifications for advancement for Electronic Warfare Technician.

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- 1-5. Which of the following is NOT a qualification for advancement to EW3 or EW2?
1. The completion of required military and professional training courses
  2. Recommendation by the educational services officer
  3. The passing of the servicewide examination for EW3 or EW2
  4. Demonstration of ability to perform the PAR Program
- 1-6. Completing all requirements for advancement indicates that a person
1. is eligible for advancement
  2. may be advanced, at the discretion of his commanding officer, without taking the written examination
  3. will be advanced after passing the written examination
  4. will be advanced as soon as there is an opening for his rate aboard his ship
- 1-7. Which of the following should you tell personnel assigned to you concerning advancement?
1. Eligibility for advancement amounts to actual promotion once all training requirements are met
  2. A good training record and high scores on written examinations are sufficient to ensure advancement
  3. Advancement is automatic if satisfactory training progress is made
  4. Promotion quotas, written examination scores, length of service, and performance marks all affect advancement possibilities
- 
- Learning Objective: Identify sources of information which should be used to prepare yourself for advancement.
- 
- 1-8. Which of the following publications lists the minimum requirements for advancement for each rate within a rating?
1. Personnel Advancement Requirement (PAR) Program, NAVPERS 1414/4
  2. Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards, NAVPERS 18068 (series)
  3. Bibliography for Advancement Study, NAVEDTRA 10052 (series)
  4. List of Training Manuals and Correspondence Courses, NAVEDTRA 10060 (series)
- Question 1-9 is to be judged True or False.
- 1-9. One of the purposes of the PAR program is to allow the command to evaluate the overall abilities of an individual.
- 1-10. Which of the following information is/are recorded on the Personnel Advancement Requirement (PAR), NAVPERS 1414/4 form?
1. Checkoff of task statements
  2. Checkoff for completion of training courses
  3. Checkoff for completion of Military Examination
  4. All of the above
- 1-11. In order to find out what manuals would help you prepare for advancement, you should consult
1. the Quals Manual
  2. the Record of Practical Factors
  3. Electronics Warfare Technician 3&2
  4. Bibliography for Advancement Study, NAVEDTRA 10052
- 1-12. Which of the following is NOT a correct statement regarding the Bibliography for Advancement Study, NAVEDTRA 10052?
1. NAVEDTRA 10052 lists the required and recommended rate training materials and other reference materials to be used for advancement
  2. NAVEDTRA 10052 is revised and issued when a new rate training manual for your rate is issued
  3. All references listed in NAVEDTRA 10052 may be used as source material for the written examination
  4. Rate training manuals that are marked with an asterisk in NAVEDTRA 10052 are mandatory at the pay grade indicated
- 1-13. Which of the following references should you use to ensure that you have the latest edition of a rate training manual?
1. Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards, NAVPERS 18068D
  2. Personnel Advancement Requirement (PAR), NAVPERS 1414/4
  3. List of Training Manuals and Correspondence Courses, NAVEDTRA 10061 (revised)
  4. Bibliography for Advancement Study, NAVEDTRA 10052 (series)
- 1-14. Which of the following is a purpose of a rate training manual?
1. To replace NWIP manuals
  2. To supplement NAVELEC instructions
  3. To provide commands with a testing vehicle
  4. To help you prepare for advancement

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- 1-15. In studying for advancement you should use all appropriate training aids. In your research for training material, you should consult NAVAIR 10-1-777 for a list of available
1. training devices
  2. technical publications
  3. training films
  4. correspondence courses

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Learning Objective: Discuss some of the missions and functions of CIC, including flow of information and the control and assist functions, in accordance with standard doctrine.

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- Questions 1-16 and 1-17 are to be judged True or False.

- 1-16. Conn is always the commanding officer or ODD.

- 1-17. Information handling is comprised of five major functions.

- The following information pertains to questions 1-18 through 1-22. A target aircraft is plotted and its course and speed are determined. The aircraft cannot be identified but its intent appears to be hostile. CIC informs Conn and Weapons Control that a possible hostile aircraft is inbound toward the ship. CIC next receives a radio report that this aircraft is a confirmed friend and this information is passed to Conn and Weapons Control.

- 1-18. When did CIC perform a gathering function?

1. When the aircraft was detected on radar
2. When the information that the aircraft was friendly was received
3. During both 1 and 2 above
4. When the Conn and Weapons Control were given the information that the target was friendly

- 1-19. Sorting, inspecting, and appraising are parts of a step of information handling called

1. gathering
2. processing
3. displaying
4. disseminating

- 1-20. What information function did CIC perform when the target was plotted?

1. Gathering
2. Displaying
3. Evaluating
4. Disseminating

- 1-21. What information function was performed when CIC determined that the contact was a possible hostile aircraft?

1. Gathering
2. Displaying
3. Evaluating
4. Disseminating

- 1-22. What information function was CIC performing when it informed Conn and Weapons Control that the aircraft was possibly hostile?

1. Gathering
2. Displaying
3. Evaluating
4. Disseminating

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Learning Objective: Discuss the basis and guidelines for Search and Rescue (SAR) operations.

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- 1-23. What are all SAR operations based upon?

1. The type of unit in distress
2. The size of unit in distress
3. The last known position of unit in distress
4. The type of rescuing unit

- 1-24. What publication is the CIC watchstanders guide for SAR operations?

1. NWP 33 (series)
2. Shipboard watchstanders guide
3. Current OPORDER
4. CIC doctrine

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Learning Objective: Discuss divisional and command organization, describing functions of some key personnel.

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- Questions 1-25 and 1-26 are to be judged True or False.

- 1-25. The operations department is responsible for photo intelligence.

- 1-26. Decision and evaluation team billets may be filled with petty officers.

- 1-27. During condition of readiness I, what officer fills the position of evaluation/SWC?

1. Executive officer
2. Engineer officer
3. Weapons officer
4. Electronic warfare officer

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- 1-28. To whom is the track supervisor responsible?
1. Detection and tracking supervisor
  2. Evaluator/SWC
  3. Engagement controller
  4. Intercept control
- 1-29. Under the combat systems concept, which officer has been replaced by the combat systems officer?
1. Operations officer
  2. Engineer officer
  3. Weapons officer
  4. Navigator

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Learning Objective: Describe the divisions of Electronics Warfare.

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In questions 1-30 through 1-32, select from column B the division of Electronics Warfare (EW) that is described in column A.

<u>A. Descriptions</u>	<u>B. Divisions</u>
1-30. Action taken by friendly forces to maintain their use of a frequency spectrum in spite of the use of EW by the enemy	1. Electronics Warfare Support Measures (ESM) 2. Defensive Electronic Countermeasures (DECM)
1-31. The interception and analysis of radiated electromagnetic energy	3. Electronic Countermeasures (ECCM) 4. Electronic Countermeasures (ECM)
1-32. Action taken by friendly forces to deny or reduce the use of a frequency spectrum by the enemy	

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Learning Objective: Identify some of the objectives of EW.

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- 1-33. Which of the following is an objective of EW?
1. Ensuring our own security of fleet electromagnetic capabilities
  2. Identifying detected units
  3. Downgrading the use by the enemy of his electronic systems
  4. Accomplishing all of the above goals

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Learning Objective: Recognize the relationship between Electronic Warfare Intelligence (EWI) and Electronics Warfare operations.

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- 1-34. Which of the following best describes Electronic Warfare Intelligence (EWI)?
1. Collection, evaluation and analysis of all available information about foreign nations
  2. Collection, analysis and integration of all available information about foreign nations
  3. Collection, evaluation, analysis, and interception of all available information about foreign nations
  4. Collection, evaluation, analysis, integration and interpretation of all available information about foreign nations

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Learning Objective: Define the aspects of jamming as it pertains to security and training in Electronics Warfare.

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- 1-35. At what maximum range from Sino-Soviet bloc radars may you use electronic jamming in training exercises?
1. One and one-half times probable intercept range
  2. One and one-half times normal acquisition range
  3. Twice normal acquisition range
  4. Normal acquisition range
- 1-36. Where would you most likely find information on locations and ranges of Sino-Soviet bloc electronics equipment?
1. Current Radar Order of Battle (ROB)
  2. Current Electronics Order of Battle (EOB)
  3. ATP 1A
  4. NWP 33
- 1-37. At what range from land are you allowed to use rope for training exercises?
1. 150 miles or closer
  2. 150 miles or farther
  3. 100 miles or closer
  4. 100 miles or farther

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Learning Objective: Identify control functions and responsibilities of control for some of the individuals involved in EW.

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- 1-38. The overall control of EW for a group of ships is exercised by the
  1. officer in tactical command (OTC)
  2. anti-air warfare commander (AAWC)
  3. electronic warfare coordinator (EWC)
  4. electronic warfare officer (EWO)
- 1-39. Which of the following sequences gives the correct descending order of commands of the EW officer, the CIC officer, and the operations officer?
  1. EW officer, CIC officer, operations officer
  2. EW officer, operations officer, CIC officer
  3. Operations officer, CIC officer, EW officer
  4. Operations officer, EW officer, CIC officer
- 1-40. The maintenance, repair, and calibration of EW equipment aboard ship is the direct responsibility of the
  1. CIC officer
  2. EW officer
  3. electronics material officer
  4. EW watch supervisor

In questions 1-41 through 1-45, select from column B the enlisted watchstander that performs the job described in column A.

<u>A. Job</u>	<u>B. Watchstander</u>
1-41. Maintains a current display of the EMCON in effect	1. EW watch supervisor
1-42. Instructs EW operators in the current PMS program for all EW equipment	2. Intercept search operator
	3. Assistant ESM operator
	4. EW status board keeper
1-43. Assists the EW watch officer with intelligence information	
1-44. Conducts a search on the frequency band assigned	

- 1-45. Makes recordings on tape and photographs enemy signals

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Learning Objective: Determine procedures and equipment used in the EW Support Measures (ESM) division of EW.

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- 1-46. What is the primary method of conducting ESM?
  1. Deception
  2. Interception
  3. Evasion
  4. Target acquisition
- 1-47. What is the primary equipment used for ESM?
  1. Radar
  2. Intercept
  3. Radio
  4. Electronic navigation aids
- 1-48. ESM effectiveness depends primarily on the enemy's use of which of the following?
  1. Evasive tactics
  2. Search aircraft
  3. Electromagnetic emitters
  4. All of the above
- 1-49. Direction finding (DF) equipment is used during ESM in order to
  1. locate and track enemy ships and aircraft
  2. determine technical data about enemy electronic equipment
  3. evaluate the type and size of enemy forces
  4. verify search intercept equipment indications

A. Identification
B. Evaluation
C. ECM
D. Recording

Figure 1-1

● To answer question 1-50, refer to figure 1-1.

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- 1-50. The tactical situation requires that rapid analysis of unidentified enemy signals is of prime concern. What EW steps are taken immediately and which can be delayed?
1. A, B, C, and D are all immediate
  2. A, B, and C are immediate with D delayed
  3. A and B are immediate with C and D delayed
  4. A is immediate with B, C, and D delayed
- 1-51. Intercept search equipment aboard aircraft is best adapted for
1. early warning of enemy forces
  2. complete analysis of enemy electromagnetic emissions
  3. evaluation of enemy electromagnetic emissions
  4. jamming of enemy electromagnetic emissions
- 1-52. To monitor particular frequencies in intercept search operations, thus assuring complete coverage of the spectrum, the OTC assigns ships designated as
1. patrol vessels
  2. picket vessels
  3. guardships
  4. screen ships
- 1-53. Why is only one intercept receiver used to guard any one frequency band?
1. To eliminate confusion
  2. To eliminate delay in shifting bands
  3. To detect weaker signals
  4. To maintain reliable communications
- 1-57. What are the two types of intercept receivers?
1. Wide and narrow
  2. Passive and active
  3. Sweep and barrage
  4. Tactical and homing
- 1-58. What is the principle difference between the types of intercept receivers?
1. Frequency spectrum
  2. Number of operators
  3. Frequency search method
  4. Pulse blanking circuits
- 1-59. An intercepted signal is presented on the acquisition scope of the ESM receiver as a
1. horizontal line
  2. series of pulses
  3. series of rails
  4. bright spot
- 1-60. Which of the following signal characteristics is/are NOT determined with the pulse analyzer?
1. Repetition rate
  2. Peak power
  3. Width
  4. Shape
- 1-61. What tactical information can the ESM operator obtain from the audio output of his receiver?
1. Exact scan rate of the emitter
  2. Exact PRF of the emitter
  3. Power output of the emitter
  4. All of the above

In questions 1-54 through 1-56, select from column B the publication you should consult to determine the frequency of the intercept guard listed in column A.

A. Intercept Guards	B. Publications
1-54. Item 1850	1. NWP 33
1-55. Page 24	2. ATP 1, Vol 1
1-56. Indicator 135	3. NIS-1730S-002-(YR)
	4. Threat Emitter Guide

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Learning Objective: Perform duties as ECM operator in the ECM division of EW.

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- 1-62. Which of the following are uses of jamming operations?
1. Denying an enemy data for fire control
  2. Reducing the enemy's effective use of his radio communications
  3. Preventing an enemy from tracking our forces
  4. Accomplishing all of the above
- 1-63. Into what classification is electronic jamming placed?
1. On-target and off-target
  2. Offensive and defensive
  3. Tactical and home-on
  4. Airborne and shipborne

- 1-64. What non-electronic devices can be used to obscure aircraft and ship movements?
1. Kite
  2. Chaff
  3. Corner reflector
  4. Gull
- 1-65. What function is performed by both jamming and deceptive ECM?
1. Both reduce the effectiveness of enemy electronic detection equipment
  2. Both increase the effectiveness of our electronic detection equipment
  3. Both prevent enemy detection of our forces
  4. Both prevent enemy use of jamming or deception EW

- 1-71. What type of jamming should be used to jam a number of enemy radars operating on several different frequencies over a wide band?
1. Barrage
  2. Spot
  3. Non-electronic
  4. On-target
- 1-72. Which of the following devices is used to make picket ships appear to be the main craft in the fleet?
1. Rope
  2. Chaff
  3. Corner reflectors
  4. High-altitude kites

---

In questions 1-66 through 1-68, select from column B the type of communications countermeasures (COMCM) equipment modulation that produces the audio sound described in column A.

	<u>A. Sounds</u>	<u>B. Modulations</u>
1-66.	Very strong static	1. Noise
1-67.	Rapid sequence of many different tones	2. Saw 3. Random Saw
1-68.	Continuous distinctive warble	4. Bagpipes

- 
- 1-69. The transmission of jamming signals on a particular frequency being used by enemy electronics, as determined by intercept search is called
1. barrage jamming
  2. non-electronic jamming
  3. spot jamming
  4. off-target jamming
- 1-70. What type of jamming concentrates power in a narrow band and covers multiple targets?
1. Barrage jamming
  2. Search and lock jamming
  3. Spot jamming
  4. Sweep jamming

---

Learning Objective: Identify Electronic Counter-Countermeasures (ECCM) as it pertains to EW operations.

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- 1-73. Which of the following would be an example of ECCM?
1. Tactical evasion
  2. Anti-jam circuits
  3. Tactical action
  4. All of the above

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Learning Objective: Recognize the purpose for assignment of a radar guardship.

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- 1-74. What is the primary reasons for issuing a radar guardship assignment?
1. To assign each ship his share of duties within the force
  2. To minimize message traffic over communication circuits within the force
  3. To minimize the number of radars operated within the force
  4. To minimize the number of ships required to watch a sector for a force

## Assignment 2

### ESM Systems

Textbook Assignment: EW 3&2, NAVEDTRA 10127-A, pages 49 - 78

Learning Objective: Explain some of the basic operations of the countermeasures receiving set.

- 2-1. Which of the following features of the countermeasures set contributes to the set's capabilities of rapid received signal analysis and a high probability of intercept?
1. Rapid scanning techniques
  2. Long persistence raster display
  3. Simultaneous direction finding, pulse analysis, and panoramic display
  4. All of the above
- 2-2. Which of the following statements describes the capability of the automatic scan tuning?
1. Any band can be changed to an adjacent band in a few seconds
  2. Any band can be changed to any other band in a few seconds
  3. The frequency range of a given band can be covered in a few seconds
  4. The overall frequency range of the countermeasures set can be covered in a few seconds
- 2-3. What waveform is used for the vertical sweep voltage of the acquisition scope?
1. Sawtooth
  2. Sine
  3. Square
  4. Triangular
- 2-4. What pattern does a noise signal form on the acquisition scope?
1. Horizontal lines
  2. Random pattern of spots
  3. Sharp negative spikes
  4. Vertical lines of spots
- 2-5. What indication appears on the fourth trace from the top on the analysis scope?
1. Pulse duration
  2. Pulse repetition frequency
  3. Signal bearing
  4. Frequency spectrum
- 2-6. Which trace on the analysis scope is used to present the panoramic display of a portion of the frequency spectrum?
1. First (top)
  2. Third
  3. Fourth
  4. Fifth (bottom)
- In answering question 2-7, refer to figure 4-1 in your textbook.
- 2-7. Which of the RF tuners supplies a direct input to the unit 10 electronic frequency converter?
1. Unit 1 only
  2. Units 2 and 3
  3. Units 4 through 6
  4. Units 7 through 9
- 2-8. The operating controls for the countermeasures set are located on the front panels of the
1. azimuth indicator-pulse analyzer and control-storer
  2. interconnection box and azimuth indicator-pulse analyzer
  3. electrical frequency discriminator and the electronic frequency converter
  4. pulse generator and control-storer
- 2-9. Operating power for the countermeasures set pulse generator is obtained from which unit?
1. Unit 15
  2. Unit 16
  3. Unit 19
  4. Unit 31

- 2-10. What is the purpose of the servo test set?
1. To check for opens and shorts in the frequency converter servos
  2. To calibrate the power supplies
  3. To adjust the RF tuner servo potentiometers
  4. To calibrate the pulse generator

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Learning Objective: Describe some of the functions of the radio frequency transmission switches (units 18, 28, 29 and 32), the lower band frequency converter-tuners (units 1 through 5), and the upper band electronic frequency converters (units 6 through 9).

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- 2-11. Which of the following describes the signal flow through the unit 32 line switch?
1. From either units 1, 2, or 3 to the unit 10 electronic frequency converter
  2. From the azimuth indicator-pulse analyzer to the unit 13 control-storer
  3. From either the OMNI or DF antenna to a selected RF tuner/converter
  4. From the unit 29 line switch to the unit 28 line switch
- 2-12. The unit 28 line switch differs from the unit 18 line switch in that the unit 28 output is fed to what units?
1. The low frequency range converters
  2. The mid frequency range converters
  3. The high frequency range converters
  4. The mid or high frequency range converters
- 2-13. Which of the following best describes the difference in operation of the unit 1 RF tuner and the unit 5 RF tuner?
1. The crystal mixer in the unit 1 tuner is tuned by a servomotor
  2. The crystal mixer in the unit 1 tuner is fed by the RF amplifier
  3. The crystal mixer in the unit 1 tuner is free running
  4. The crystal mixer in the unit 1 tuner is controlled by the IF preamplifier
- 2-14. Where does the unit 3 RF tuner have automatic gain control voltage applied?
1. At its RF amplifier
  2. At its local oscillator
  3. At its first preamplifier stage
  4. At its fourth preamplifier stage

- 2-15. How may the operator check on the operation of the servo tuning system?
1. By observing the frequency indicator
  2. By listening for the audible pulse stretched signal through a headset
  3. By observing the TUNER LIMIT indicator lamp
  4. By listening for the cam operation on the servo shaft

- 2-16. During test of the low frequency converter tuner, how is the servomotor disabled for manual tuning?
1. By setting the SERVO DISCONNECT switch to the ON position
  2. By actuating the band-limit switch on the front panel
  3. By setting the SERVO DISCONNECT switch to the OFF position
  4. By depressing the scan button on the control-storer

- 2-17. Which of the following is an accurate comparison of the components in units 4 and 7?
1. Both units are conventional electronic oscillators
  2. Both units use klystron oscillators
  3. Unit 4 uses a klystron oscillator and unit 7 uses a conventional electronic oscillator
  4. Unit 4 uses a conventional electronic oscillator and unit 7 uses a klystron oscillator

- 2-18. What additional function is performed by the band 8 converter that is not performed by the band 3 converter?
1. Controlling the servo reference voltage
  2. Tuning the RF preselector
  3. Controlling the reflector voltage
  4. Tuning the oscillator

- 2-19. What is the purpose of the line switch, unit 29?
1. To select the proper frequency converter output that is to be applied to the tuner
  2. To switch the proper antenna to the RF tuner in use
  3. To switch the RF tuner output to the servo test set
  4. To switch the proper RF tuner output to the respective frequency converter

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Learning Objective: Explain some of the uses and operations of the lower band frequency converter (unit 10), the upper band frequency converter (unit 11), and the electrical frequency discriminator (unit 14).

- 2-20. What is the function of the unit 10 electronic frequency converter?
1. To amplify and detect the IF signal from unit 1, 2, or 3
  2. To convert the RF signal from unit 1, 2, or 3 into an IF signal
  3. To provide a reference voltage for the control-storer and frequency indicator
  4. To amplify and detect the RF signal from either the OMNI or DF antenna
- In answering question 2-21, refer to figure 4-10 in your textbook.
- 2-21. What circuit(s) in the unit 10 electronic frequency converter receive(s) inputs from the broad-band IF amplifier?
1. The wide-band detector and the isolation amplifier
  2. The AGC circuit
  3. The FM cathode follower
  4. All of the above
- 2-22. What is the purpose of the FM cathode follower in unit 10?
1. To provide a video output to the azimuth indicator-pulse analyzer
  2. To supply the electrical frequency discriminator with a video input
  3. To provide an IF output to the electrical frequency discriminator unit 14
  4. To supply the azimuth indicator-pulse analyzer with an IF input
- 2-23. In which of the following situations is the manual control of the AGC signal gain NOT provided by the GAIN control potentiometer in the control storer?
1. When the SCAN switch is depressed
  2. When the FUNCTION SELECTOR switch is in the FM-AFC position
  3. When the FUNCTION SELECTOR switch is in the VIDEO position
  4. When the FUNCTION SELECTOR switch is in the AM-MGC position
- 2-24. The horizontal sweep voltage for the panoramic sweep is provided by the
1. sweep generator
  2. frequency converter
  3. frequency discriminator
  4. fifth electron gun in the cathode-ray tube

- 2-25. What, if anything, must the operator do in order to differentiate between two signals that are in the wide bandwidth?
1. Depress the SCAN button on the control-storer
  2. Set the BANDWIDTH switch to the NARROW position
  3. Set the BANDWIDTH switch to the WIDE position
  4. No action is necessary because the equipment normally differentiates between two signals in the wide bandwidth

● In answering question 2-26, refer to figure 4-12 in your textbook.

- 2-26. What determines the frequency scanning range of the narrow-band mixer in the high frequency electronic frequency converter?
1. The position of the SWEEP WIDTH relay contacts
  2. The position of the BAND SELECTOR switch
  3. The position of the contacts and switch in 1 and 2 above
  4. The position of the WIDE-NARROW relay contacts

- 2-27. What is the function of the SWEEP WIDTH relay?
1. To supply a +150v d.c. input to the panoramic sweep generator when in the WIDE SWEEP WIDTH position
  2. To provide a change in the frequency deviation range of the sweep oscillator consistent with the tuner selected
  3. To supply a 150v d.c. input to the fixed oscillator when in the NARROW SWEEP WIDTH position
  4. To provide a change in the frequency deviation range of the panoramic sweep generator consistent with the tuner selected

- 2-28. What unit supplies the FM signal input to the unit 14 discriminator?
1. Unit 10 only
  2. Units 10 or 12
  3. Unit 11 only
  4. Units 10 or 11

- 2-29. What is the purpose of the two discriminator circuits in the unit 14 discriminator?
1. To modulate wide and narrow bandwidth signals simultaneously
  2. To demodulate wide and narrow bandwidth signals simultaneously
  3. To demodulate either wide or narrow bandwidth signals depending on the position of the FM BANDWIDTH switch
  4. To demodulate either wide or narrow bandwidth signals depending on the amplitude of gain voltage applied to the video amplifier



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- In answering question 2-30, refer to figure 4-13 in your textbook.
- 2-30. When operation of the unit 14 discriminator is desired on any of the first three low-frequency tuners, where is the IF input applied?
  1. Directly to the unit's IF amplifier limiter
  2. Directly to the unit's mixer
  3. Directly to the unit's video amplifier
  4. Directly to the unit's first oscillator
- 2-31. What circuit removes the amplitude modulation of the IF signal applied to the unit 14 wide bandwidth discriminator?
  1. The first oscillator
  2. The mixer
  3. The video amplifier
  4. The IF amplifier limiter
- 2-32. What is the output characteristic of the unit 14 wide bandwidth discriminator relay switching circuit when the FM BANDWIDTH switch is set to the narrow position?
  1. A maximum difference sensitivity signal
  2. A minimum difference sensitivity signal
  3. A consistently maximum difference sensitivity signal
  4. A consistently minimum difference sensitivity signal
- In answering question 2-33, refer to figure 4-13 in your textbook.
- 2-33. The input to the narrow bandwidth discriminator is obtained by mixing the output of the IF amplifier limiter with the output of which of the following circuits in unit 14?
  1. The discriminator relay switching circuit
  2. The narrow bandwidth amplifier
  3. The second oscillator
  4. The AGC circuit
- 2-34. What determines the condition of the K-3 relay in the unit 14 discriminator?
  1. The condition of the K-1 relay
  2. The condition of the K-2 relay
  3. The position of the FM BANDWIDTH switch
  4. The position of the RF TRANSMISSION LINE switch (unit 29)
- 2-35. What presentation other than the visual cathode-ray tube indicators are provided by the unit 12 azimuth indicator-pulse analyzer?
  1. Audible and direct reading frequency indications only
  2. Direct reading frequency and frequency exchange lamp indications only
  3. Audible and frequency-exchange lamp indications only
  4. Audible, direct reading frequency and frequency exchange lamp indications
- 2-36. The analysis scope input is taken from unit 11 when the AN/WLR-1 is using which of the following bands?
  1. 1 and 2
  2. 1 through 9
  3. 3 and 4
  4. 4 through 9
- 2-37. What action occurs simultaneously in the azimuth indicator-pulse analyzer with the depressing of the scan button that prevents the missing of an AM or CW signal due to the function selector having been left accidentally in the FM position?
  1. K-2 energizes
  2. K-2 deenergizes
  3. K-3 energizes
  4. K-3 deenergizes
- 2-38. The VIDEO IN jack is used in what situation?
  1. When the set is operated with an external acquisition scope
  2. When the set is operated with an external analysis scope
  3. When a signal from a signal generator or other receiver is presented on the analysis scope
  4. When two signals are presented simultaneously on the analysis scope
- 2-39. What is the period of the vertical sawtooth voltage applied to the acquisition scope?
  1. 1 sec
  2. 2 sec
  3. 1 min
  4. 2 min
- 2-40. What pattern does a received signal produce on the acquisition scope to distinguish CW and RF pulses from noise?
  1. Vertical lines of dots
  2. Lissajous patterns
  3. Sine waves
  4. Horizontal lines of dots

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Learning Objective: Describe some of the functions and operations of the azimuth indicator-pulse analyzer.

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- 2-41. The video pulse output of the unit 12 video input circuits are ultimately applied to the cathode of the acquisition display indicator. (a) What is the length of these pulses and (b) in which direction will these pulses drive the azimuth indicator cathode?
1. (a) 0 to 5  $\mu$ sec, (b) positive
  2. (a) 500  $\mu$ sec, (b) positive
  3. (a) 9 to 500  $\mu$ sec, (b) negative
  4. (a) 500  $\mu$ sec, (b) negative
- Questions 2-42 through 2-45 are to be judged True or False.
- 2-42. Panoramic video signals are used by the unit 12 acquisition display indicator to display CW signals.
- 2-43. When tuned to a CW signal, the output of the panoramic video amplifier is a sinusoidal wave signal.
- 2-44. The purpose of the low pass filter in the unit 12 scan display circuit is to pass all low frequencies.
- 2-45. The panoramic video signal is applied to either the vertical or horizontal deflection plates of the acquisition display depending upon the position of the DF-NB switch.
- 2-46. The triggering level of the sync-pulse generator is determined by the
1. amplitude of the video signal output from the unit 12 video input circuit
  2. setting of the sync trigger frequency control on the unit 12 front panel
  3. frequency of the intensity tailoring circuit output
  4. setting of the sync level control on the unit 12 front panel
- 2-47. What is the purpose of the lockout multivibrator negative gate that causes the gated amplifier to reject sync pulses for the gate time of the multivibrator?
1. To permit the multivibrator voltage to reach its maximum amplitude
  2. To allow recovery of the multivibrator sweep circuits to ensure stability
  3. To increase the pulse visibility at slow writing speeds
  4. To allow the sweep to start before the video is applied to the indicator
- 2-48. What action produces the output of the exponential sweep generator?
1. The buildup of an inductive field
  2. The discharge of a capacitor
  3. The collapse of an inductive field
  4. The rise time of a resistor-capacitor network
- 2-49. What type of network is used in the intensity tailoring circuits associated with the grid of the 0 to 5  $\mu$ sec analysis indicator?
1. Transformer-inductor
  2. Resistive-transformer
  3. Inductor-capacitor
  4. Resistor-capacitor
- 2-50. What signal produces the exponential lockout for the 500 to 50,000  $\mu$ sec analysis indicator?
1. The leading edge of the logarithmic sweep generator's 495  $\mu$ sec positive gate
  2. The trailing edge of the logarithmic sweep generator's 49,500  $\mu$ sec positive gate
  3. The leading edge of the logarithmic sweep generator's 49,500  $\mu$ sec negative gate
  4. The trailing edge of the logarithmic sweep generator's 495  $\mu$ sec negative gate
- In answering question 2-51, refer to figure 4-16 in your textbook.
- 2-51. What factor determines the amount of pulse stretching in the pulse stretcher associated with the upper vertical deflection plates of the 5 to 500  $\mu$ sec analysis indicator gun?
1. Frequency of the received signal
  2. Amplitude of the received signal
  3. Amplitude of the sweep trace
  4. Speed of the sweep trace
- 2-52. Where does the spot indicating antenna rotation from 15° to 45° appear on the AN/WLR-1 analysis scope?
1. Lower bearing scale, moving from left to right
  2. Lower bearing scale, moving from right to left
  3. Upper bearing scale, moving from left to right
  4. Upper bearing scale, moving from right to left
- 2-53. What indication appears on the direction finding trace to show that a signal is received when the antenna angular position is 290°?
1. The spot jumps from the lower scale to the upper scale
  2. The spot stops at a reading of 290° on the upper scale
  3. A downward deflection appears on the scale
  4. An upward deflection appears on the upper scale

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- 2-54. The DF antenna control unit contains a (a) phase resolver that is used (two, three) to (b) modulate the (amplitude, frequency) DF carrier.
1. (a) two, (b) frequency
  2. (a) two, (b) amplitude
  3. (a) three, (b) frequency
  4. (a) three, (b) amplitude
- 2-55. How far does the resolver rotate for 90° of antenna rotation?
1. 45°
  2. 90°
  3. 180°
  4. 360°
- 2-56. What waveform does the sweep voltage for the DF trace of the analysis indicator have?
1. Irregular
  2. Sine
  3. Square
  4. Triangular
- 2-57. How often and in what direction is the horizontal trace shifted in order to eliminate any possible ambiguity in indicating the antenna angular position?
1. Every 180 degrees vertically
  2. Every 180 degrees horizontally
  3. Every 90 degrees horizontally
  4. Every 90 degrees vertically
- 2-58. The differential amplifier (phase detector) shown in figure 4-18 of your textbook produces an output under which of the following conditions?
1. When the phase B clipper is conducting and the phase A clipper is non-conducting
  2. When the phase B clipper is nonconducting and the phase A clipper is conducting
  3. When the output of the phase B clipper is in phase with the output of the phase A clipper
  4. When the output of the phase B clipper is out of phase with the phase A clipper
- In answering question 2-59, refer to figure 4-18 in your textbook.
- 2-59. DF video is applied to the vertical deflection control and amplifier stages from the output of which of the following?
1. The DF display circuits pulse combiner
  2. The signal analysis video circuits pulse stretcher and cathode follower
  3. The sweep sync circuits paraphase amplifier and logarithmic sweep generator
  4. The scan display circuits narrow band amplifier
- 2-60. The appearance of an extra spike on the DF display is caused by what action in the circuit?
1. Oscillation in the DF display circuit pulse combiner
  2. Pulse detection in the panoramic video circuit
  3. Resonance in the scan display circuit low-pass filter
  4. Video intensification in the DF display circuit pulse combiner
- 2-61. Intensification of the video on the DF display permits which of the following?
1. Intensification of the base line
  2. Intensification of the DF display at all times
  3. Suppression of the base line
  4. Suppression of the DF display at all times
- 2-62. Which of the following signals, in addition to video intensification, is applied to the DF display gun intensity grid?
1. A pulse stretched video
  2. A panoramic video
  3. A detected envelope similar to a CW signal
  4. A DF vertical skew correction
- 2-63. The push-pull sawtooth signal applied to the panoramic display by either unit 10 or unit 11 is used for what voltage?
1. As the display's vertical sweep voltage
  2. As the display's panoramic video voltage
  3. As the display's horizontal sweep voltage
  4. As the display's DF horizontal skew correction voltage

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- 2-64. In what way does the panoramic sweep arrange the high and low frequencies on the screen of the panoramic display indicator?
1. Low frequencies to the left and high frequencies to the right
  2. Low frequencies to the right and high frequencies to the left
  3. Low frequencies in the center and high frequencies to the left and right
  4. High frequencies in the center and low frequencies to the left and right
- 2-65. From which unit is the signal received that is applied to the upper vertical deflection plate of the panoramic indicator gun?
1. Control-storer unit 13
  2. Frequency converter unit 10 or unit 11
  3. Frequency discriminator unit 14
  4. Pulse generator unit 19
- 2-66. Intensification of the panoramic display is primarily dependent upon the gated amplifier receiving an input signal from the
1. panoramic sweep amplifier
  2. differentiating circuit
  3. panoramic intensity amplifier
  4. panoramic vertical amplifier
- 2-67. What is the output of the differentiating circuit that is applied to the gated amplifier?
1. A constant d.c. level signal
  2. A negative cutoff voltage
  3. A constant a.c. level signal
  4. A positive cutoff voltage
- 2-68. The purpose of the audio circuit of unit 12 is to provide a monitoring capability of
1. video and audio frequency components of narrow pulses
  2. audio frequency components of only wide pulses and voice communications
  3. video and audio frequency components of wide pulses
  4. audio frequency components of narrow pulses and voice communications
- 2-69. How is tuning of the preselector and local oscillator of the countermeasures equipment frequency converter tuners accomplished during analysis operation?
1. By varying the manual tune control
  2. Automatically by a scan generator
  3. By automatic variations on a servo motor
  4. By screwdriver adjustments to the servo potentiometer
- In answering question 2-70, refer to figure 4-2 in your textbook.
- 2-70. During analysis operation, the output of the scan chopper is in phase with the a.c. reference voltage when the output voltage of the tuner servo-potentiometer is
1. lower than the storage channel potentiometer voltage
  2. higher than the storage channel potentiometer voltage
  3. out of phase with the storage channel potentiometer voltage
  4. the same as the storage channel potentiometer voltage
- 2-71. Which of the following conditions causes the tuner servomotor to run in a direction which decreases the voltage of the tuner servo-potentiometer?
1. The voltage output of the scan chopper is in phase with the a.c. reference voltage
  2. The voltage output of the scan chopper is 90° out of phase with the a.c. reference voltage
  3. The voltage output of the scan is 180° out of phase with the a.c. reference voltage
  4. The paraphase amplifier produces two output voltages which are 180° out of phase with each other
- 2-72. What type of presentation is observed on the countermeasures equipment frequency indicator when the storage channel select button associated with channel six is depressed?
1. A direct digital reading of the frequency to which the receiver is tuned
  2. A deflection of an indicating needle across a scale corresponding to applied frequency
  3. The center frequency of the RF tuner in use
  4. A sum video waveform proportional along its horizontal axis to the frequency to which the receiver is tuned
- 2-73. What type of presentation is observed on the countermeasures equipment frequency indicator during scan operation?
1. A direct digital reading of the high end of the tuner frequency range
  2. A deflection of an indicating needle across a scale corresponding to applied frequency
  3. The center frequency of the RF tuner in use
  4. A sum video waveform proportional along its horizontal axis to the frequency to which the receiver is tuned

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Learning Objective: Explain some of the functional characteristics of the control-storer and power supplies.

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- 2-74. What are the operating controls associated with the unit 13 control-storer?
1. Ten SELECT pushbutton switches, ten MANUAL TUNE controls, and one RELEASE pushbutton
  2. Ten SELECT pushbutton switches, ten MANUAL TUNE controls, and ten RELEASE pushbuttons
  3. One SELECT pushbutton switch, ten MANUAL TUNE controls, and ten RELEASE pushbuttons
  4. Ten SELECT pushbutton switches, one MANUAL TUNE control, and ten RELEASE pushbuttons
- 2-75. The band indicator light indicating that a frequency position is stored on the corresponding storage channel remains illuminated until what occurs?
1. A new SELECT button is depressed
  2. The frequency is no longer being analyzed
  3. The frequency is re-presented for analysis
  4. The corresponding release button is depressed.

## Assignment 3

ESM Systems; ESM Antennas; Blankers and Preamplifiers

Textbook Assignment: EW 3&2, NAVEDTRA 10127-A, pages 79 - 127

Learning Objective: Explain some of the functional characteristics of the control-storer and power supplies.

- 3-1. The purpose of the countermeasures equipment power supplies is to convert primary power into
1. various a.c. and d.c. voltages
  2. a high potential klystron oscillator output
  3. various d.c. voltages
  4. a regulated supply of a.c. voltages
- 3-2. Which of the RF tuners used the output of the unit 31 power supply?
1. 1 and 2 only
  2. 1 through 9
  3. 3 and 4 only
  4. 6 through 9 only
- 3-3. The power and control for all units of the AN/WLR-1 is produced by three power supplies that contain which of the following?
1. 14 separate supplies providing 14 different output voltages
  2. 6 separate supplies providing 6 different output voltages
  3. 12 separate supplies providing 12 different output voltages
  4. 13 separate supplies providing 18 different output voltages
- Learning Objective: Identify some of the functions of the unit 17 inter-connecting box, the unit 19 pulse generator, and the unit 17 servo test set.
- 3-4. The unit 17 interconnecting box contains terminal boards, relays, line filters, fuzes, load indicators and wiring that are used for what purpose?
1. To provide the interface connections for the ESM and ECM equipments
  2. To supply the feedthrough for bypassing the equipment in emergency operation
  3. To provide the interconnections for the entire countermeasures equipment
  4. To connect the countermeasures equipment into an automated, computer operated console
- 3-5. Selection of the proper power and control voltages for units 10 and 11 is a function of which of the following?
1. The relays in unit 17
  2. The control switches on unit 27
  3. The line filters in unit 17
  4. The control switches on unit 16
- 3-6. The unit 19 pulse generator is used for what purpose?
1. To supply alignment pulses to the servo test set
  2. To provide a reference pulse for calibration of the electrical frequency discriminator
  3. To supply alignment pulses to the azimuth indicator-pulse analyzer
  4. To do all of the above
- 3-7. What frequencies may be internally synchronized in the unit 19 pulse generator?
1. 0.1 kHz and 1 kHz
  2. 1 kHz and 10 kHz
  3. 100 kHz and 1000 kHz
  4. All of the above
- 3-8. Why are the unit 19 pulse generator dividers synchronized by the crystal oscillator?
1. To provide a wide range of output frequencies
  2. To limit the output to a single pulse
  3. To provide good frequency stability
  4. To improve the overall gain of the generator

- 3-9. What is the polarity of the unit 19 pulse generator output pulses?
1. Either positive or negative depending upon the setting of the control switch
  2. Both positive and negative
  3. Positive only
  4. Negative only

● Questions 3-10 through 3-12 are to be judged True or False.

- 3-10. The servo test set (unit 27) is used to align the high and low servo-potentiometers in the RF tuners.
- 3-11. The servo test set, when connected to the tuner servo-potentiometer circuit, forms a Wheatstone bridge.
- 3-12. The electronic equipment maintenance kit (unit 30) includes special tools, test cables, and accessory items required to troubleshoot the AN/WLR-1.

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Learning Objective: Identify some of the functions of the Converter-Tuner CV-3292/WLR-1G.

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- 3-13. What is the frequency range of the Converter-Tuner (CV-3292)?
1. 0 to 20 GHz
  2. 7.5 to 18 GHz
  3. 10 to 20 GHz
  4. 10.75 to 18 GHz
- 3-14. What is the basic function of the CV-3292?
1. To receive signals in the 10.75 to 20 GHz range
  2. To extend the frequency range of the WLR-1C
  3. To replace the upper band of the WLR-1C
  4. To receive signals in the 10 to 18 GHz range
- 3-15. What is the intermediate frequency (IF) of the CV-3292?
1. 30 MHz
  2. 60 MHz
  3. 160 MHz
  4. 320 MHz

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Learning Objective: Explain the use and operation of the Countermeasures Receiving Set (AN-WLR-8(V)).

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- 3-16. What is the frequency range of the Countermeasures Receiving Set (AN/WLR-8(V))?
1. 0 to 18 GHz
  2. 0 to 20 GHz
  3. 0.25 to 18 GHz
  4. 0.25 to 20 GHz
- 3-17. Which of the following are the primary modes of operation of the AN/WLR-8(V)?
1. LIMIT SCAN, ANALYZE, BAND SCAN and SET SCAN LOCK
  2. ANALYZE, LIMIT SCAN, READOUT and SET SCAN LOCK
  3. LIMIT SCAN, READOUT, ANALYZE and SIGNAL ALARM
  4. SIGNAL ALARM, ANALYZE, LIMIT SCAN and BAND SCAN
- 3-18. In the ANALYZE mode of operation, how many traces are available for displaying the signal parameters of an intercept?
1. 5
  2. 2
  3. 3
  4. 4
- 3-19. Which, if any, of the following traces on the IP-301 and IP-302 indicate over-all signal activity of the seven receivers of the AN/WLR-8(V)?
1. The top two traces of the IP-302 and all five traces of the IP-301
  2. The last three traces of the IP-302 and all five traces of the IP-301
  3. All five traces of the IP-302 only
  4. No activity indication is observed on the IP-302

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Learning Objective: Explain the operation and function of the Countermeasures Receiving Set (AN/WLR-11A).

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- 3-20. Which of the following is the primary purpose of the AN/WLR-11A?
1. It replaces the bands of the AN/WLR-1C in the 7 to 18 GHz range
  2. It provides acquisition capability for the AN/WLR-1C
  3. It facilitates operations completely independent of the AN/WLR-1C
  4. It operates in conjunction with the AN/WLR-8(V)

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- 3-21. What band(s) of the AN/WLR-1C, when operated, produce a marker strobe indication on the AN/WLR-11A display to indicate the frequency to which the AN/WLR-1C is tuned?
1. Bands 6 through 9
  2. Bands 7 through 9 only
  3. Bands 8 and 9 only
  4. Band 9 only

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Learning Objective: Explain some of the operations of the side-band receivers.

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- 3-22. What is the frequency range of the low band of the AN/WLR-3?
1. 1100 to 2200 MHz
  2. 2300 to 11000 MHz
  3. 2300 to 5200 MHz
  4. 4800 to 11000 MHz
- 3-23. What is the purpose of the AM-1936?
1. To detect and amplify the received signals for visual presentation
  2. To amplify, make audible, and deliver for visual presentation
  3. To detect, amplify, and make audible the signal which is to be delivered to the external amplifier
  4. To amplify, make audible, and deliver the signal for the headset for audio presentation
- 3-24. What does the detector switching unit of the AN/WLR-3 contain?
1. One crystal video detecting arrangement and two solenoid-operated coaxial switches
  2. Two crystal video detecting arrangements and two solenoid-operated coaxial switches
  3. Two crystal video detecting arrangements and three solenoid-operated coaxial switches
  4. Two antennas and two amplifiers
- 3-25. The 27 volt d.c. output of the AN/WLR-3 is used by the
1. detector switching unit
  2. video amplifiers
  3. primary power supply
  4. narrow-band ESM equipment
- 3-26. Operation of the AN/WLR-3 is performed at which place?
1. RF-81 detector switching unit
  2. 260 volt d.c. power supply
  3. AM-1936 amplifier control
  4. Remote ECM station

- 3-27. When the DF control of the AN/WLR-3 is set to the NORMAL position, what does it indicate?
1. The signal is connected to an external DF display
  2. The audio signal is normally connected to the DF display
  3. Both the high and low signals are connected to an external DF display
  4. No signal is being connected to an external display connected to an operation of the equipment is being performed
- 3-28. The AM-4255 uses four bands to cover the frequency range of 1 GHz to 10.75 GHz. To permit processing, how many independent channels does it have?
1. Six
  2. Two
  3. Three
  4. Four
- 3-29. What is displayed on the CRT of the AM-4255?
1. True signal bearings
  2. True or relative signal bearings
  3. Relative signal bearings
  4. Phase relationship of all signals received
- 3-30. When the control-indicator controls are set up, the speed control should be set for what speed?
1. Maximum speed
  2. Minimum speed
  3. Any desired speed
  4. Approximately 200 rpm
- 3-31. If you desire to listen to all four bands of the AM-4255 at the same time, which of the following actions must you take?
1. Select the SEARCH mode
  2. Select the GATING mode
  3. Actuate the ALL AUDIO switch
  4. Do all of the above operations
- 3-32. The AN/SLR-12 may be operated in the SPIN mode with which of the following antenna speeds?
1. 20 to 300 rpm clockwise only
  2. 20 to 300 rpm counterclockwise only
  3. 20 to 300 rpm clockwise or counterclockwise
  4. 0 to 400 rpm clockwise or counterclockwise



- 3-33. All operating controls for the AN/SLR-12 are located on what unit?
1. Control-indicator
  2. Amplifier control
  3. Antenna control unit
- 3-34. If the TRUE indicator is not illuminated, what type bearings will be obtained?
1. True at all times
  2. Relative as long as the TRUE-REL switch is in the REL position
  3. Relative regardless of the setting of the TRUE-REL switch
  4. True regardless of the setting of the TRUE-REL switch
- 
- Learning Objective: Describe the function and principles of ESM antennas.
- 
- Questions 3-35 through 3-38 are to be judged True or False.
- 3-35. The AS-571 is an omnidirectional antenna.
- 3-36. Antenna AS-571 receives both horizontally and vertically polarized signals.
- 3-37. The frequency range of the AS-571 antenna corresponds to band 4 of the narrowband ESM receiver.
- 3-38. Maximum speed of rotation for the AS-571 antenna is 250 rpm.
- 3-39. Which of the following statements best describes the AS-616A antenna?
1. It receives horizontally polarized signals in the 500 to 2400 MHz frequency range only
  2. It receives both horizontally and vertically polarized signals in the 100 to 2400 MHz frequency range
  3. It receives both horizontally and vertically polarized signals in the 500 to 2400 MHz frequency range
  4. It receives only vertically polarized signals in the 500 to 2400 MHz frequency range
- 3-40. What is the maximum speed of rotation for the AS-616A antenna?
1. 200 rpm
  2. 250 rpm
  3. 300 rpm
  4. 350 rpm
- 3-41. The antenna AS-616A consists of how many principal antenna units?
1. 1
  2. 2
  3. 3
  4. 4
- 3-42. Switching from the vertical polarized arrays to the horizontal polarized arrays is accomplished by which of the following methods?
1. The coaxial switches
  2. The polarization switch
  3. The control-indicator C-3118
  4. All of the above
- 3-43. How many video crystal detectors does the antenna AS-899A have?
1. 1
  2. 6
  3. 8
  4. 4
- 3-44. The antenna AS-899 covers a frequency range of 1000 to 12,000 MHz, and corresponds to which bands of the narrowband ESM equipment?
1. Bands 6 and 7
  2. Bands 7 and 8
  3. Bands 7, 8 and 9
  4. Bands 6, 7, 8 and 9
- 3-45. Which of the following statements best describes the AS-899 antenna?
1. It is a circularly-polarized high-gain omnidirectional antenna
  2. It is a circularly-polarized low-gain DF antenna
  3. It is a circularly-polarized high-gain DF antenna
  4. It is a circularly-polarized low-gain omnidirectional antenna
- 3-46. The AS-899 antenna provides how many inputs to the ESM equipment?
1. 10
  2. 8
  3. 6
  4. 4
- 3-47. Which of the following statements best describes the rotation of the AS-899 antenna?
1. It may be rotated clockwise at speeds up to 400 rpm
  2. It may be rotated counterclockwise at speeds up to 300 rpm
  3. It may be rotated counterclockwise at speeds up to 300 rpm and manually counterclockwise
  4. It may be rotated clockwise at any rate from zero to 300 rpm or manually trained in either direction

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- 3-48. What is the frequency range of the AS-899F/SLR antenna?
1. 1000 to 20,000 MHz
  2. 1000 to 12,000 MHz
  3. 500 to 12,000 MHz
  4. 300 to 12,000 MHz
- 3-49. In the AS-899F/SLR antenna, waveguide outputs are provided for what AN/WLR-1C bands?
1. 6 and 7 only
  2. 7 and 8 only
  3. 8 and 9 only
  4. 9 and 10 only
- 3-50. Which of the following is/are the purpose(s) of the heating elements in the AS-899F/SLR antenna?
1. To maintain a uniform temperature in the interior of the pedestal and top cap
  2. To help prevent condensation
  3. To keep the lubricants and components at the proper operating temperature
  4. All of the above
- Questions 3-51 through 3-54 are to be judged True or False.
- 3-51. The AS-1096 antenna provides omnidirectional coverage in the frequency range of 50 to 1000 MHz.
- 3-52. Antennas AS-1173, AS-1174, and AS-1175 cover only the upper 4 bands of the narrowband ESM receiver.
- 3-53. The frequency range of the AS-1173 antenna is 50 to 300 MHz.
- 3-54. Antennas AS-1174 and AS-1175 both have the same frequency coverage.
- 3-55. Which of the following equipments uses the AS-2918/S antenna?
1. AN/WLR-1C
  2. AN/WLR-1G
  3. AN/WLR-11
  4. AN/WLR-11A
- 3-56. What is the frequency range of the AS-2918/S antenna?
1. 7-11 GHz
  2. 11-18 GHz
  3. 7-18 GHz
  4. 7-20 GHz
- 3-57. Which of the following statements best describes the Navy type 66131 antenna?
1. It provides frequency coverage from 300 to 2600 MHz, and is sensitive to only vertically polarized signals
  2. It provides frequency coverage from 300 to 2600 MHz, and is equally sensitive to both vertically and horizontally polarized signals
  3. It provides frequency coverage from 500 to 2600 MHz and is equally sensitive to both horizontally and vertically polarized signals
  4. It provides frequency coverage from 300 to 2600 MHz and is sensitive only to horizontally polarized signals
- 3-58. Which of the following statements best describes the NT-66131 antennas?
1. They are mounted in pairs at 45° angles to the horizontal plane and 180° angles to each other in azimuth
  2. They are mounted in pairs at 45° angles to the horizontal plane and 90° angles to each other in azimuth
  3. They are mounted in pairs at 90° angles to the horizontal plane and 90° angles to each other in azimuth
  4. Each of the above installations may be used
- Question 3-59 is to be judged True or False.
- 3-59. The NT-66131 and 66132 antennas provide 360° omnidirectional coverage only when mounted in pairs.
- 3-60. The NT-66132 is a(n) (a) (omnidirectional, DF) antenna, often referred to as a (b), (derby, sword).
1. (a) omnidirectional, (b) sword
  2. (a) omnidirectional, (b) derby
  3. (a) DF, (b) sword
  4. (a) DF, (b) derby
- 3-61. What is the frequency coverage of the Navy type 66132 antenna?
1. 40-150 MHz
  2. 40-300 MHz
  3. 100-300 MHz
  4. 300-600 MHz
- 3-62. How many antennas may be controlled by the C-3118?
1. 5
  2. 2
  3. 3
  4. 4

- 3-63. What component reverses the polarity to the 1F synchro in the C-3118 to correct the position of the spot on the DF trace?
1. The manual tune knob
  2. The Relative/True bearing switch
  3. The Polarization switch
  4. The Automatic/Manual Tune switch
- 3-64. What is the mechanical displacement of the stator windings of the resolver positioned by the 1F synchro receiver in the C-3118?
1. 45°
  2. 90°
  3. 120°
  4. 180°
- 
- Learning Objective: Describe some of the components associated with and located in the blanker-mixer video group used in a typical ESM installation.
- 
- 3-65. How many major components are there in AN/SLA-10 blanker-video mixer group installation?
1. 5
  2. 6
  3. 3
  4. 4
- 3-66. The 60 and 160 MHz switches of the ESM system are controlled by the outputs from which of the following components?
1. Master blanker
  2. Interference blanker
  3. RF selector switches
  4. IF amplifiers
- 3-67. The master blanker has 20 input connectors on the left side of the case. What is the number of output connectors on the right side?
1. 9
  2. 11
  3. 13
  4. 15
- 3-68. How many printed circuit boards are there in the master blanker?
1. 21
  2. 23
  3. 26
  4. 27
- 3-69. The control, blanker disable is mounted close to the ESM operator and has how many spring-loaded pushbutton switches?
1. 5
  2. 7
  3. 9
  4. 11
- 3-70. How many major components are there in an AN/SLA-10A blanker-video mixer group installation?
1. 5
  2. 6
  3. 3
  4. 4
- 
- Learning Objective: Describe some of the functions and operations of the preamplifier.
- 
- 3-71. Which of the following statements best describes the preamplifier?
1. It uses four bands to supply video to the narrowband ESM receiver
  2. It uses four bands to supply both RF and video to the wideband ESM receiver
  3. It uses four bands to supply RF and video to the narrowband ESM receiver
  4. It supplies RF, video and omnidirectional bearings to the ESM receiver
- 3-72. How many power supplies does the pre-amplifier have?
1. 1
  2. 2
  3. 3
  4. 4
- Questions 3-73 through 3-75 are to be judged True or False.
- 3-73. The RF amplifiers have only one control switch that allows them all to be switched in or out of the circuit simultaneously.
- 3-74. The indicator lamps above the selector switch show whether the omnidirectional or DF antenna has been selected.
- 3-75. Primary power is routed via the control-indicator to the four power supplies.

## Assignment 4

Blankers and Preamplifiers; EW Recording Devices; ECM Systems and Antennas

Textbook Assignment: EW 3&2, NAVEDTRA 10127-A, pages 127 - 157

Learning Objective: Describe some of the functions and operations of the preamplifier.

- 4-1. The antenna used with the preamplifier is controlled by which of the following?
1. The control-indicator
  2. The amplifier assembly
  3. The associated ESM equipment
  4. All of the above
- 4-2. How many RF amplifiers are there in the AM-6844/WLA-3B?
1. 1
  2. 2
  3. 3
  4. 4
- 4-3. What is the frequency range of the AM-6844/WLA-3B?
1. 1.0 to 4.5 GHz
  2. 2.0 to 11.0 GHz
  3. 2.0 to 8.0 GHz
  4. 1.0 to 11.0 GHz
- 4-4. Which bands of the AM-6844/WLA-3B contains TWTAs?
1. Band 1 only
  2. Band 3 only
  3. Band 4 only
  4. Bands 3 and 4
- 4-5. Which of the following controls whether an omnidirectional or DF input is selected for the AN/WLA-3B?
1. A switch on the AN/WLA-3B
  2. A switch on the control indicator
  3. Relays in the AN/WLA-3B
  4. Relays in the control indicator
- 4-6. What type of circuit is used for the +28v d.c. supply in the AN/WLA-3B?
1. A full wave bridge rectifier
  2. A half wave rectifier
  3. A selenium rectifier
  4. A tube rectifier with a gas VR tube
- 4-7. In the DF-DIR mode of operation, the DF signal is fed through K1 and K2 to the output connector, J6, and the video signal is fed where?
1. To K3 and to J5
  2. To K3 and Z1J2
  3. To the TWT amplifier
  4. There is no video output in this mode
- Learning Objective: Describe the operation of the AN/UNQ-7D and AN/UNQ-7E in recording and reproducing ESM and ECM information.
- 4-8. Which of the following audio signal(s) may be recorded on channel A of the AN/UNQ-7D?
1. Voice only
  2. Reference tone only
  3. Both 1 and 2 above
  4. Intercept signal data only
- 4-9. Of the three tape speeds available on the AN/UNQ-7D, which speed is the most desirable for recording ELINT information?
1. 3.75 ips
  2. 7.5 ips
  3. 15.0 ips
  4. The appropriate speed that will provide the ELINT center with sufficient length tape to analyze the signal
- 4-10. In the making of ESM recordings why is a tape speed of 3.75 ips undesirable?
1. It increases the loading effect of the signal
  2. It inhibits the recording of intermittent signals
  3. It detracts from the recording of rapidly recurring signals
  4. It does not provide a good enough frequency response for ESM work

- 4-11. The STANDBY and RECORD indicators on the remote control will not light if which of the following conditions exist(s)?
1. The power is not on
  2. The tape is improperly threaded
  3. A tape is being reproduced
  4. All of the above
- 4-12. An end-of-tape (E.O.T.) warning occurs a few minutes before the tape runs out. This is apparent to the operator on the remote unit when the
1. standby light goes off
  2. record light comes on
  3. standby light flashes
  4. record light flashes
- 4-13. What is the primary advantage of the AN/UNQ-7E over the AN/UNQ-7D?
1. The AN/UNQ-7E has improved frequency response
  2. The AN/UNQ-7E is easier to operate
  3. The AN/UNQ-7E has faster available tape speeds
  4. The AN/UNQ-7E has two tape transports
- 4-14. The E.O.T. warning light that flashes on the AN/UNQ-7E occurs 5 minutes before E.O.T. when the recorder is in which of the following speeds?
1. 3.75 ips
  2. 7.5 ips
  3. 15.0 ips
  4. Either of the above speeds
- 4-15. Where is the AGC defeat switch located on the AN/UNQ-7E?
1. On the record preamplifier card in the equipment cabinet
  2. On the back of the cabinet
  3. On the remote control unit (RCU)
  4. On the power supply card in the equipment cabinet
- 4-16. What channel is affected by the bias defeat switch on the AN/UNQ-7E?
1. Channel B record head bias only
  2. Channel A reference tone only
  3. Channel A voice input only
  4. Channel A bias only
- 4-17. What advantage does the CRZ-6 or CR-1A camera have over the 35 mm camera in ELINT photography?
1. The CRZ-6 or CR-1A allows you to make more pictures without reloading
  2. The CRZ-6 or CR-1A makes clearer pictures
  3. The CRZ-6 or CR-1A allows immediate evaluation of signals
  4. The CRZ-6 or CR-1A allows oscilloscope spectrum analysis and the 35 mm does not

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Learning Objective: Describe the overall function and basic circuitry (at a block-diagram level) of the representative countermeasures set.

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- 4-18. Which of the following techniques would provide the best protection for your equipment against an enemy conical-scan automatic-tracking radar guided missile?
1. Saturation jamming
  2. ESM countermeasures
  3. Deception
  4. Corner reflectors
- 4-19. The equipment function that enlarges radar echoes on the scope of the interrogating radar is referred to as which of the following modes of operation?
1. Decoy repeater
  2. Range gate pull-off (RGPO)
  3. Deception jammer
  4. Trackbreak
- 4-20. What are the major units of the countermeasures set?
1. A RF amplifier and two control-indicators
  2. A radio frequency memory generator and two RF amplifiers
  3. A control-indicator and two RF amplifiers
  4. A control-indicator, a RF amplifier, and a radio frequency generator
- 4-21. What are the two main functions on the countermeasures set?
1. To enhance internally displayed video and to produce a false scanning beam radar-tracking angle
  2. To enhance radar target echoes and to produce a false responder signal for search radars
  3. To enhance radar target echoes and to produce a false scanning beam radar-tracking angle
  4. To produce a false scanning beam radar-tracking angle and a false responder signal for search radars

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Learning Objective: Describe the advantage of Polaroid cameras over conventional 35 mm cameras as used in ELINT scope photography.

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- 4-22. What is the purpose of the video circuits in the countermeasures set?
1. To amplify the RF input signals
  2. To provide an interrogation signal
  3. To provide gating pulses to the transmitter traveling wave tube (TWT)
  4. To bypass the first RF stage
- 4-23. The circuits in the modulator that operate on a low voltage level are supplied their potentials by the power supply in which of the following units?
1. Unit 1
  2. Regulator in unit 2
  3. Regulator in unit 1
  4. Unit 2
- 4-24. Which of the following signals may be modulated by a variable audio oscillator signal?
1. RF input pulses
  2. D.C. grid and beam voltage
  3. Video pulse train
  4. Control-indicator output voltages
- 4-25. The unit 3 control-indicator is designed for which of the following purposes?
1. To be used for operating the equipment at a remote station
  2. To provide a means for checkout testing of the set
  3. To provide an external audio oscillator for equipment testing
  4. All of the above
- 4-26. The RF input and output connections for the RGPO unit are made on which of the following units?
1. The RF amplifier unit 2
  2. The control-indicator unit 3
  3. The RF amplifier unit 1
  4. All of the above
- 4-27. Range gate pull-off signals are used in the (a) mode of operation for (b) deception of (c) radars.  
(DECOY, TRACKBREAK)  
(frequency, range)  
(search, guided missile)
1. (a) DECOY, (b) frequency, (c) search
  2. (a) DECOY, (b) range, (c) guided missile
  3. (a) TRACKBREAK, (b) frequency, (c) search
  4. (a) TRACKBREAK, (b) range, (c) guided missile

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Learning Objective: Explain the functions and operations of the various circuits that are contained in the unit 1 RF amplifier.

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- 4-28. The unit 1 RF amplifier (a) and amplifies a (b) signal.  
(detects, generates)  
(RF, video)
1. (a) detects, (b) video
  2. (a) detects, (b) RF
  3. (a) generates, (b) RF
  4. (a) generates, (b) video
- 4-29. The reason that the low-level TWT is bypassed in the TRACKBREAK mode of operation is because the equipment requires (a) amplification in the (b) TRACKBREAK mode because of the use of (c).  
(less, more)  
(low-level modulation, high-gain antennas)
1. (a) less, (b) low-level modulation
  2. (a) more, (b) low-level modulation
  3. (a) less, (b) high-gain antennas
  4. (a) more, (b) high-gain antennas
- 4-30. The countermeasures set provides for a setting of from 0 dB to 15 dB of attenuation in two separate switched attenuators. What is the purpose of (a) the first attenuator and (b) the second attenuator?
1. Both (a) and (b) prevent saturation of the video detector
  2. (a) compensates for differences between the receive and transmit antennas and (b) prevents saturation of the video detector
  3. Both (a) and (b) compensate for differences between the receive and transmit antennas
  4. (a) prevents saturation of the video detector and (b) compensates for differences between the receive and transmit antennas
- 4-31. The level of attenuation set on the second attenuator is used to regulate which of the following?
1. The auxiliary RF input from the RGPO unit
  2. The RF input level applied to unit 2
  3. The blanking pulse to the low-level TWT
  4. The gain of the intermediate level TWT

- 4-32. The video detector receives its input signal from the (a)  
(RGPO amplifier, third dB directional coupler, second switch attenuator) which is a/an (b)  
low-level d.c., RF signal.
1. (a) RGPO amplifier,  
(b) low-level d.c.
  2. (a) third 10 dB directional coupler,  
(b) low-level d.c.
  3. (a) second switched attenuator,  
(b) RF
  4. (a) third 10 dB directional coupler,  
(b) RF
- 4-33. During RGPO operation, what is the time-frame relationship between the blanking input from the RGPO unit and the blanking input to the low-level TWT?
1. The input to the low-level TWT leads the input from the RGPO unit
  2. Both of the inputs are in coincidence
  3. The input of the low-level TWT lags the input from the RGPO unit
  4. The input to the low-level TWT may either lead or lag the input from the RGPO unit depending on the amount of attenuation introduced at the first switched attenuator
- 4-34. What signals comprise the blanking input to the intermediate level TWT?
1. The blanking input to the intermediate level TWT is the same as the input to the low-level TWT
  2. The intermediate level TWT blanking input is a composite of the RF pulses from the second switched attenuator and the radar blanking signal
  3. The blanking input to the intermediate level TWT is a combination of the radar blanking signal and the blanking and delayed video inputs from the RGPO unit
  4. The radar blanking signal and the blanking input from the RGPO are mixed to form the intermediate level TWT blanking input
- Questions 4-35 and 4-36 are to be judged True or False
- 4-35. In the TRACKBREAK mode of operation the low-level TWT is bypassed because the 4-port microswitches are deenergized.
- 4-36. In the TRACKBREAK mode of operation the amplifier output of the low-level TWT is fed through the second switched attenuator to the RGPO unit.
- 4-37. What prevents the TWT from being triggered into transmitting upon receipt of spurious signals from local radars?
1. The blanking input from the RGPO, in the TRACKBREAK mode, gating off the low-level TWT
  2. The delayed video input from the RGPO, in the TRACKBREAK mode, gating off the intermediate level TWT
  3. The low-level TWT is being gated off, in all modes, by the delayed video input from the RGPO
  4. The intermediate level TWT being gated off, in all modes, by the radar blanking signal
- 4-38. Which of the following signals unblanks the intermediate level TWT to allow transmission of the coincident portion of the RGPO RF pulse?
1. Radar blanking pulse
  2. Undelayed video pulse
  3. The delayed video pulse
  4. The RGPO blanking pulse
- 4-39. The major difference between the TRACKBREAK mode and the DECOY mode exists in the condition of the microwave switches and the low-level TWT. In the DECOY mode the low-level TWT is (a)  
(the first RF amplifier, bypassed) and both of the microwave switches are (b)  
(deenergized, energized)
1. (a) the first RF amplifier,  
(b) deenergized
  2. (a) bypassed,  
(b) energized
  3. (a) the first RF amplifier,  
(b) energized
  4. (a) bypassed,  
(b) deenergized
- 4-40. How does RF energy flow through (a) the first microwave switch and (b) the second microwave switch?
1. (a) Input at port 2 and output at port 4,  
(b) input at port 1 and output at port 4
  2. (a) Input at port 1 and output at port 4,  
(b) input at port 2 and output at port 3
  3. (a) Input at port 2 and output at port 3,  
(b) input at port 4 and output at port 1
  4. (a) Input at port 4 and output at port 1,  
(b) input at port 2 and output at port 3

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- 4-41. What unit is used to adjust the intermediate level gain in the DECOY mode?
1. The video detector
  2. The first switched attenuator
  3. The intermediate level TWT
  4. The second switched attenuator
- 4-42. The video amplifier contains two channels: a linear video amplifier and a/an (a) amplifier, (unsymmetrical, saturated) together with a dynamic, diode load that is used to present a (b) load impedance for low-level signals and a (c) impedance for high-level signals.
1. (a) saturated, (b) high, (c) low
  2. (a) unsymmetrical, (b) high, (c) high
  3. (a) saturated, (b) low, (c) high
  4. (a) unsymmetrical, (b) low, (c) low
- 4-43. What methods are used to control the load of the video detector and reduce the strength of strong video signals to the first video amplifier?
1. The AGC circuitry in the unit 1 receiver controls the video detector diode load and a diode demodulator is used to reduce strong video signals
  2. The AGC circuitry in the unit 1 receiver controls the video detector diode load and a diode limiter is used to reduce strong video signals
  3. The low-level TWT in the unit 1 receiver controls the video detector diode load and a diode demodulator is used to reduce strong video signals
  4. The low-level TWT in the unit 1 receiver controls the video detector diode load and a diode limiter is used to reduce strong video signals
- 4-44. The frequency response of the video detector is uniformly amplified and the signal-to-noise ratio of the video detector is intensified by the action of which of the following?
1. Forward bias on the video detector diode
  2. Forward bias on the limiter diode
  3. Reverse bias on the video detector diode
  4. Reverse bias on the limiter diode
- 4-45. A low-level signal causes the diode load tube to conduct a (a) amount of current since it is connected to a peak detector (limiter) and acts as a (b) impedance.
1. (a) greater, (b) high
  2. (a) lesser, (b) high
  3. (a) greater, (b) low
  4. (a) lesser, (b) low
- 4-46. The linear video amplifier channel is capable of accommodating a large range of input signals. The large dynamic range of the channel is provided by the control of which of the following?
1. The first and third stages of amplification by the AGC voltage
  2. The first and second stages of amplification by the AGC voltage
  3. The limiter-clamper network clamping the baseline to a large positive value
  4. The limiter-clamper network clamping the baseline to a large negative value
- 4-47. Which of the following explains why the video detector output level is lower in the TRACKBREAK mode than in the DECOY mode?
1. The video detector is provided with only one stage of input RF amplification
  2. The video detector is provided with two stages of input amplification
  3. The video detector is provided with one stage of input and one stage of output RF amplification
  4. The video detector is provided with two stages of input and two stages of output RF amplification
- 4-48. What direct effect does the lower output level of the video detector in the TRACKBREAK mode have on the operation of the linear video amplifier channel?
1. Less linear channel amplification and no input bias
  2. A smaller amount of linear channel input bias
  3. A greater amount of linear channel input bias
  4. Additional linear channel amplification and a greater amount of input bias



- 4-49. The purpose of the diode clamp is to aid recovery after (a) signals by eliminating the (b) edge overshoots.  
 1. (a) weak, (b) trailing  
 2. (a) strong, (b) trailing  
 3. (a) weak, (b) leading  
 4. (a) strong, (b) leading
- Questions 4-50 through 4-62 are based on the saturated video amplifier channel and are to be judged True or False.
- 4-50. The major components of the channel consist of an emitter follower and four transistor stages.
- 4-51. The first and third stages are PNP transistor amplifiers.
- 4-52. The physical connection of the four transistor stages are cascade.
- 4-53. The channel transistors are connected in cascade configuration to minimize overshoot and recovery problems.
- 4-54. The channel is a high-gain unit that introduces minimum time delay to video signals.
- 4-55. Only negative overshoots are eliminated by the limiter-clamper network.
- 4-56. Sensitivity of the channel is controlled by the threshold control.
- 4-57. The final amplifier stage has a constant negative voltage applied to its collector.
- 4-58. A transistor that appears as a short circuit allows the RGPO pulse to retrigger the RGPO unit whenever the auxiliary RF input from the RGPO unit is produced.
- 4-59. The modulator in unit 2 is supplied saturated video pulses through the control action of a zero delay gate from the auxiliary RF unit.
- 4-60. The gated cathode follower that feeds the video pulses to the unit 2 modulator has a negative potential applied to its grid during RGPO operation dwell time.
- 4-61. The auxiliary RF unit delayed video pulses are fed to the diode clamp that precedes the final video amplifier stage.
- 4-62. The purpose of the auxiliary RF unit delayed video pulses is to permit the transmission of RGPO.

- 4-63. Which of the following are the three major functional circuit groups that comprise the AGC and scan information circuits?  
 1. AGC, pulse width limiting, and threshold  
 2. AGC, scan information, and threshold  
 3. Pulse width limiting, scan information, and threshold  
 4. Pulse width limiting, AGC and threshold, and scan information circuits
- 4-64. Stretched pulse-for-pulse output is a function of which of the following?  
 1. The delayed video circuits  
 2. The scan information circuits  
 3. The AGC circuits  
 4. The pulse width limiting circuits
- 4-65. The stretched pulse-for-pulse output is also referred to as the (a) and one of (b) their functions is to ensure that the detectors are not sensitive to (b)  
(standard pulse width, interleaving pulses)  
(pulse width only, pulse width and pulse repetition rate.)  
 1. (a) standard pulse width, (b) pulse width only  
 2. (a) standard pulse width, (b) pulse width and pulse repetition rate  
 3. (a) interleaving pulses, (b) pulse width only  
 4. (a) interleaving pulses, (b) pulse width and pulse repetition rate
- 4-66. Another purpose for the stretched pulse-for-pulse output is that pulse width limiting will do which of the following?  
 1. It will enhance pulse sampling during any system oscillation  
 2. It will increase the pulse sampling time to permit system oscillation  
 3. It will prevent pulse sampling and allow the system to oscillate  
 4. It will prohibit the sampling of a pulse when the system could oscillate
- 4-67. If RF oscillations do start, at what time will the system begin to act as an oscillator?  
 1. Between one and three microseconds after the receipt of the pulse  
 2. At any time prior to the receipt of the pulse  
 3. In coincidence with the receipt of the pulse  
 4. Within one microsecond after the receipt of the pulse

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- 4-68. Which of the following units produces the video blanking input to the isolating cathode follower?  
1. The linear video amplifier  
2. The auxiliary RF unit  
3. The scan information circuits  
4. The saturated video amplifier
- 4-69. Which of the following is a purpose of the video blanking pulse?  
1. To allow RGPO pulses to pass and trigger the AGC circuits  
2. To permit the passage of RGPO pulses into the scan information circuits  
3. To prohibit RGPO pulses from influencing the AGC and scan information circuits  
4. To energize a special blanking circuit that eliminates all video signals

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In answering questions 4-70 through 4-72, select from column B the unit of the AGC and threshold circuits that produces the output listed in column A.

<u>A. Outputs</u>	<u>B. Units</u>
4-70. Threshold control to the saturated video amplifier channel	1. Schmitt trigger 2. Peak detector 3. Diode gate 4. Cathode follower
4-71. AGC bus to the linear video amplifier channel	
4-72. Peak detector to the video amplifier	

- 4-73. What is the purpose of the threshold control input to the saturated video amplifier channel?  
1. To control the sensitivity of the channel  
2. To provide a trigger for the RGPO unit  
3. To eliminate overshoots in the channel's limiter-clamper network  
4. To control the output of the channel's final amplifier stage
- 4-74. What type of output is produced by the scan information circuits?  
1. A stretched (boxcar) pulse output  
2. A sine wave output  
3. A sampling pulse output  
4. An amplified RF output
- 4-75. Which of the following signals is/are applied to the scan information circuits?  
1. The only input is the video signal  
2. The only input is the stretched pulse  
3. Both the video signal and stretched pulses are inputs  
4. Both the stretched pulses and sampling pulses are inputs

## Assignment 5

### ECM Systems and Antennas

Textbook Assignment: EW 3&2, NAVEDTRA 10127-A, pages 158 - 171

Learning Objective: Explain the functions and operations of the various circuits that are contained in unit 1 RF amplifiers.

- 5-1. The primary purpose of the unit 1 TWT blanking circuits is to provide (a) signals directly to the (b) (video amplifier and TWT, TWT and AGC) circuits.
- (a) video, (b) video amplifier and TWT
  - (a) video, (b) TWT and AGC
  - (a) blanking, (b) video amplifier and TWT
  - (a) blanking, (b) TWT and AGC
- 5-2. The purpose of the blocking diode in the unit 1 TWT blanking circuit is to
- prevent the positive video pulse from entering the mixer amplifier
  - eliminate the radar blanking input from the local control panel
  - delay the video input from the auxiliary RF unit
  - produce a sawtooth voltage
- 5-3. What is the output produced by the mixer amplifier?
- A sum output of the video blanking and delayed video less the video blanking
  - A difference of the radar blanking minus the video blanking and delayed video
  - A sum output of the radar blanking and video blanking less the delayed video
  - A difference output of the video blanking minus the radar blanking plus the delayed video
- 5-4. The mixer amplifier is used to combine the (a) radar blanking (negative, positive) signal with the (b) (transverse, inverted) video blanking signal.
- (a) negative, (b) transverse
  - (a) positive, (b) transverse
  - (a) negative, (b) inverted
  - (a) positive, (b) inverted
- 5-5. Which of the following amplified signals are applied to the intermediate level TWT from the unit 1 TWT blanking circuits?
- Negative, composite blanking signal
  - Negative, single enabling signal
  - Positive, composite blanking signal
  - Positive, single enabling signal
- 5-6. The unit 1 audio oscillator output is (a) and is used by the (b) (AGC, modulator) circuits.
- (a) variable, (b) AGC
  - (a) fixed, (b) modulator
  - (a) fixed, (b) AGC
  - (a) variable, (b) modulator
- 5-7. There are various front panel controls for the sweep-frequency, audio output signal of the audio oscillator. Which of the following portions of this signal may be varied?
- The center frequency and sweep period only
  - The sweep width, sweep period, and bandpass frequency
  - The sweep width and center frequency only
  - The sweep width, center frequency, and sweep period

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- 5-8. The sweep amplifier input is in the form of which of the following signals?
1. Negative pulse train
  2. Square wave
  3. Triangular wave
  4. Sine wave
- 5-9. What is the purpose of the variable d.c. level input to the paraphase amplifier?
1. To allow control of the sweep period of the oscillator
  2. To cut off the oscillator
  3. To control the amplitude of the oscillator output
  4. To permit changes to the oscillator center frequency
- 5-10. To deenergize both the external and internal audio relays, the AUDIO switch must be in which of the following positions?
1. The INT position
  2. The OFF position
  3. The EXT position
  4. All positions except OFF are acceptable
- Questions 5-11 through 5-28 are to be judged True or False. All the information for these items is taken from the section covering the low-level and intermediate-level TWTs, and the low voltage power supply of the unit 1 RF amplifier.
- 5-11. The low-level TWT power supply provides a negative 1200 volts to the cathode of the TWT and other negative voltages to the TWT grid and anode.
- 5-12. The reason the low-level TWT power supply furnishes the potentials as specified is that both the TWT collector and helix are maintained at a positive potential with respect to ground.
- 5-13. The input to the half-wave rectifier circuit of the low-level TWT power supply is three phase 1550 v.a.c.
- 5-14. Both the focusing and acceleration electrodes of the low-level TWT have their voltages furnished by the dividing network of the regulated output.
- 5-15. A series relay in the overload chain provides current overload protection for the low-level TWT helix.
- 5-16. One of the input potentials to the intermediate level TWT power supply is 1600 v.d.c.
- 5-17. A voltage output that is going more negative will cause the application of a positive-going error voltage to the grid of the series pass-tubes in the intermediate level TWT power supply circuits.
- 5-18. The intermediate level TWT helix is protected from current overloads in the same way as the low-level TWT helix is protected from current overloads.
- 5-19. There are five functional circuit groups in the unit 1 low voltage power supply.
- 5-20. The +200 v. power supply uses both three-phase power and three-phase full-wave bridge rectifiers.
- 5-21. The high d.c. current requirements of the +200 v. power supply determines its power requirements and types of rectification.
- 5-22. The control grid in the +200 v. power supply series pass-tube is driven by the plate of the control amplifier.
- 5-23. The voltage regulator tubes in the +400 v. power supply are used to provide a stable reference for the cathode of only the +400 v. power supply control amplifier.
- 5-24. The pair of control amplifier nuvistors in the -90 v. power supply operate as a summing amplifier.
- 5-25. Temperature compensation in the 2nd control amplifier of the -90 v. power supply is provided by a thermistor.
- 5-26. Temperature compensation in the 2nd control amplifier of the -90 v. power supply is necessary because of the variations in the zener diode voltage at the plate of the 2nd amplifier.
- 5-27. The outputs of the +6 v. and -15 v. power supply are utilized as zener-diode regulated voltages in the video amplifier and local control assembly transistorized circuits.
- 5-28. The regulation of the +6 v. and -15 v. power supply requires the use of a complex circuit.
- 5-29. What is the cathode voltage of the low-level TWT?
1. 1000 volts d.c.
  2. 1200 volts d.c.
  3. 1400 volts d.c.
  4. 1600 volts d.c.

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- 5-30. What type of regulation, if any, is used in the +400 volt d.c. power supply?
1. Series
  2. Parallel
  3. Series-parallel
  4. None
- 5-31. A zener diode provides regulation in which of the following power supply(ies)?
1. +400 volt
  2. +200 volt
  3. -90 volt
  4. +6 and -15 volts

Learning Objective: Describe the functions and operations of the various circuits that make up the unit 2 RF amplifier.

- 5-32. The unit 2 RF amplifier transmitter microwave circuit receives its input RF signal from the \_\_\_\_\_ (a) \_\_\_\_\_ (antenna, unit 1 RF amplifier) and applies it directly to the \_\_\_\_\_ (b) \_\_\_\_\_ (switched attenuator, directional coupler)
1. (a) antenna, (b) switched attenuator
  2. (a) unit 1 RF amplifier, (b) directional coupler
  3. (a) unit 1 RF amplifier, (b) switched attenuator
  4. (a) antenna, (b) directional coupler
- 5-33. Which of the following is a function of the equalizer?
1. To dissipate the full-power output
  2. To apply a sample of the RF output to an adapter
  3. To flatten the overall frequency response
  4. To attenuate the input RF signal in both operational modes
- 5-34. In the ALERT condition the output of the 30 dB directional coupler will be \_\_\_\_\_ (a) \_\_\_\_\_ by the \_\_\_\_\_ (b) \_\_\_\_\_ (transmitted, terminated) (dummy load, antenna)
1. (a) transmitted, (b) dummy load
  2. (a) transmitted, (b) antenna
  3. (a) terminated, (b) dummy load
  4. (a) terminated, (b) antenna
- 5-35. From what point in the circuit is the power monitoring sample taken?
1. The switched attenuator
  2. The four-port waveguide switch
  3. The dummy load
  4. The 10 dB directional coupler

- 5-36. What is the condition of the gated amplifier in the TRACKBREAK and DECOY modes of operation?
1. It is biased off in the DECOY mode until video signals are present for at least two seconds and the amplifier is normally on in all TRACKBREAK modes
  2. It is biased off in all modes until video signals are present for at least two seconds
  3. It is normally on in the DECOY mode and the amplifier is biased off in all TRACKBACK modes until video signals are present for at least two seconds
  4. It is normally on in all modes

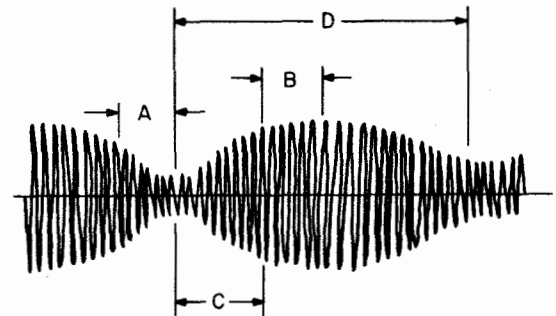


Figure 5-1.--Modulation envelope.

- For question 5-37, refer to figure 5-1.
- 5-37. In the inverse gain (IG) mode of operation, the gated amplifier is gated on during what portion of the envelope shown in figure 5-1?
1. A
  2. B
  3. C
  4. D
- 5-38. The electron multiplier tube operates on the principle of secondary emission, has a good rise time, a \_\_\_\_\_ (a) \_\_\_\_\_ delay, \_\_\_\_\_ (high, low) and a \_\_\_\_\_ (b) \_\_\_\_\_ recovery. \_\_\_\_\_ (fast, slow)
1. (a) high, (b) fast
  2. (a) high, (b) slow
  3. (a) low, (b) fast
  4. (a) low, (b) slow

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- 5-39. From which of the nine elements of the electron multiplier tube is the output taken?
1. Control grid
  2. Accelerating grid
  3. Last dynode
  4. Collector
- 5-40. To provide stable operation, only certain dynodes in the electron multiplier tube are voltage regulated. What are the designations of these dynodes?
1. First, second, and third dynodes
  2. First, third, and fifth dynodes
  3. Second, third, and fourth dynodes
  4. Third, fourth, and fifth dynodes
- 5-41. Why is it necessary to shape the pulse in the pulse-shaping network?
1. The pulse shaper shortens any pulse that has been stretched by the voltage divider network
  2. The TWT grid coupling capacitor and high-level TWT power supply cause a droop in the top of the pulse that is restored by the pulse shaper
  3. The pulse shaper lengthens any pulse that has been shortened by the electron multiplier modulator
  4. The TWT grid coupling capacitor and high-level TWT power supply caused sharp peak on top of the pulse that is removed by the pulse shaper
- 5-42. The scan modulation gating circuits produce a (a) whenever the scan modulation signal (b) a prescribed percent of modulation.
1. (a) feedback, (b) modulation
  2. (a) gate, (b) falls below
  3. (a) gate, (b) reaches
  4. (a) feedback, (b) reaches
- 5-43. The split load phase inverter produces two outputs. What are these outputs?
1. A cathode follower output that is 180° out of phase with the unit 1 signal and a plate output that is in phase with the received radar signal
  2. A cathode follower output that is in phase with the unit 1 signal and a plate output that is in phase with the received radar signal
  3. A cathode follower output that is 180° out of phase with the unit 1 signal and a plate output that is 180° out of phase with the received radar signal
  4. A cathode follower output that is in phase with the unit 1 signal and a plate output that is 180° out of phase with the received radar signal
- 5-44. What determines which output of the split load phase inverter is used by the scan amplifier and the modulation circuit?
1. The position of the INT-EXT audio relay contacts
  2. The signal level of the INT audio from unit 1
  3. The position of the IG-AUX relay contacts
  4. The frequency of the scan disable signal from unit 1
- 5-45. The Schmitt trigger in the scan modulation gating circuits produces two (a) wave outputs (b) with the one out of phase, both in phase) received radar signal.
1. (a) sine, (b) one in and one out of phase
  2. (a) sine, (b) both in phase
  3. (a) square, (b) one in and one out of phase
  4. (a) square, (b) both in phase
- 5-46. In addition to supplying the chopped inputs from the pulse width limiting circuits, the cathode follower in the scan modulation gating circuits supplies the modulator circuits with which of the following voltages?
1. Screen voltage to the electron multiplier modulator
  2. Plate voltage to the amplifiers
  3. Plate voltage to the voltage regulators
  4. Screen voltage to the gated amplifier
- 5-47. In the DECOY and RGPO mode of operation the scan amplifier is (a) and the cathode follower circuits keep the gated amplifier in a normally (b) condition.
1. (a) enabled, (b) off
  2. (a) disabled, (b) on
  3. (a) enabled, (b) on
  4. (a) disabled, (b) off
- 5-48. The pulse width limiting circuits in the unit 2 RF amplifier are designed to perform which of the following functions?
1. Limit the modulator output pulses to 1 microsecond wide in the TRACKBREAK modes
  2. Limit the modulator output pulses to 5 microseconds wide in the DECOY mode
  3. Prevent spurious RF build-up of the transmitted pulses due to leakage
  4. All of the above

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- 5-49. The major difference in the operation of the pulse width limiting circuits in the TRACKBREAK mode and the DECOY mode is determined by which of the following?
1. The charge time of either the integrating or DECOY mode capacitors
  2. The discharge time of either the integrating or DECOY mode capacitor
  3. The condition of the first amplifier
  4. The state of the monostable multi-vibrator
- 5-50. To change the off-time of the pulse width limiting circuit you should vary which of the following circuit parameters?
1. The value of a capacitor
  2. The amplitude of the input signal
  3. The value of a potentiometer
  4. The frequency of the sweep circuits
- 5-51. What is the purpose of the activity circuits?
1. To activate a power supply
  2. To deenergize a relay
  3. To deactivate a power supply
  4. To energize a relay
- 5-52. The condition of the activity relay determines the state of which of the following?
1. The first pulse stretcher
  2. The decoy relay
  3. The 2-second delay switch circuit
  4. The second pulse stretcher
- A. Biased off

B. Cutoff

C. Conducting

D. Biased on
- Figure 5-2
- In answering questions 5-53 through 5-56, select from figure 5-2 the condition of (a) the 2-second delay switch tube and (b) the modulator circuit gated amplifier during the circuit condition used as the question.
- 5-53. TRACKBREAK modes with no signal input.
1. (a) A, (b) B
  2. (a) C, (b) B
  3. (a) C, (b) A
  4. (a) A, (b) D
- 5-54. DECOY mode with no signal input.
1. (a) A, (b) B
  2. (a) C, (b) B
  3. (a) C, (b) D
  4. (a) A, (b) D
- 5-55. TRACKBREAK modes with an input signal applied.
1. (a) A, (b) B
  2. (a) C, (b) B
  3. (a) C, (b) D
  4. (a) A, (b) D
- 5-56. DECOY mode with an input signal applied.
1. (a) A, (b) B
  2. (a) C, (b) B
  3. (a) C, (b) A
  4. (a) A, (b) D
- 5-57. What is the function of the power indication circuits?
1. To energize a relay which in turn provides a visual indication on the local and remote front panels
  2. To deenergize a relay which in turn activates an audible indicator on the local and remote front panels
  3. To energize a relay which in turn activates an audible indicator on the local and remote front panels
  4. To deenergize a relay which in turn provides a visual indication on the local and remote front panels
- 5-58. The operation of the power indication circuits is dependent upon the receipt of a detected pulse sample from the power monitor detector. For the operation of the power indicator lamp, the amplitude of this pulse must represent which of the following power figures?
1. Maximum RF power output of 100 watts
  2. Minimum RF power output of 100 watts
  3. Maximum video power output of 100 watts
  4. Minimum video power output of 100 watts
- 5-59. The LOW MODULATION indicator lamps on the local and remote control panels will be illuminated when the scan modulation gate sample indicates modulation in excess of what percent?
1. 1.0 percent
  2. 1.5 percent
  3. 2.0 percent
  4. 2.5 percent
- 5-60. HIGH MODULATION indicators will illuminate when the modulation input indicates what percent?
1. 2.5 percent
  2. 12.5 percent
  3. 25 percent
  4. 50 percent

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- 5-61. Which of the following is one of the purposes of the control diode (SCR) in the modulation indicator circuits?
1. To provide a source of 12 v.d.c. to the indicator lamps
  2. To provide a source of current to energize the high modulation relay
  3. To set the firing potential for the high modulation indication circuits Schmitt trigger
  4. To complete the ground return path for the LOW MODULATION indicator lamps
- Questions 5-62 through 5-66 are to be judged True or False.
- 5-62. The scan modulation signal to the high modulation indicator circuit is obtained from the output of the split-load phase inverter in the scan modulation indication circuit.
- 5-63. The pickoff point of the scan modulation signal in the scan modulation gating circuits is after the point where the internal audio signal is injected into the scan modulation gating circuits.
- 5-64. The scan modulation input signal to the high modulation indication circuit is peak detected which results in a positive d.c. voltage proportional to the percent of modulation.
- 5-65. The firing of the Schmitt trigger in the high modulation indication circuits causes the high modulation relay to energize.
- 5-66. A 12 v.a.c. is applied to the HIGH MODULATION indicator lamps through the deenergized contacts of the high modulation relay.
- 5-67. The duty cycle overload relay will energize when the equipment duty cycle exceeds what percent?
1. 0.25 percent
  2. 0.50 percent
  3. 0.75 percent
  4. 1.00 percent
- 5-68. The duty cycle overload relay is energized by the bistable operation of
1. the peak clamping network
  2. the integrating network
  3. the Schmitt trigger
  4. the peak detector



## Assignment 6

ECM Systems and Antennas; EW Publications and Instructions; Signal Analysis and Identification

Textbook Assignment: EW 3&2, NAVEDTRA 10127-A, pages 172 - 193

Learning Objective: Describe the functions and operations of the various circuits that make up the unit 2 RF amplifier and determine the purpose of the unit 3 control-indicator.

- 6-1. The modulator power supply contains two power supplies, a -1850 volt power supply and a (a) volt power supply and both are (b).
- (regulated, unregulated)
- (a) +600, (b) regulated
  - (a) -600, (b) regulated
  - (a) +600, (b) unregulated
  - (a) -600, (b) unregulated
- 6-2. The -1850 volt power supply furnishes an operating potential to the modulator. Which of the following voltages is not developed in the modulator for the electron multiplier?
- The cathode and control grid voltage
  - The accelerating grid voltage
  - The dynode voltage
  - The plate voltage
- 6-3. What is the purpose of the series regulator tube in the -1850 power supply?
- To act as a fixed resistor in series with the load to maintain a constant a.c. voltage across the load
  - To act as a variable resistor in parallel with the load to maintain a constant d.c. voltage across the load
  - To act as a fixed resistor in parallel with the load to maintain a constant d.c. voltage across the load
  - To act as a variable resistor in series with the load to maintain a constant a.c. voltage across the load
- 6-4. In the control amplifier, the control tube has two sections. What do the specific connections of these sections result in?
- A cathode-coupled difference amplifier whose output error voltage is a function of the grid differences of the tube
  - A grid-coupled difference amplifier whose output error voltage is a function of the cathode difference of the tube
  - A plate-coupled difference amplifier whose output error voltage is a function of the cathode to grid difference of the tube
  - A cathode-coupled difference amplifier whose output error voltage is a function of the plate to grid differences of the tube
- In answering question 6-5, refer to figure 8-28 of your textbook.
- 6-5. What is the condition of the control amplifier tube is the EM ANODE VOLT DELAY relay is deenergized?
- The plate and cathode are grounded resulting in a large negative biasing of the tube
  - The grid and cathode are grounded resulting in a zero biasing of the stage
  - The plate and cathode are grounded resulting in a zero biasing of the stage
  - The grid and cathode are grounded resulting in a large negative biasing of the stage
- 6-6. A constant a.c. input to the plate of the high level TWT power supply series regulator is assured because of the actions of which of the following?
- The voltage doubler
  - The control amplifier
  - The magnetic amplifier
  - The spark gap

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- 6-7. The voltage regulator tubes in the high level TWT power supply are provided with their input by which of the following?
1. The magnetic amplifier
  2. The series regulator
  3. The voltage reference
  4. The half-wave rectifier
- 6-8. The zener regulator diode is used to regulate which of the following TWT elements?
1. To maintain the cathode at a +100 volts potential in respect to the collector
  2. To maintain the grid at a -100 volts potential with respect to the cathode
  3. To maintain the helix at a -100 volts potential with respect to the collector
  4. To maintain the grid at a +100 volts potential with respect to the cathode
- 6-9. Certain components are used to minimize the possibility of arcing in the high level TWT power supply. What are these components?
1. Two buffering resistors, energy storage capacitors, and one of the two spark gaps
  2. Two spark gaps and some buffering resistors
  3. Energy storage capacitors and the buffering resistors
  4. The spark gaps and the energy storage capacitors
- 6-10. What is the purpose of the unit 3 control-indicator?
1. To allow an operator to override the open interlock switches on either unit 1 or unit 2
  2. To permit the operation of the countermeasures set from a remote location
  3. To control the operation of unit 1 when the LOCAL REMOTE switch is set to the LOCAL position
  4. To provide a control of audio gain that is not available on any other unit
- 6-11. What is the purpose of the countermeasures set antenna group?
1. To function as a range-finding receiver system
  2. To provide for ECM transmission only
  3. To function as a direction-finding receiving system
  4. To provide for ECM reception only
- 6-12. Which of the following is/are contained in the lower shroud of the antenna group?
1. The circularly polarized conical horn used for ECM reception
  2. A pair of circularly polarized DF horns with their required switching components
  3. The circularly polarized conical horn used for ECM transmission
  4. All of the above
- 6-13. The design of the antenna group provides for a capability for amplitude comparison lobing. Which of the following singular characteristics of the design establish(es) this capability?
1. The physical relationship of the ECM receiving and transmitting horns
  2. The circular polarization of the two ECM horns
  3. The physical position of the two DF horns
  4. All of the above
- 6-14. What does a typical shipboard countermeasures set antenna group installation include?
1. One complete antenna group mounted at the center of the ship
  2. Two complete antenna groups; one mounted on the bow facing forward and the second mounted on the stern facing aft
  3. Four complete antenna groups
  4. Two complete antenna groups; one mounted facing starboard and the second mounted facing port
- 6-15. What condition determines the type of ECM horns that will be installed in the countermeasures set trainable antenna assembly?
1. The desired beamwidth
  2. The anticipated maximum range requirements
  3. The desired bandpass
  4. The capabilities of the set operator

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Learning Objective: Explain the function, physical configuration, and characteristics of the countermeasures set antennas and control-indicators.

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- 6-16. What are the characteristics of the circularly polarized conical horns in the direction-finding (DF) antenna system?
1. High gain, narrow-beam
  2. Low gain, narrow-beam
  3. Low gain, wide-beam
  4. High gain, wide-beam
- 6-17. What instrument is used by the operator to position DF?
1. The AGC meter
  2. A CRT display
  3. A digital read-out meter
  4. The high level function monitor
- 6-18. What provides RF amplification in the control-indicator?
1. The paraphase amplifier
  2. The low noise phantastron circuit
  3. The low noise TWT
  4. The transistorized power amplifier
- 6-19. What is the purpose of the screwdriver controls on the servoamplifier?
1. To eliminate the "rate" and "error" information
  2. To control the amplifier gain
  3. To increase the power output of the set
  4. To mix the "rate" and "error" information
- 6-20. Which unit permits the simultaneous display of both relative bearing and true bearing information without the use of a separate synchro amplifier?
1. The bearing conversion unit
  2. The mixer amplifier
  3. The staircase detector diode bridge
  4. The video detector diode load unit
- 
- Learning Objective: Describe some of the basic publications and instructions used in the EW field to include fundamental content and applicability of such documents.
- 
- 6-21. What publication is used to provide detailed information about the format of either an operation plan (OPLAN) or an operation order (OPORDER)?
1. NWP 0
  2. NWP 11
  3. AXP 2
  4. ATP1, Vol 1
- 6-22. OPLANS may best be described by a statement that says they are
1. based on assumptions
  2. prepared during an operation
  3. developed to start on an effective date
  4. issued for a specific operation
- Questions 6-23 through 6-25 are to be judged True or False.
- 6-23. An OPORDER directs the conduct of an operation.
- 6-24. One feature of an OPORDER is that it must contain assumptions.
- 6-25. An OPORDER is effective for a time and date specified.
- 6-26. For which of the following purposes may Tactical Warfare Publications NOT be used?
1. Reference for current tactics doctrine and procedures
  2. Study material for increasing professional knowledge
  3. Training material for foreign nationals
  4. A basis for orientation and training
- Questions 6-27 through 6-29 are to be judged True or False.
- 6-27. Tactical doctrine publications are to be safeguarded and accounted for in accordance with the procedures set forth in the Information Security Program Regulation Manual.
- 6-28. Information from tactical doctrine publications is not to be extracted or reproduced at any time.
- 6-29. Tactical Warfare Publications may not be reproduced or extracted from without prior permission in accordance with CMS-4.
- 6-30. What color is the binder for a secret NATO publication?
1. Red
  2. Blue
  3. White
  4. Yellow
- 6-31. You are on a new ship and wish to obtain information on setting up a Tactical Warfare Publications library. You should refer to
1. NWP 0
  2. NWP 33
  3. NWIP 1-4
  4. ATP 1, Vol 2

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- 6-32. The publication that contains information for electronic warfare and anti-air warfare in a missile threat environment is
1. NWP 33
  2. NWP 31
  3. NWP 32
  4. NWP 24
- 6-33. The publication you will use for guidance in employing electronic warfare in naval operations is
1. NWP 16
  2. NWP 24
  3. NWP 33
  4. NWP 37
- 6-34. An instruction serves which of the following purposes?
1. Establishes policy
  2. Assigns responsibility
  3. Initiates a course of action
  4. All of the above
- 6-35. Which of the following instructions establishes policy guidance to prevent disclosure of electronic warfare information when in the vicinity of Sino-Soviet bloc forces?
1. OPNAVINST 003430.1
  2. OPNAVINST 5430.30
  3. OPNAVINST 03430.4
  4. OPNAVINST 003430.13
- 6-36. When entering corrections in official publications, you may use ink of any dark color except
1. red
  2. black
  3. blue
  4. green
- 6-37. Publications kept in EW must be inventoried at least once each
1. watch
  2. day
  3. week
  4. month
- 
- Learning Objective: Explain some of the procedures for analyzing and identifying electromagnetic emissions.
- 
- 6-38. Which of the following statements best describes a normal use of modulation?
1. Modulation is used for better musical tones
  2. Modulation is used to convey intelligence
  3. All radars use frequency modulation
  4. Morse code uses amplitude modulation
- 6-39. Of the communications systems listed below, which one does NOT use amplitude modulation?
1. Communications
  2. TV video
  3. TV audio
  4. Music
- 6-40. The length of time a radar fires is called pulse width (PW). What is pulse width used to determine?
1. Bearing and range resolution
  2. Minimum range and target altitude
  3. Target altitude
  4. Theoretical minimum range
- 6-41. You have intercepted a signal from a radar that has a pulse width of 60 microseconds. What is the range of the radar?
1. Very short range
  2. Short range
  3. Medium range
  4. Long range
- 6-42. A radar having a short range will have a pulse width of
1. 1  $\mu$ sec
  2. 2  $\mu$ sec
  3. less than 1  $\mu$ sec
  4. over 4  $\mu$ sec
- 6-43. For a radar to obtain good minimum range of a target, the pulse should be
1. wide with a flat top
  2. short with a steep trailing edge
  3. wide with a steep trailing edge
  4. short with a steep trailing edge
- 6-44. A radar with a pulse repetition frequency (PRF) of 950 pulses per second (pps) will probably have
1. very long range
  2. medium range
  3. long range
  4. short range
- 6-45. The pitch of the audio from the ESM receiver is determined by the
1. PW
  2. PRF
  3. modulation
  4. pulse shape
- 6-46. You have intercepted a signal, and it has a high-pitched, shrill sound. It can be classified as to its probable function as
1. long-range surface search
  2. short-range air search
  3. fire control
  4. IFF

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- 6-47. You are listening to the audio tone of an intercepted signal and it has a varying pitch. You should suspect that it is
1. short-range search
  2. missile guidance
  3. gun control
  4. surface search
- 6-48. If an intercepted signal is suspected to be a missile guidance radar, you can tell by checking which of the following?
1. Frequency
  2. PRF
  3. Beam width
  4. Pulse amplitude/pulse width
- 6-49. What is the range capability of a radar operating at 300 MHz?
1. Short
  2. Medium
  3. Both 1 and 2 above
  4. Long
- 6-50. Which of the following determines the beam width of a radar?
1. Frequency, shape, and size of the antenna
  2. Frequency, PRF, PW, and size of the antenna
  3. Frequency, pulse shape, and PRF
  4. Frequency, pulse width, and size of the antenna
- 6-51. Lobe duration is the length of time that a target is illuminated by which of the following?
1. Minor lobes
  2. Side lobes
  3. Back lobes
  4. Main lobe
- 6-52. Circular scan is used for search and is measured in
1. seconds per rotation
  2. cycles per second
  3. cycles per sector
  4. revolutions per minute
- 6-53. A sector scan signal will sound exactly like a circular scan signal in what part of the sector?
1. On the extreme outer edge of the sector
  2. Near the outer limits of the sector
  3. Exactly on the center line of the sector
  4. At any point within the sector
- 6-54. Which of the following types of scan is used for precision tracking?
1. Sector
  2. Lobe switching
  3. Mono-pulse
  4. Conical
- 6-55. The spiral scan is normally used for
1. tracking
  2. acquisition
  3. missile guidance
  4. search
- 6-56. The raster scan is normally used for
1. airborne weapons control
  2. shipboard target acquisition
  3. airborne search
  4. target tracking
- 6-57. Vertical sector can be either electronic or mechanical and is used for
1. search only
  2. tracking only
  3. search and tracking
  4. height-finding
- 6-58. The person responsible for the initial evaluation of a signal is the
1. EW watch officer
  2. operator
  3. EWO
  4. watch supervisor
- 6-59. The two most important things you need to know about an intercepted signal are
1. frequency and bearing
  2. type of radar and platform
  3. function and platform
  4. range and bearing
- 6-60. What characteristic(s) of an emitter will normally be used to indicate platform?
1. Frequency
  2. PRF
  3. PW
  4. All of the above
- 6-61. Radars in the frequency range of 25 to 3000 MHz are normally used for all of the following except
1. early warning
  2. height finding
  3. air search
  4. NAVAIDS
- 6-62. FM or CW above the 5500 MHz range may indicate which of the following?
1. Missile guidance
  2. Speed measuring device
  3. Both 1 and 2 above
  4. Airborne missile tracking
- 6-63. The characteristic of the intercepted signal used to make the general range estimate is which of the following?
1. Frequency
  2. Pulse shape
  3. PRF
  4. PW

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6-64. With which of the following radars would you associate scan rates of 20 SPR or higher?

1. Height-finders and long-range radars
2. Medium-range and missile guidance radars
3. Short-range and target tracking radars
4. Surface search and navigational radars

6-65. Search radars use which of the following types of scan?

1. Sector
2. Circular
3. Both 1 and 2
4. Palmer

6-66. Of the types of scan listed below, which one is NOT used for height-finding?

1. Vertical scan
2. Nodding scan
3. Circular scan with V-beam
4. Lobe switching

## Assignment 7

Signal Analysis and Identification; Communications; EW Status Boards, Logs and Plots

Textbook Assignment: EW 3&2, NAVEDTRA 10127-A, pages 193 - 228

Learning Objective: Explain some of the procedures for analyzing and identifying electromagnetic emissions.

- 7-1. Which of the following characteristics is used for determining the function of the radar?
1. Frequency
  2. Scan rate
  3. Type of scan
  4. Pulse width
- 7-2. You have intercepted a signal that has a rapid bearing drift. The signal is probably coming from
1. a submarine
  2. an aircraft
  3. either 1 or 2 above
  4. a surface ship
- 7-3. Which of the following radars are associated with very narrow beam-widths?
1. Long-range search
  2. Target tracking
  3. Weapons control
  4. Short-range navigation
- 7-4. The second trace of the analysis scope is calibrated to which of the following?
1. 0 to 5  $\mu$ sec
  2. 0 to 500  $\mu$ sec
  3. 5 to 500  $\mu$ sec
  4. 50 to 500  $\mu$ sec
- 7-5. The horizontal axis of the acquisition scope represents which of the following?
1. Frequency
  2. Signal amplitude
  3. Time of intercept
  4. All of the above
- 7-6. Which of the following can NOT be determined through the use of the panoramic trace?
1. Bandwidth
  2. Modulation type
  3. Signal-to-noise ratio
  4. Position of the target
- 7-7. Which of the following can NOT be determined through the use of the analysis traces?
1. Type of scan
  2. Lobe duration
  3. Pulse repetition time
  4. Frequency relationship
- 7-8. From which of the following will an ESM operator receive his first indication of an intercepted signal?
1. Acquisition scope or earphone
  2. Panoramic trace or earphone
  3. Analysis scope or earphone
  4. Analysis scope or panoramic display
- 7-9. Which of the following is the frequency range in which polarization can normally be determined?
1. 200 to 11000 MHz
  2. 300 to 10750 MHz
  3. 500 to 11000 MHz
  4. 7000 to 18000 MHz
- 7-10. What is your initial step in analyzing a signal?
1. Determine the frequency
  2. Determine the type of modulation
  3. Determine the scan rate
  4. Determine the bearing
- Questions 7-11 through 7-16 are to be judged True or False.
- 7-11. When switching the antenna from automatic to manual to determine the bearing, you should not switch until the antenna has come to a stop.

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- 7-12. You are trying to determine whether you have a true or image response, and are tuning up in frequency. If the signal moves to the left on the panoramic trace, you have a true response.
- 7-13. All local oscillators in ESM equipment track above the IF of the bands.
- 7-14. A spurious response can be determined by measuring the bandpass of the tuner and observing the panoramic trace.
- 7-15. You should always read the center frequency after blooming the signal.
- 7-16. It is possible to receive more than one signal at a time, and both will be displayed at the same time.

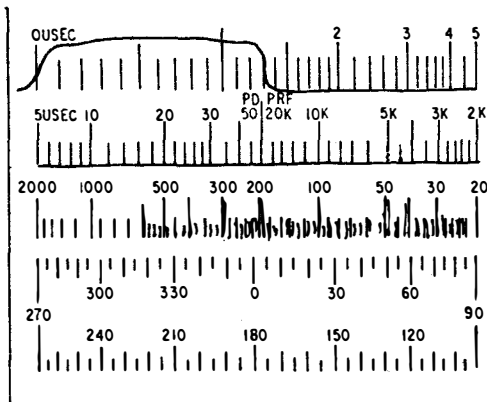


Figure 7-1.--Analysis traces.

In answering questions 7-17 and 7-18, refer to figure 7-1.

- 7-17. What is the pulse width of the signal?
  - 1. 0.5  $\mu$ sec
  - 2. 1.0  $\mu$ sec
  - 3. 1.3  $\mu$ sec
  - 4. 1.5  $\mu$ sec
- 7-18. What is the PRF of the signal?
  - 1. 100 pps
  - 2. 200 pps
  - 3. 300 pps
  - 4. 600 pps
- 7-19. To determine the type of scan, what should you observe?
  - 1. The acquisition scope
  - 2. The third trace of the analysis scope
  - 3. The second trace of the analysis scope
  - 4. The third trace and audio from the earphone

- 7-20. What should you read to determine the scan rate of a complex scan?
  - 1. The second trace from left to right to the first null
  - 2. The third trace from right to left to the first null
  - 3. The second trace from right to left to the first null
  - 4. The third trace from left to right to the first null
- 7-21. Glide-path radars are normally found in which band?
  - 1. 5
  - 2. 6
  - 3. 3
  - 4. 4
- 7-22. Airborne, submarine, and precision radars are found in what band?
  - 1. 7
  - 2. 8
  - 3. 9
  - 4. 10

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Learning Objective: Describe some of the types of communications systems used on board ship and explain their purposes and functions.

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- 7-23. Which of the following internal communications systems is usually most durable?
  - 1. Sound-powered telephones
  - 2. MC circuits
  - 3. Ship's service telephones
  - 4. Voice tubes
- 7-24. Which of the following internal communications systems is used for normal administrative routine on board ship?
  - 1. Messengers
  - 2. Teletypewriters
  - 3. Ship's service telephones
  - 4. Pneumatic tubes
- 7-25. The oldest type of communications is the
  - 1. messenger
  - 2. voice tube
  - 3. pneumatic tube
  - 4. flaghoist
- 7-26. Which of the following types of communications is best suited for training a large number of men at the same time?
  - 1. Teletypewriters
  - 2. Multichannel systems
  - 3. Target designation equipment
  - 4. Television sets



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- 7-27. One of the disadvantages of the pneumatic tube is that it requires
1. the message to be spoken very slowly
  2. very high voltage to transmit the message
  3. compressed air
  4. the message to be spoken very rapidly
- 7-28. What is the busy signal for a station called on an MC unit?
1. A lighted busy lamp
  2. A flashing green light
  3. A buzzing sound
  4. No lights
- 7-29. Which of the following MC systems is a one-way general announcing system?
1. 1 MC
  2. 19 MC
  3. 21 MC
  4. 22 MC
- 7-30. The MC circuit that is used for combat intelligence and connects all the main plotting groups together is the
1. 19 MC
  2. 20 MC
  3. 21 MC
  4. 22 MC
- 7-31. Initial contact reports are sent to the bridge via which of the following MC systems?
1. 20 MC
  2. 21 MC
  3. 22 MC
  4. 24 MC
- 7-32. Which of the following MC systems should you use to call radio to check on a radio receiver that is drifting off frequency?
1. 29 MC
  2. 24 MC
  3. 22 MC
  4. 20 MC
- 7-33. Which of the following is/are an advantage(s) of the sound-powered telephone system?
1. It is simple to operate
  2. The talker is mobile
  3. It does not contribute to the noise level
  4. All of the above
- 7-34. Which of the following statements best describes the emergency procedure for sound-powered phones?
1. If the mouthpiece does not work you can talk into either earphone
  2. If the mouthpiece does not work you can talk into the breastplate
  3. If any part of the set fails to work you must have it repaired at once
  4. The sound-powered system is very durable and very seldom fails
- 
- Learning Objective: Describe some of the types of communications systems used to relay information to other ships and stations and explain their purposes and functions.
- 
- 7-35. What is the most secure communications system in use?
1. Messenger
  2. Visual
  3. Radiotelephone
  4. Sound-powered telephones
- 7-36. During daylight hours, most tactical and maneuvering signals are sent and received by the use of
1. flashing light
  2. radiotelegraph
  3. flaghoist
  4. yardarm blinkers
- 7-37. The primary means of external communications used by EW is the
1. messenger
  2. radiotelegraph
  3. radiotelephone
  4. radioteletypewriter
- 7-38. During shakedown operations you wish to maintain voice communications with a shore station which is about 65 miles away. What frequency range is most desirable for this purpose?
1. HF
  2. SHF
  3. UHF
  4. VHF
- 7-39. Which of the following factors may affect the range capabilities of radio equipment used in EW?
1. Weather
  2. Material condition
  3. Antenna position
  4. All of the above

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- 7-40. The responsibility for setting up receivers and transmitters to be patched to EW remote control units is a function of the
1. OTC
  2. EW officer
  3. communications officer
  4. net control station

- 7-41. You have pressed the start button of an EW remote control unit and have keyed the transmitter with your headset button. What signals indicate to you that the remote control unit is ON and that carrier signal is being emitted?
1. A red light and a green light
  2. A small red light and a larger red light
  3. A small green light and a larger green light
  4. A white light and a red light

---

Learning Objective: Describe some of the radio nets used in communications in terms of types and classes of nets and explain their purposes and functions.

---

- 7-42. Which of the following receiver watches requires a transmitter for immediate use?
1. Guard
  2. Cover
  3. Listen
  4. Copy
- 7-43. Which of the following receivers does NOT require a complete log?
1. Copy
  2. Guard
  3. Cover
  4. Listen
- 7-44. A net whose purpose is to control DUFFERS and ESM reporting ships is classified as a
1. special net
  2. functional net
  3. command net
  4. common net
- 7-45. Which of the following statements is true of a directed radio net but not true of a free radio net?
1. It has a net control station
  2. It is a temporary net which is disestablished when its purpose is fulfilled
  3. It may be used for transmission of classified traffic only
  4. It carries the requirement that net stations obtain permission to transmit

---

Learning Objective: Describe the operating rules involved in establishing and using radio nets, call signs, and circuit logs.

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- 7-46. You are on watch in EW when the bridge calls to inquire the name of the unit using the call sign FOUR ACES. What publication would you refer to in order to find this information?
1. DNC 5
  2. NWP 16
  3. JANAP 195
  4. JANAP 119

● Information for questions 7-47 and 7-48. Assume that the signs of four ships in a radio net are as follows:

USS ELDORADO (net control). . . . .DOG TROT  
USS POLARIS. . . . .ANTIE MAME  
USS MANSFIELD. . . . .FOUR ACES  
USS FREESE. . . . .CREW CUT

- 7-47. The ELDORADO transmits a message establishing the harbor common as a directed net between these ships. The first station to reply will be one whose call sign is
1. CREW CUT
  2. ANTIE MAME
  3. DOG TROT
  4. FOUR ACES
- 7-48. The MANSFIELD has a message for the POLARIS. What procedure does the MANSFIELD follow?
1. She obtains permission from DOG TROT to use the net
  2. She warns ANTIE MAME that she has a message for her, thus giving her time to copy
  3. She gets a radio check with ANTIE MAME, then sends the message
  4. She sends the message to DOG TROT, who then re-transmits it to ANTIE MAME
- 7-49. You are the radiotelephone talker on a net and another station calls you for a radio check. Assuming you hear the station loud and clear, what should be your reply?
1. GOOD AND CLEAR
  2. LOUD AND CLEAR
  3. ROGER
  4. Both 2 and 3 above

- 7-50. You are maintaining a radiotelephone log and a message is being transmitted to your ship. The message contains the proword READ BACK. The R/T talker on your ship must do which of the following?
1. Roger for the message when it is received
  2. Repeat the message back exactly as it was sent to him
  3. Nothing, READ BACK means that the transmitting ship must send the message twice
  4. Say "I SAY AGAIN" and repeat the message

- 7-51. What is the highest Navy message precedence?
1. Immediate
  2. Emergency
  3. Flash
  4. Priority

- 7-52. Messages made by the immediate executive method should be
1. verified
  2. acknowledged
  3. in plain language
  4. limited to signals from the signal book

- 7-53. Messages sent by the delayed executive method and not yet executed may be cancelled by using the word
1. DISREGARD
  2. EXEMPT
  3. CANCEL
  4. NEGAT

- 7-54. Of the following statements, select the one that is correct concerning communication security.
1. Only trained personnel are to operate radio nets
  2. Radio transmissions cannot be intercepted
  3. Anything can be sent in plain language
  4. Only authorized prowords may be used

- Question 7-55 is to be judged True or False.

- 7-55. All radiotelephone nets and circuits must have a circuit log maintained at all times.

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Learning Objective: Describe some of the purposes for and uses of Operational Brevity Codes.

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- Questions 7-56 through 7-58 are to be judged True or False.

- 7-56. ACP 165 is the only publication that contains authorized Operational Brevity Code words.

- 7-57. The proword for communications jamming is CONFETTI.

- 7-58. The code word is BRUSH when you send the antenna rotation rate by rpm.

---

Learning Objective: Describe some of the EW reporting procedures used to coordinate task force EW operations.

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- 7-59. The purpose of plotting DF bearings is to determine
1. location of the contact
  2. location and course of the contact only
  3. location, course, and speed of the contact only
  4. location, bearing, and range of the contact

- 7-60. The station responsible for initiating scrub reports is the
1. OTC
  2. EWC
  3. duffer ship
  4. initial reporting unit

- 7-61. The initial passive intercept report should contain what three things?
1. Designation, frequency, and time
  2. Designation, frequency, and bearing
  3. Frequency, time, and bearing
  4. Identification, bearing, and time

---

Learning Objective: Identify some of the logs required for EW according to purpose and applicability during various tactical situations.

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- 7-62. A complete log must be kept on all of the following except
1. intercepts
  2. EW exercises
  3. jamming and deception
  4. sound-powered communications

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- 7-63. What is the purpose of the signal diary?
1. To be a permanent record of intercepts
  2. To be sent as part of the ELINT report
  3. To facilitate rapid reference
  4. All of the above
- 7-64. Sketches of unusual signals should be included in
1. the operator's intercept log only
  2. the signal diary only
  3. the ECM log
  4. both the operator's intercept log and signal diary
- Questions 6-54 through 7-68 are to be judged True or False.
- 7-65. NTP 4 states that complete logs must be kept on all radiotelephone circuits.
- 7-66. Radio logs may be recorded in freehand or typewritten.
- 7-67. If a transmission is not addressed to your ship you should ignore it.
- 7-68. It is not permissible to use prowords in keeping a radio log.
- 7-69. Select the correct statement pertaining to the EW watch log entries.
1. All entries are made by the EW watch officer
  2. The initial entry should begin at 0000 Zulu
  3. The entries may be either typewritten or in longhand
  4. Only selected events need to be logged

## Assignment 8

### EW Status Boards, Logs and Plots; EMCON; ELINT Collection and Reporting Procedures; Maintenance and Test Equipment

Textbook Assignment: EW 3&2, NAVEDTRA 10127-A, pages 230 - 270

Learning Objective: Identify some of the logs required for EW according to purpose and applicability during various

- 8-1. Instructions for keeping the EW watch log can be found in which of the following publications?
1. NTP 4
  2. Quartermaster's log
  3. NAVTRA 91272
  4. Ship's deck log

- 8-2. What information does the EW watch log contain?
1. An accurate chronological account of everything that happened during the watch
  2. All tactical information pertaining to current operations
  3. Time of equipment failures and estimated time of repairs
  4. All of the above information

Learning Objective: Describe some of the status boards used by EW personnel.

- 8-3. What is the primary purpose for using status boards?
1. To display tactical information
  2. To make the EW's job easier
  3. To summarize the EW doctrine
  4. To do all of the above
- 8-4. What information is NOT listed on the EW control ship status board?
1. Duffer units
  2. Guard assignments
  3. Intercepts
  4. Voice calls

- 8-5. Where are EMCON conditions and time-sharing plans normally plotted?
1. On the EW control ship status board
  2. On the EW status board
  3. On the equipment status board
  4. On all of the above

- 8-6. Which status board or boards is/are for assigning radar guards and time-sharing plans?
1. Communications status board
  2. EW control ship status board
  3. Equipment status board
  4. Both 2 and 3 above

Learning Objective: Discuss some of the plots used in EW positions.

- 8-7. What information should be contained in the strategic plot?
1. Friendly forces only
  2. Friendly and enemy forces
  3. The electronic order of battle
  4. Both 2 and 3 above
- 8-8. What information should be plotted on the vertical plot?
1. Coordinated information
  2. Early warning and identifying information
  3. Frequency and PRF
  4. EOB information

Learning Objective: Discuss some of the procedures and doctrine for emission control (EMCON).

- 8-9. Which of the following is NOT a valid reason for EMCON?
1. Tactical evasion
  2. Tactical deception
  3. Preventing disclosure
  4. Avoiding interference

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- Questions 8-10 and 8-11 are to be judged True or False.
- 8-10. EMCON increases the effectiveness of intercept search.
- 8-11. No maintenance work should be accomplished during periods of silence.
- 8-12. The responsibility of control and execution of EMCON is a function of the
  1. CIC officer
  2. electronic warfare officer
  3. officer in tactical command
  4. commanding officer of the ship
- 8-13. Instructions and doctrine for EMCON can be found in which of the following publications?
  1. NWP 33
  2. ATP 1
  3. NWP 31
  4. All of the above
- 8-14. For which of the following purposes are EMCON orders NOT issued?
  1. To modify an EMCON condition
  2. To amplify an EMCON condition
  3. To organize a trout
  4. To prohibit the use of electronic emissions
- 8-15. An EMCON condition is in effect, and your ship detects a signal that is on the threat emitter list. What action should you take?
  1. Remain silent and hope you won't be detected
  2. Turn on all your radars and track the threat
  3. Provide warning to the force via a reporting net
  4. Both 2 and 3 above
- Questions 8-16 through 8-18 are to be judged True or False.
- 8-16. The breaking of EMCON by a unit is the signal for all units to activate their equipment.
- 8-17. It is permissible to break EMCON during a tactical emergency.
- 8-18. A unit that detects an ASCM will report it by any means regardless of the EMCON condition in effect.
- 8-19. Which of the following is NOT a duty of the EW control ship?
  1. To coordinate the overall intercept effort
  2. To assign intercept search guards
  3. To assign personnel for search equipment
  4. To monitor and enforce EMCON
- 8-20. How many duffers should be switched to an intercepted signal if possible?
  1. 2
  2. 2 or 3
  3. 3 or 4
  4. 4 or 5
- 8-21. To optimize the reaction to EMCON changes, each ship will have a/an
  1. EMCON bill
  2. EMCON plan
  3. standard silence table
  4. monitoring procedure
- 8-22. The EMCON control center is normally located in
  1. the bridge
  2. EW
  3. CIC
  4. the operations office
- 8-23. Which person is responsible for ensuring that equipment is secured after an EMCON order is received?
  1. Watch supervisor
  2. Commanding officer
  3. Operation officer
  4. EW watch officer
- 8-24. Where may time-sharing plans be found?
  1. The EW annex to the OORDER
  2. The EMCON bill
  3. ATP 1, Vol. II
  4. In all of the above
- 8-25. The advantage of a time-sharing plan is that
  1. it provides protection from passive detection
  2. it allows for time to maintain the equipment
  3. it allows maximum effective use of intercept equipment
  4. it eliminates all outside interference with intercept equipment
- 8-26. What may we use to make passive intercept harder for the enemy?
  1. Time-sharing plans
  2. Intermittent operation
  3. Total silence
  4. Both 2 and 3 above

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- 8-27. The OTC orders a total electronic silence. When may it be broken?
1. By the OTC releasing order
  2. During a tactical maneuvering emergency
  3. To report a possible missile attack
  4. All of the above
- 8-28. Radar guards are used to control the EMCON plan and
1. indicate the ships that are to track and report radar targets
  2. indicate that all units are to track and report radar targets
  3. allow all ships to run their own tracks and radars as they desire
  4. indicate specific radars to be guarded by all units

● Questions 8-29 through 8-32 are to be judged True or False.

- 8-29. Excerpts from the EMCON Bill will be posted on or near each piece of equipment affected by EMCON.
- 8-30. A ship's EMCON plan is promulgated by the EW Control Ship (EWCS).
- 8-31. Medical and Dental Departments are not affected by EMCON.
- 8-32. The Commanding Officer directs the setting of specific EMCON conditions.
- 8-33. Using the Standard Silence Policy Table, what letter designates "operate as pre-briefed"?
1. CHARLIE
  2. GOLF
  3. JULIETT
  4. PAPA
- 8-34. What Emission Status Indicator denotes IFF interrogators?
1. GOLF
  2. ROMEO
  3. UNIFORM
  4. VICTOR

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Learning Objective: Describe some of the procedures, doctrines and requirements for ELINT, as set forth in current tactical publications and directives.

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- 8-35. The collection of ELINT information is primarily the function of the
1. Department of Defense
  2. Central Intelligence Agency
  3. Defense Intelligence Agency
  4. ships and aircraft

- 8-36. The primary concern when your ship has been assigned an ELINT mission is to
1. brief the division officers
  2. plot the intercept area
  3. establish the requirements
  4. do all of the above
- 8-37. When briefing operators for an ELINT mission, which of the following should you include?
1. Priority of signals
  2. Estimated time of intercept
  3. Collection procedures
  4. All of the above
- 8-38. ELINT reports, consisting of data from collecting units, are forwarded to the appropriate processing center
1. daily
  2. weekly
  3. on a specified date, or on completion of a mission or operation
  4. monthly

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Learning Objective: Describe some of the procedures for logging, recording, and photographing ELINT information.

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- 8-39. Signal numbers, when entered on the ELINT log sheet, are to begin with
1. the number 001 and run consecutively for the duration of the reports
  2. the number 1 and run consecutively for the duration of the report
  3. the number 001 and to run consecutively for the calendar year
  4. the number 1 and run consecutively for the duration of the watch
- 8-40. The letter "C", when entered in the RF (Radio Frequency) column of the intercept log sheet, indicates the RF reading was
1. read from the RF dial
  2. unknown
  3. Confidential
  4. measured/calibrated from the turning head in use
- 8-41. Entries made in the PRF column with the suffix "M", means the PRF was
1. measured manually
  2. moving
  3. measured by estimation
  4. measured using an audio oscillator and electronic counter

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- 8-42. You are logging a signal on the ELINT log and the operator has told you it is a conical scan at 30 cycles per second, the correct log entry would be
1. F-30 cps
  2. K-30 Hz
  3. F-30 Hz
  4. F-30 rpm
- 8-43. A signal strength of 4/1 would indicate
1. signal is weak and intermittent
  2. every sweep is heard, side lobes are present
  3. every sweep is heard, no receiver noise is present
  4. the signal completely saturates the scope
- 8-44. What is the minimum number of bearings to be entered on the ELINT log?
1. Six
  2. Five
  3. Three
  4. Four
- 8-45. What information should be entered in the Operator Remarks section of the ELINT log?
1. The watch officer's evaluation
  2. The supervisor's remarks
  3. Both 1 and 2 above
  4. The operator's own words
- 8-46. What speed should you use when recording a video signal?
1. 7-1/2 ips
  2. 15 ips
  3. The fastest speed available
  4. The slowest speed available
- 8-47. The first thing recorded on a reel of tape should be the
1. name of the unit making the recording
  2. classification of the reel
  3. operator's name
  4. recording number
- 8-48. When you are recording with the AN/UNQ-7 recorder, channel "B" should contain
1. the reference tone
  2. voice annotations
  3. the signal of interest
  4. all of the above
- 8-49. Which of the following information is NOT placed on the side of each reel of completed magnetic tape?
1. Signal strength
  2. Classification
  3. Reel number
  4. Unit identification
- 8-50. Which of the following statements concerning antennas is/are correct?
1. When possible an omnidirectional antenna should be used when recording
  2. The DF antenna should be stopped and pointed at the signal source
  3. Both 1 and 2 are correct depending on the antenna in use
  4. The DF antenna should be rotating in order to eliminate errors
- 8-51. Which of the following statements about ELINT photographs is correct?
1. They show only pulse shapes of complex forms of modulation
  2. They are used only by the operator for training purposes
  3. They allow the analyst to view exactly what the operator saw at the time of the intercept
  4. All of the above statements are correct
- 
- Learning Objective: Determine the correct standard operating sequence for collecting ELINT data and describe ELINT reports to be made.
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- Questions 8-52 through 8-54 are to be judged True or False.
- 8-52. One of the primary aims for establishing standard operating procedures is to achieve a high degree of operator proficiency.
- 8-53. The first thing you should do when a signal has been intercepted is obtain the bearing and stop the antenna.
- 8-54. When you are obtaining the center frequency of a signal, the fixed oscillator should be OFF.
- 8-55. What are the minimum requirements when you are recording a signal?
1. Two minutes or five sweeps of a slow scanning radar
  2. Longer than normal if the signal changes modes
  3. Listed in the collection requirements publications
  4. All of the above
- 8-56. What should you determine while the signal is being recorded?
1. The bearing of the signal
  2. Additional signal characteristics
  3. Center frequency
  4. All of the above



- 8-57. What signals require message reports?
1. Suspected submarines or missiles
  2. New electronic weapons or techniques
  3. Unusual intercepts
  4. All of the above
- 8-58. What minimum classification, if any, would you use on information and documents relating to the success of ELINT Search?
1. Confidential
  2. Secret
  3. Top Secret
  4. They are not classified

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Learning Objective: Define some of the preventive maintenance procedures used in caring for EW equipment.

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- 8-59. The 3-M System is designed for use with which of the following equipments?
1. Medical and dental
  2. FBMs and nuclear power plants
  3. Nuclear power plants and associated test equipment
  4. General purpose test equipment and shipboard radars
- 8-60. As an EW aboard a destroyer, which volumes of the 3-M Manual would you use?
1. Volume 1 and 2 only
  2. Volume 1 and 3 only
  3. Volume 2 and 3 only
  4. All three volumes of the 3-M Manual
- 8-61. Detailed procedures for conducting PMS may be found in which of the following locations?
1. The Maintenance Requirement Card in the work center
  2. The Equipment Guide List in the work center
  3. The Maintenance Index Page in the Departmental Master PMS Record
  4. The Weekly Schedule in the work center
- 8-62. Which of the following forms are prepared using the Cycle Schedule as a guide?
1. Daily and Weekly Schedules
  2. Weekly and Monthly Schedules
  3. Weekly and Quarterly Schedules
  4. Monthly and Quarterly Schedules

- 8-63. What action should you take if you discover an erroneous maintenance procedure on an MRC?
1. Continue your maintenance and submit a 4790/2K to your work center supervisor
  2. Halt your maintenance and submit a FBR to your work center supervisor
  3. Continue your maintenance as the error will be corrected by the next quarterly update
  4. Change the error on the MRC to reflect the correct procedure

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Learning Objective: Define some of the corrective maintenance procedures used in caring for EW equipment and test equipment procedures used for troubleshooting EW equipment.

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- 8-64. What source provides planned maintenance procedures for the deactivation and reactivation of entire systems onboard ship?
1. TYCOM
  2. SECAS
  3. PMDO
  4. MDCS
- 8-65. Where could you retrieve information that was previously reported by the MDCS?
1. From the TYCOM
  2. From the MSO data bank
  3. From both 1 and 2 above
  4. From the NMMFO
- 8-66. From what chapter of the 3-M Manual could you obtain detailed information on CSMP?
1. 9
  2. 7
  3. 5
  4. 4

● Questions 8-67 through 8-79 are to be judged True or False.

- 8-67. To become a proficient technician, you must have a thorough knowledge of basic electronics and the types of circuits used in the equipment, but you do not have to know how the equipment operates.
- 8-68. Technical manuals for your equipment include information on operating the equipment as well as maintenance and troubleshooting hints.

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8-69. EIBs (Electronics Information Bulletins) are published monthly and contain information on all types of electronics equipment.

8-70. Which of the following publications contain(s) information on operating instructions, capabilities and limitations of test equipment?

1. Test Equipment EIMB
2. EIBs
3. Technical Manuals
4. All the above have information on test equipment

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