# CHAPTER 4

# DEMODULATORS, REKEYERS, AND DEMULTIPLEXERS

As explained in chapter 1, teletype signals have to be routed from a receiver to additional equipment for further processing. The more complex the signal, the more processing stages will be required, i.e., a two-channel teletype signal, in addition to being demodulated, has to be separated into individual channels for print-out. Common demodulators, rekeyers, and demultiplexers that are used throughout the Naval Security Group will be explained in this chapter.

## DEMODULATORS

Modulation is applied to a signal to make it compatible for transmission over the air. Once the signal is received, the modulation, having served its purpose, must be removed or changed before the signal can be further processed. This is accomplished by the use of a demodulator. The type of demodulator to be employed will depend upon the type of modulation used to transmit the signal. The first type of demodulator to be discussed will be the AN/FRA-86 Frequency Shift Converter.

### AN/FRA-86 FREQUENCY SHIFT CONVERTER

The AN/FRA-86 Frequency Shift Converter (figure 4-1) is widely used to demodulate the frequency shift keyed carrier methods known as FREQUENCY SHIFT KEY (FSK) and DOUBLE FREQUENCY SHIFT KEY (DFSK). Frequency Shift Key (FSK) is a special type of frequency modulation whereby the frequency of the transmitted RF carrier is shifted between two distinct frequency values (MARK/SPACE), determined by one sending device. Double Frequency Shift Key (DFSK) is also a special type of frequency modulation. In this case, the frequency of the transmitted RF carrier is shifted between four distinct frequency values and combined into two canals of information, representing two independent sending devices. The AN/FRA-86 will also detect and indicate, by means of a cathode ray tube (CRT), the frequency drift of a received signal. This allows the operator to visually monitor and, when necessary, retune the signal.

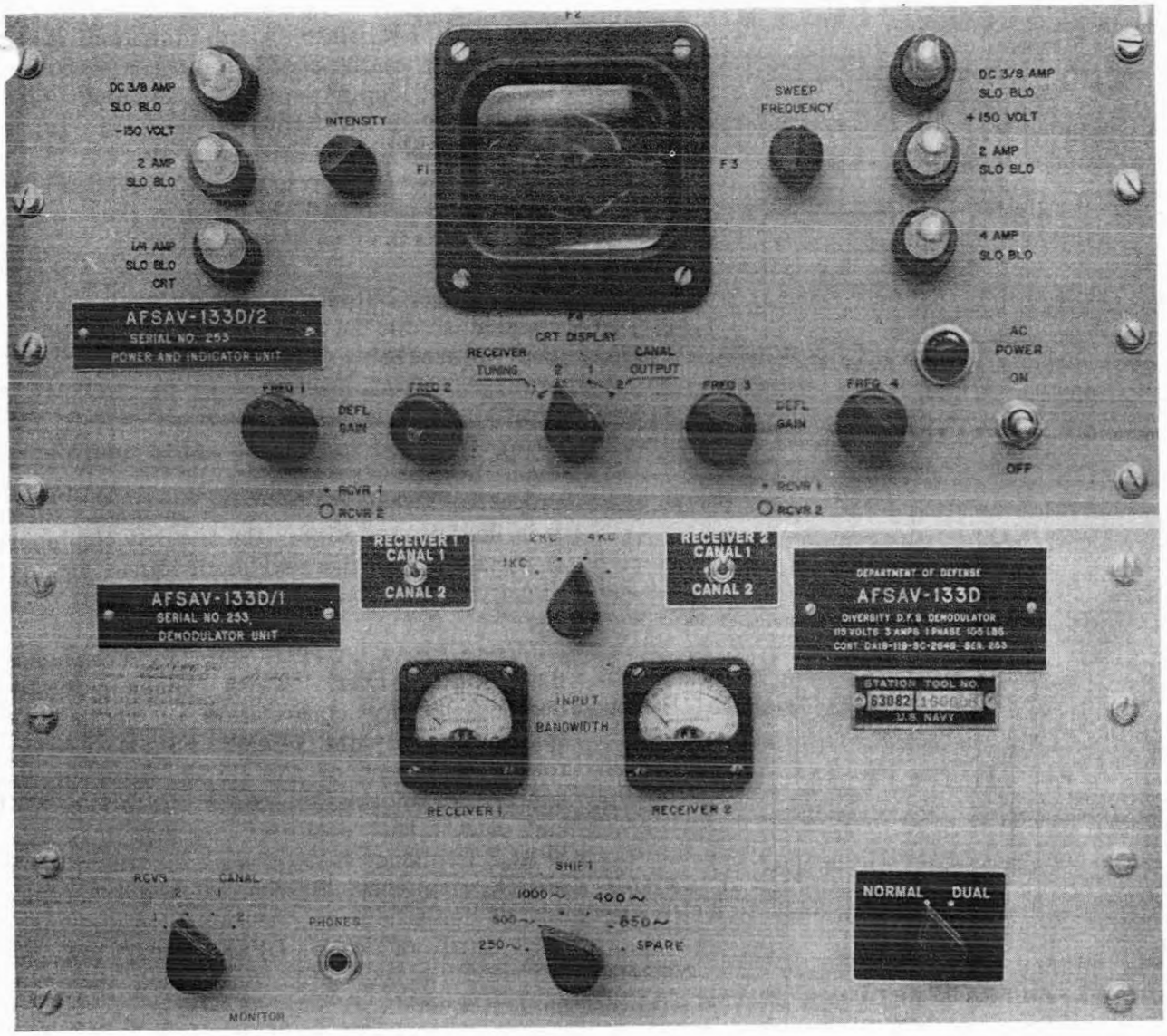
The AN/FRA-86 Frequency Shift Converter consists of two rack-mounted units: FREQUENCY SHIFT CONVERTER unit and INDICATOR unit.

#### Frequency Shift Converter Unit

The frequency shift converter unit contains twin circuits which perform all of the selection, demodulation, and conversion functions of the AN/FRA-86. The twin circuits allow for two independent receiver inputs, if desired.

#### Indicator Unit

The indicator unit contains the CRT which, as noted above, enables the operator to visually monitor the incoming signals from each receiver. One presentation available on the CRT (figure 4-2) corresponds to the incoming AF signal and displays the frequency levels of the FSK and DFSK signal being received. Another presentation (figure 4-3) displays the Keyed Direct Current (KDC) output of each information canal. The indicator unit also




264.27

Figure 4-1.—AN/FRA-86 frequency shift converter.

contains the power supplies for all voltages used in the AN/FRA-86.

### Input

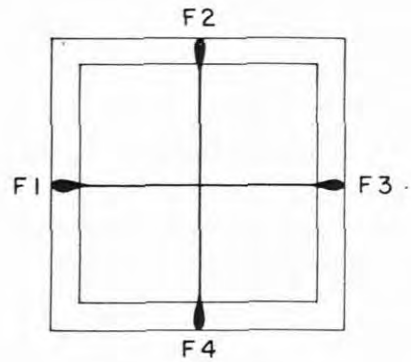
The AN/FRA-86 will accept two input signals, either in the form of audio frequency (AF), FSK, or DFSK, or a combination of both types. The input frequency range is from 4 to 7 kHz, with a center frequency of 5.5 kHz.

### Outputs

The AN/FRA-86 is designed to provide a total of six signal outputs. The types of outputs are as follows:

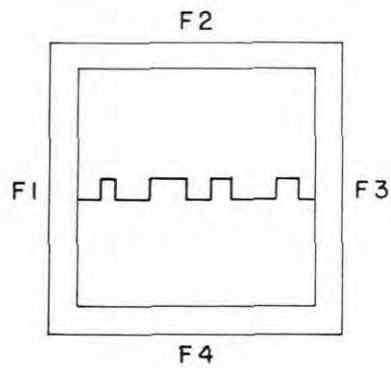
KEYED DIRECT CURRENT (KDC)—1 KDC output for each canal.

KEYED TONE (KT)—1 KT output for each canal.




264.28

**Figure 4-2.—AN/FRA-86 CRT display of frequency levels.**




264.29

**Figure 4-3.—AN/FRA-86 CRT display of keyed direct current (KDC).**

LIMITER (AF output)—1 limiter output for each AF input.

### Theory of Operation

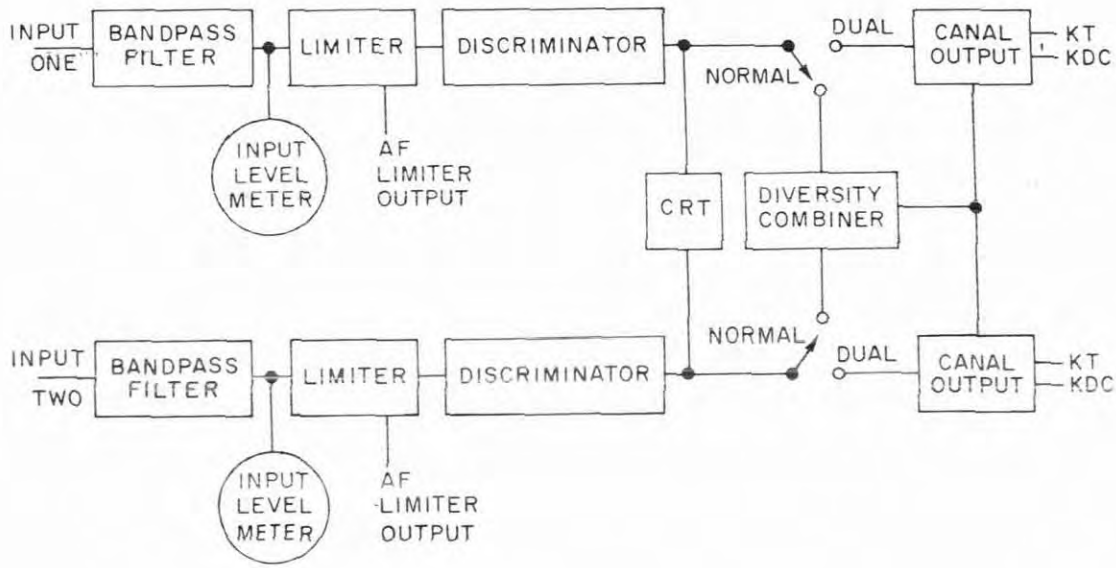
As shown in figure 4-4, the incoming audio frequency signals are fed to two separate, but functionally identical, circuits. Within each circuit, the AF signal first passes through a BANDPASS FILTER where unwanted frequencies are eliminated. Immediately following the BANDPASS FILTER, an INPUT LEVEL METER is used to monitor the incoming signal level. The signal then passes to the LIMITER stage whose function is to maintain a nearly constant output level even though the input level may fluctuate. The output of the limiter is fed to a DISCRIMINATOR network. The DISCRIMINATOR responds to each of the frequencies of the DFSK signal as they appear and converts them to KDC pulses.

The four outputs of the discriminator are coupled to the DIVERSITY COMBINER and the indicator (CRT) unit. When the NORMAL/DUAL switch is in the NORMAL position, the diversity combiner selects the stronger of the two input signals and allows them to pass to the outputs for follow-on processing. When the NORMAL/DUAL switch is in the DUAL position, the diversity combiner is bypassed and the two input signals are fed directly to the output stages.

The CANAL OUTPUT stage, by means of a patching network which enables it to demodulate any combination of marks and spaces, i.e., F1=MM, F2=MS, F3=SM, F4=SS, routes each arm of the DFSK signal to its appropriate information canal in the form of KT and KDC. This condition assumes that the SPACE frequency is lower than the transmitted MARK frequency. Because of the two-canal output limitation of the AN/FRA-86, only one canal of each DFSK signal can be outputted at any given time when the dual mode is used.

### Cathode Ray Tube (CRT) Presentations

A knowledge of the various conditions in which FSK and DFSK signals may appear is necessary to determine an existing signal condition and the proper tuning of a FSK or DFSK signal with a known signal condition. In order to best understand and interpret the various keying conditions, refer to table 4-1 and compare the four frequencies of a DFSK signal to the four outputs of the discriminator stage of the AN/FRA-86.




264.30

Figure 4-4.–AN/FRA-86 block diagram.

Table 4-1.–DFSK Signal Keying Condition

(1000Hz Shift)

| R-390A INPUT FREQUENCY | CANAL "A" CONDITION | CANAL "B" CONDITION | DISCRIMINATOR OUTPUT FREQUENCY |
|---|---|---|---|
| 4kHz | MARK | MARK | F1 |
| 5kHz | MARK | SPACE | F2 |
| 6kHz | SPACE | MARK | F3 |
| 7kHz | SPACE | SPACE | F4 |

## Controls and Functions

The AN/FRA-86 FREQUENCY SHIFT CONVERTER is used to receive various types of Frequency Shift Key signals. It is important for the operator to know the controls and their functions in order to properly tune and determine existing signal conditions. The CONVERTER unit controls and indicators are listed in Table 4-2 and the INDICATOR unit controls and indicators are listed in Table 4-3. (Refer to figure 4-1 while studying these tables.)

As explained in the discussion of DFSK modulation, when the MARK or SPACE elements in a CANAL change, a corresponding change is made in the DFSK frequency level keyed. These changes will appear on the CRT. For example, a DFSK signal with both canals actively transmitting (MARK/SPACE transitions occurring) would appear on the CRT as a "cross". If canal A stops transmitting and holds on its MARK frequency, only the frequencies

Table 4-2.—AN/FRA-86 Converter Unit Operating Controls, Indicators and Functions

| CONTROL OR INDICATOR | FUNCTION |
|---|---|
| MONITOR Switch | A four-position switch that selects one of four signals to be monitored at the phone jack.<br><br>RCVR 1 or 2 Position - The output of the selected receiver can be monitored.<br><br>CANAL 1 or 2 - The KT output from the selected canal can be monitored. |
| PHONES Jack | A receptacle which accepts the headset plug for monitoring the signal selected by the monitor switch. |
| SHIFT Switch | A six-position switch (250, 400, 500, 850, 1000, and one spare position) that is used to select the frequency shift characteristics of the discriminator. A DFSK signal with a frequency excursion of 1500Hz would require a setting of 500. A FSK signal shifting 500Hz would also require a setting of 500. |
| RECEIVER 1/ RECEIVER 2 level meters | VU (volume unit) meters used to indicate the level of the output signals from receiver No. 1 or receiver No. 2. |
| INPUT BANDWIDTH Switch | A four-position switch (1, 2, 4, and one spare position) used to select a pair of bandpass filters through which the receiver input signals must pass. For FSK signals, set this switch to match the frequency shift/excursion of the incoming signal. For DFSK signals, set this switch at four (4) times the frequency shift of the incoming signal.<br><br>1 KC - The selected bandpass filters enable only frequencies that are within 500Hz of the center frequency to pass.<br><br>2 KC - The selected bandpass filters enable only frequencies that are within 1kHz of the center frequency to pass.<br><br>4 KC - The selected bandpass filters enable only frequencies that are within 2kHz of the center frequency to pass.<br><br>SPARE - Normally not used, however, an additional setting may be installed. |

**Table 4-2.–AN/FRA-86 Converter Unit Operating Controls, Indicators and Functions–Continued**

| CONTROL OR INDICATOR | FUNCTION |
|---|---|
| RECEIVER 1/ RECEIVER 2 CANAL selectors | A two-position miniature toggle switch that allows for the selection of either canal 1 or canal 2 for processing. |
| NORMAL/DUAL switch | A two-position mode switch<br><br>NORMAL - When the RECEIVER 1 and 2 CANAL SELECT Switches are in the CANAL 1 and CANAL 2 positions respectively, the AN/FRA-86 will accept a single FSK or DFSK signal and allows for diversity reception if desired.<br><br>DUAL - The AN/FRA-86 will accept two separate FSK or DFSK signals (one canal of each) or one FSK and one DFSK (one canal only) signal. Selection of the desired DFSK canal is made by placing the RECEIVER 1 or 2 CANAL selector switch in the CANAL 1 or CANAL 2 position. |

**Table 4-3.–AN/FRA-86 Indicator Unit Operating Controls, Indicators and Functions**

| CONTROL OR INDICATOR | FUNCTION |
|---|---|
| AC POWER switch | A two-position switch (ON-OFF) used to supply power to both units. |
| AC POWER indicator | A red lamp which lights when a.c. power is applied to the power supply and is extinguished when the power is disconnected from the power supply. |
| CRT DISPLAY | A four-position switch used to select one of the four outputs for display on the CRT screen.<br><br>RECEIVER 1 TUNING - The output frequencies F1, F2, F3, and F4 of receiver No. 1 are displayed on the CRT screen.<br><br>RECEIVER 2 TUNING - the output frequencies F1, F2, F3, and F4 of receiver No. 2 are displayed on the CRT screen.<br><br>CANAL 1 OUTPUT - The KDC output of canal No. 1 is displayed on CRT screen.<br><br>CANAL 2 OUTPUT - The KDC output of canal No. 2 is displayed on CRT screen. |

Table 4-3.—AN/FRA-86 Indicator Unit Operating Controls, Indicators and Functions—Continued

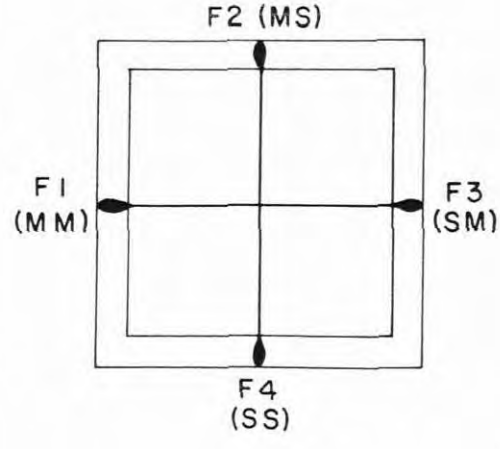
| CONTROL OR INDICATOR | FUNCTION |
|---|---|
| DEFL GAIN (Deflection Gain) | Four sets of two-knob controls which control the amplitude of the F1, F2, F3, and F4 images on the CRT screen when the CRT DISPLAY switch is in the RECEIVER 1 TUNING or RECEIVER 2 TUNING position. The outer (smaller) knobs control the amplitude of receiver number 1 and the inner (larger) knobs control the amplitude of receiver No. 2. F1, F2, F3, and F4 correspond to the four frequencies of a DFSK signal; an FSK signal will use only F2 and F3. |
| INTENSITY | Controls the brightness of the image on the CRT screen. KEEP IT AS LOW AS POSSIBLE FOR EYE COMFORT AND TO PREVENT BURNING OF THE SCOPE FACE. |
| SWEEP FREQUENCY | Controls the sweep duration when the CRT DISPLAY switch is in the CANAL 1 or 2 OUTPUT position. It controls how fast the MARK/SPACE format of the signal is displayed on the CRT DISPLAY screen. You can slow down or speed up this presentation by adjusting the SWEEP FREQUENCY control. |

F1 (MM) and F2 (MS) will appear on the CRT. (Refer to figure 4-5 through 4-9 for DFSK CRT displays.)

When the input signal is an FSK signal, properly tuned, the higher frequency will correspond to F2 (M) and the lower frequency to F3 (S). (Refer to figure 4-10.)

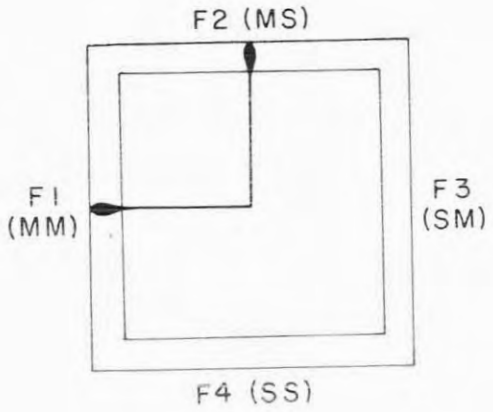
**Operating Procedures**

The operating procedures for the AN/FRA-86 FREQUENCY SHIFT CONVERTER include: Preliminary Operating Procedures; Calibration Procedures; NORMAL mode Operating Procedures; DUAL mode Operating Procedures, and Signal Re-tuning Procedures. The R-390A/URR receiver with a modified BFO microdial is used to supply inputs to the AN/FRA-86; therefore, it is imperative that an operator know the operating and calibrating procedures of the R-390A/URR




264.31

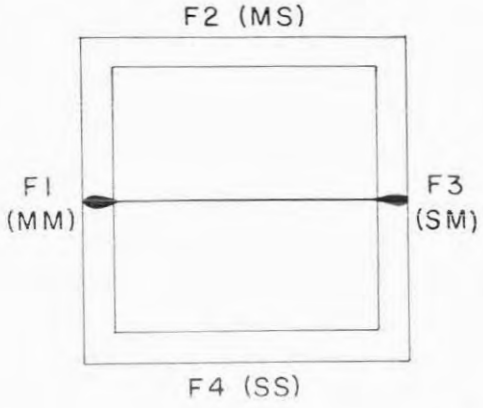
Figure 4-5.—DFSK signal condition with both canals active.




264.32

Figure 4-6.—DFSK signal condition.

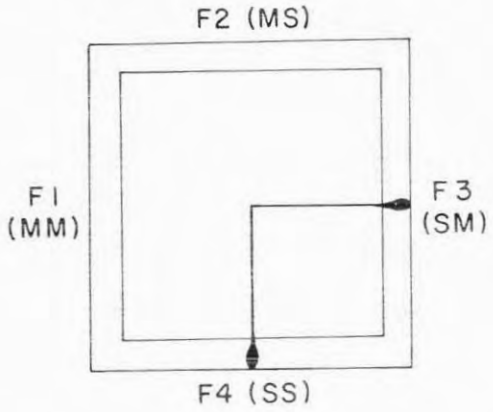
Canal A—Holding on a Mark Frequency
Canal B—Transmitting




264.34

Figure 4-8.—DFSK signal condition.

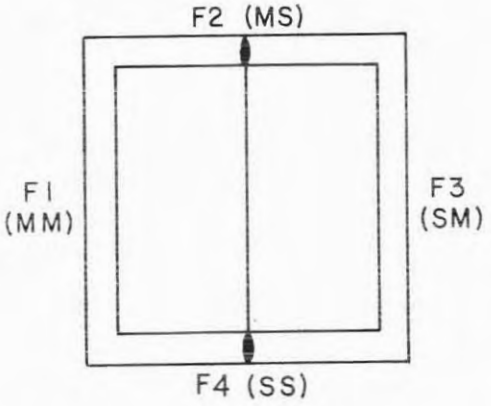
Canal A—Transmitting
Canal B—Holding on a Mark Frequency




264.33

Figure 4-7.—DFSK signal condition.

Canal A—Holding on a Space Frequency
Canal B—Transmitting




264.35

Figure 4-9.—DFSK signal condition.

Canal A—Transmitting
Canal B—Holding on a Space Frequency

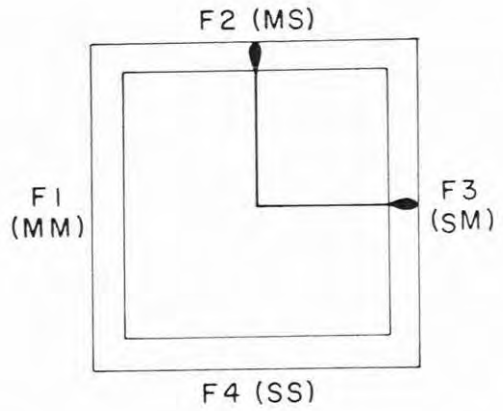
when operating the AN/FRA-86 FREQUENCY SHIFT CONVERTER.

PRELIMINARY OPERATING PROCEDURES.—The preliminary AN/FRA-86 operating procedure steps are listed below:

a. Turn the AC POWER switch to ON. The red a.c. power indicator lamp should light up, indicating that power has been applied to the AN/FRA-86. Allow a minimum warmup interval of 15 minutes before continuing.

b. Rotate all the DEFL GAIN controls full counterclockwise.

c. Set the CRT DISPLAY switch to the RECEIVER TUNING 1 position.




264.36

**Figure 4-10.—FSK signal condition transmitting.**

d. Rotate the INTENSITY control clockwise until a clear round dot appears in the center of the CRT screen.

e. Set the NORMAL /DUAL switch to the NORMAL position.

f. Set the RECEIVER 1 CANAL SELECTOR miniature toggle switch to CANAL 1.

g. Set the RECEIVER 2 CANAL SELECTOR miniature toggle switch to CANAL 2.

CALIBRATION OF AN/FRA-86 RECEIVER 1.—The calibration procedures for RECEIVER 1 are as follows:

a. Calibrate Receiver 1 (R-390A/URR) using normal R-390A calibration procedures.

b. Set the R-390A BANDWIDTH KC selector to 8.

c. Set the INPUT BANDWIDTH switch on the AN/FRA-86 to 4 KC.

d. Set the AN/FRA-86 SHIFT switch to the frequency shift of the signal to be copied.

e. Rotate the BFO MICRODIAL on the R-390A in a clockwise direction while observing the AN/FRA-86 INPUT LEVEL meter. Continue turning the MICRODIAL until the meter peaks and starts dropping.

f. Rotate clockwise the outer (smaller) DEFL GAIN control for F4 until the dot is slightly off the center of the CRT.

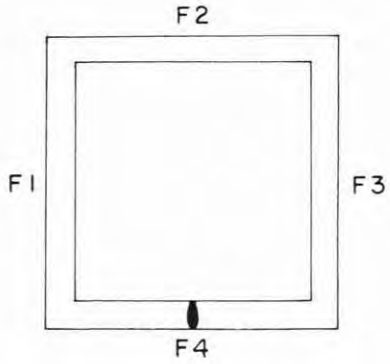
g. Set the R-390A LINE GAIN control to maximum.

h. Rotate counterclockwise the R-39 BFO MICRODIAL until the first maximum deflection for F4 is noted on the CRT.

i. Adjust the R-390A LINE GAIN to provide a 0 VU indication on the AN/FRA-86 input level meter for receiver 1.

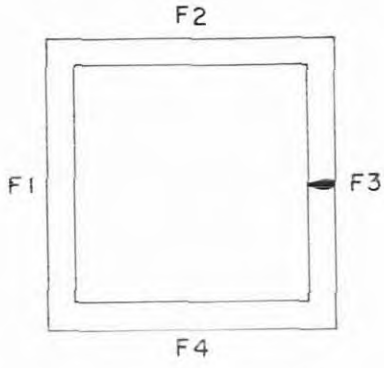
j. Using the R-390A BFO MICRODIAL and the F4 DEFL GAIN control, position the dot on the CRT between the bottom horizontal lines printed on the plastic overlay on the CRT (see figure 4-11). (This is a crucial step and must be understood thoroughly if proper calibration is to be accomplished.) The dot can be moved by either the BFO MICRODIAL or the F4 DEFL GAIN; however, the object is to position the dot so that it is at its maximum peaking point. In other words, PEAK it with the BFO MICRODIAL and POSITION it with the DEFL GAIN. When the dot is peaked, the input frequency from the R-390A is exactly 7kHz and is represented as such on the AN/FRA-86 by the dot being between the bottom horizontal lines.

k. Rotate the BFO MICRODIAL counterclockwise until the dot returns to the center of the CRT. Now rotate the F3 DEFL GAIN clockwise until the dot is slightly off the center of the CRT. Adjust the BFO MICRODIAL and F3 DEFL GAIN until the dot is between the vertical lines on the right side of the CRT display (see figure 4-12). Note the BFO MICRODIAL




264.37

**Figure 4-11.—F4 Peaked.**




264.38

Figure 4-12.–F3 Peaked.

reading at the F3 peak. This represents an input frequency of 6 kHz.

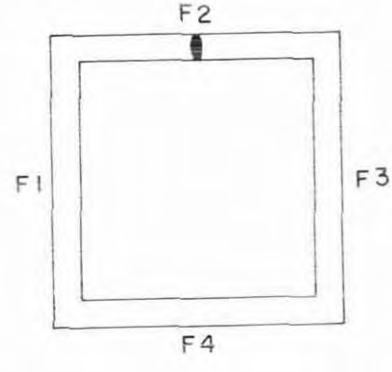
l. Rotate the BFO MICRODIAL counterclockwise until the dot returns to the center of the CRT. Now rotate the F2 DEFL GAIN clockwise until the dot is slightly off the center of the CRT. Adjust the MICRODIAL and F2 DEFL GAIN until the dot is between the upper horizontal lines of the CRT DISPLAY (see figure 4-13). Note the BFO MICRODIAL reading at the F2 peak point. This represents an input frequency of 5kHz.

m. Rotate the BFO MICRODIAL counterclockwise until the dot returns to the center of the CRT. Now rotate the F1 DEFL GAIN clockwise until the dot is slightly off the center of the CRT. Adjust the BFO MICRODIAL and F1 DEFL GAIN until the dot is between the vertical lines of the CRT DISPLAY (see figure 4-14). This represents an input frequency of 4kHz.

n. Determine the BFO MICRODIAL calibration point. Subtract the F2 BFO MICRODIAL reading obtained in (l) above from the F3 BFO MICRODIAL reading obtained in (k) above and HALVE the difference. Either add this value to the F2 setting or subtract it from the F3 setting and set the BFO MICRODIAL to this reading. This will set the BFO to true 5.5kHz. (This reading should be recorded for each individual BFO calibrated.)

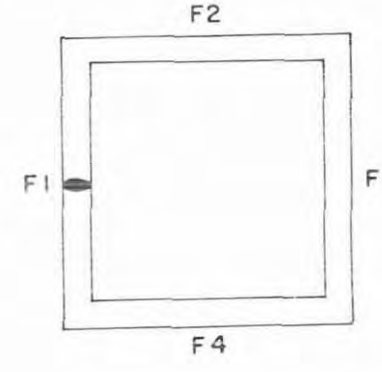
NOTE: THE CALIBRATED POSITION PEAKS AT F1, F2, F3, and F4 WILL CHANGE WHEN THE SHIFT SWITCH IS SET TO A POSITION OTHER THAN THAT OF ITS CALIBRATED POSITION; THEREFORE, THE AN/FRA-86 SHOULD BE CALIBRATED WHENEVER THE FREQUENCY SHIFT CHANGES.

CALIBRATION OF AN/FRA-86 RECEIVER 2.–The procedures for calibrating RECEIVER 2 are the same as those for RECEIVER 1, except that the CRT DISPLAY switch should be set to RECEIVER 2 TUNING position and the inner (larger) DEFL GAIN knobs must be used to position the dot at F4, F3, F2, and F1.




264.39

Figure 4-13.–F2 Peaked.




264.40

Figure 4-14.–F1 Peaked.

NORMAL MODE OPERATING PROCEDURES.–The following procedures are based on a 3000Hz DFSK signal input with both canals active:

a. Set the AN/FRA-86 NORMAL/DUAL switch to NORMAL.

b. Set the SHIFT switch to the position which corresponds to the shift between adjacent frequencies of the DFSK signal to be demodulated-in this case, 1000 Hz.

c. Set the INPUT BANDWIDTH switch to 4 KC (for DFSK signals, a bandwidth setting equal to four times the shift between adjacent frequencies is required). Under NO circumstances should a bandwidth setting be used that is as narrow as, or more narrow than, the input signal's total excursion. If possible, the R-390A BANDWIDTH setting should be the same as that of the AN/FRA-86 INPUT BANDWIDTH setting.

d. Set the AN/FRA-86 CRT DISPLAY switch to the RECEIVER 1 TUNING position.

e. Set the AN/FRA-86 RECEIVER 1 CANAL selector to CANAL 1, and RECEIVER 2 CANAL selector to CANAL 2.

f. Set the R-390A FUNCTION switch to the AGC position.

g. Using the R-390A KILOCYCLE CHANGE control, tune to the desired signal. Adjust the KILOCYCLE CHANGE control until dots/rays appear at F1, F2, F3, and F4 on the CRT DISPLAY tube. All four dots/rays should appear to reach their peak simultaneously. To accomplish this, slow movement of the KILOCYCLE CHANGE control is necessary. The CRT DISPLAY should appear as a "cross" as shown in figure 4-5.

h. Adjust the R-390A LINE GAIN control until a ZERO (Ø) VU reading is obtained on the AN/FRA-86 RECEIVER 1 input level meter on the CONVERTER unit. At this point, the signal in the first R-390A is properly tuned.

i. The procedures for tuning FSK signals are the same as those for DFSK signals, with the exception of the INPUT BANDWIDTH setting and the CRT DISPLAY presentation. A properly tuned FSK signal should appear as depicted in figure 4-10.

j. The procedure for tuning the second R-390A is the same as that for the first; however, set the CRT DISPLAY switch to RECEIVER 2 TUNING position. DO NOT disturb the RECEIVER 1 settings.

DUAL MODE OPERATING PROCEDURES.–The DUAL mode can be used to demodulate two FSK signals, one FSK signal and one DFSK signal, or two DFSK signals. When demodulating DFSK signals in the DUAL mode, only one canal (either A or B) of a DFSK signal can be selected for output.

a. Set the AN/FRA-86 NORMAL/DUAL switch to DUAL.

b. Set the AN/FRA-86 SHIFT switch as follows:

TWO FSK Signals–If the frequency shifts are not the same, set the SHIFT switch to match the lower of the two shifts.

TWO DFSK Signals–The frequency shift of the two signals must be equal.

ONE FSK and ONE DFSK Signal–Set the SHIFT switch to the frequency shift of the DFSK signal. The frequency shift of the FSK signal must be either equal to or twice the shift of the DFSK signal.

c. Set the INPUT BANDWIDTH switch as follows:

TWO FSK Signals–Use the setting that corresponds to the highest frequency excursion (shift) of the two signals.

TWO DFSK Signals–Use the setting that corresponds to four (4) times the frequency shift.

ONE DFSK and ONE FSK Signal–Use the setting that corresponds to four (4) times the frequency shift of the DFSK signal.

d. Use the R-390A KILOCYCLE CHANGE control to tune to the desired signals. Adjust the control until the proper CRT presentations are obtained for the type of signal being tuned (figures 4-5 and 4-10).

e. Adjust the receiver R-390A LINE GAIN control until a ZERO (Ø) VU reading is obtained on the input level meter on the CONVERTER unit.

f. Set the AN/FRA-86 RECEIVER 1 and RECEIVER 2 CANAL selector switches to the the appropriate position to obtain proper output when receiving two FSK signals (either canal may be selected).

g. Select either CANAL 1 or CANAL 2 by using the appropriate RECEIVER 1/2 and CANAL 1/2 switches when receiving two DFSK signals or a combination of one FSK and one DFSK signal.

SIGNAL RE-TUNING.—The CRT DISPLAY should be checked periodically to ensure that the signal is properly tuned (RECEIVER TUNING 1/2). Whenever the legs of the dots/rays fail to lie just outside of the inner screen rectangle, the receiver must be re-tuned. Use the KILOCYCLE CHANGE control to re-tune the signal. DO NOT ADJUST THE BFO MICRODIAL SETTING OR ADJUST THE DOTS/RAYS BY MEANS OF THE DEFL GAIN CONTROLS.

## CV-1627/URR TWO-CHANNEL REKEYER

The CV-1627/URR (AFSAV 39-C) two-channel rekeyer (figure 4-15) is used to convert Keyed Tone (KT) signals received from the AN/FRA-86, or similar terminal equipment, into d.c. pulses to operate teleprinters for one or two independent single-channel teletype systems. The input is Keyed Tone with a minimum element length of 5 MS.

### Controls and Functions

The operator controls and functions explained in Table 4-4 below, can be found on the front panel on the CV/1627/URR (see figure 4-15).

### Operating Procedures

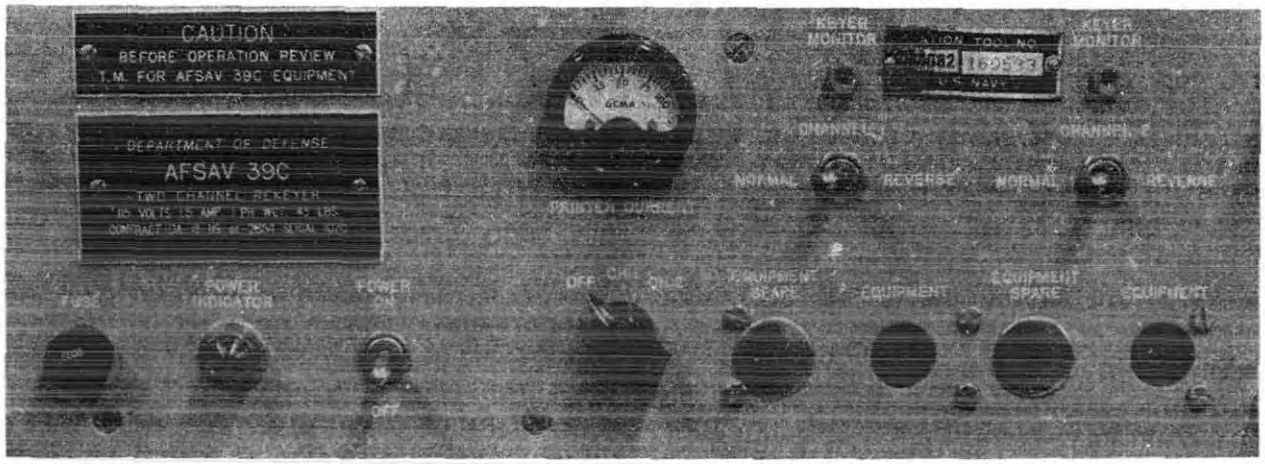
The following operating procedures are based on a single-channel teletype signal:

a. Place the POWER ON-OFF switch in the ON position. The POWER INDICATOR lamp should glow.

b. Place the CHANNEL 1 NORMAL-REVERSE switch in the NORMAL position.

c. Patch the channel 1 signal from AN/FRA-86 Keyed Tone output to the channel 1 input of the CV-1627/URR.

d. Place the PRINTER CURRENT meter switch in the Channel 1 position.




264.41

Figure 4-15.—CV-1627/URR two-channel rekeyer.

Table 4-4.—CV-1627/URR Operating Controls, Indicators and Functions

| CONTROL OR INDICATOR | FUNCTION |
|---|---|
| POWER ON-OFF Switch | Supplies filament and plate power to all tubes when in the ON position. |
| POWER INDICATOR | Visual Indicator that lights up when the a.c. power is on. |
| NORMAL-REVERSE | Two switches, one for each channel, used to select the proper polarity to match the polarity of the incoming signal. |
| FUSE | Line fuse to protect the equipment. |
| PRINTER CURRENT Meter | Measures the direct current pulse outputs to printers (channel 1 or 2). |
| EQUIPMENT Jacks | Used to supply d.c. pulses to printers from front panel patching. It should be noted that the terminal patch on the rear of the chassis will automatically be disconnected when the EQUIPMENT Jack is used. |
| EQUIPMENT SPARE | Same as the EQUIPMENT Jack, but permits the rear terminal patch to remain operative. |

e. Check the printer. If it is garbling, place the Channel 1 NORMAL-REVERSE switch in the REVERSE position and recheck the printer.

NOTE: GARBLE IS A TERM USED IN RADIO COMMUNICATIONS TO DENOTE AN ERROR IN TRANSMISSION OR RECEPTION THAT RENDERS INCORRECT OR UNINTELLIGIBLE A PART OR ALL OF THE TRANSMISSION. Figure 4-16 shows a standard teletype test transmission, while figure 4-17 shows a garbled transmission.

THE QUICK BROWN FOX JUMPED OVER THE LAZY DOG'S BACK 1234567890 TIMES RYRYRYRYRYRY RYRYRYRYRYRYRYRYRYRYRYRYRYRYRY RYRYRYRYRYRYRYRY

*Figure 4-16.—Standard teletype test.*

48&.MCAVB#S$';NCH?/CMVNHAKSJDM-63 &FJDHJGKZMXNHSG"/,"

*Figure 4-17.—Garbled teletype transmission.*

## Safety Precautions

It is extremely important for you to observe the safety precautions related to this piece of equipment. (Failure to do so may result in serious electrical shock.) IN PARTICULAR, DO NOT PLUG HEADPHONES INTO EQUIPMENT JACKS/SPARES AND DO NOT POKE ANY OBJECT INTO OPENINGS AROUND EQUIPMENT SPARES/JACKS. USE ONLY PROPER PLUG OR JACK PATCHES. Whenever you use front panel jacks, the proper procedure is to plug into your equipment, and THEN into the CV-1627/URR.

## CV-157/URR SINGLE SIDEBAND CONVERTER

The CV-157/URR single sideband converter (figure 4-18) is used to separate and demodulate the intelligence contained in a single sideband or in one sideband of an independent sideband transmission. The sideband transmission can be voice, teletype, or a combination of the two. It can also be used as an aid in the reception of amplitude modulated double sideband transmissions under extreme atmospheric conditions of fading. The R-390A/URR receiver is normally used to provide an input to the CV-157/URR. The CV-157/URR has an audio output in the frequency range of 125 Hz to 6kHz. An Automatic Frequency Control (AFC) circuit holds the converter IF at exactly 100 kHz and assures that accurate audio frequencies are delivered from the converter to terminal equipment.

### Controls and Functions

The front-panel controls of the CV - 157/URR are explained in table 4-5 below: (Refer to figure 4-18.)

### Operating Procedures

The following operating procedures for the CV-157/URR Single Sideband Converter cover the reception of single sideband or independent sideband signals containing multitones:

1. Set the CV-157/URR controls as follows:

| | |
|---|---|
| MONITOR GAIN | 5 |
| SB SELECT | LSB-A USB-B |
| VU RANGE | +10db |
| SQUELCH | OFF |
| AFC | OFF |
| AGC SELECT | REC |
| CARRIER SELECT | LC |
| SB AGC | 7.5 |
| AGC TIME | SLOW |
| VERNIER | ∅ kHz |
| CARRIER COMPENSATOR | Set to the level of the desired signal carrier; 6.5 (20 db reduced carrier), 3.0 (10 db reduced carrier), 10.0 (no reduction in carrier). |
| DRIFT INDICATOR | ∅ kHz |
| MONITOR Switch | Set to the opposite position of the sideband containing the Keyed-Tones:<br>A—If the Keyed-tone intelligence is in the upper sideband.<br>B—If the Keyed-tone intelligence is in the lower sideband. |
| VU SELECT Switch | Set to the same position as the MONITOR Switch. |

2. Plug a headset into the MONITOR jack.

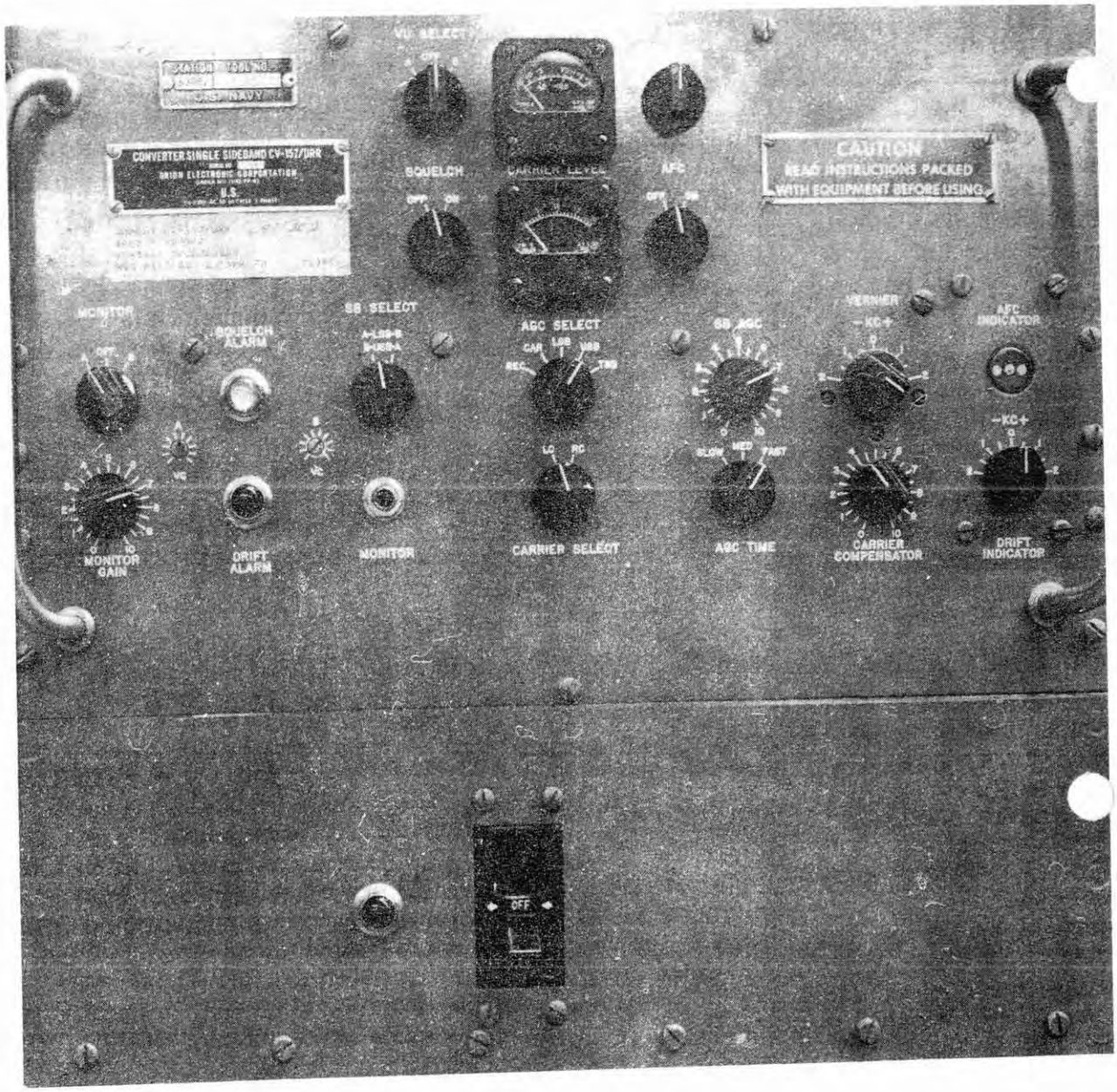
3. Adjust the MONITOR GAIN control for a comfortable and audible level.

4. Readjust the KILOCYCLE CHANGE control of the R-390A/URR until most of the keyed-tone intelligence is audible in the undesired channel of the converter.

5. Using the KILOCYCLE CHANGE control of the R-390A/URR, slowly tune back towards the known carrier frequency.

6. As the carrier frequency is approached, each tone in turn will pass through a zero beat and the CARRIER LEVEL meter of the converter will deflect to the right.

7. As the last tone (transmitted carrier) approaches zero beat, observe the carrier level meter of the converter. It will deflect sharply to the right and no signal will be heard in the headsets. If difficulty is experienced in zero beating the carrier in the above manner, tune as near as possible using the KILOCYCLE CHANGE control of the R-390A/URR, then use the VERNIER control on the converter for fine tuning.




264.42

Figure 4-18.—CV-157/URR single sideband converter.

8. Set the AFC switch of the converter to ON.

9. Set the SQUELCH switch of the converter to ON.

10. Set the AGC SELECT switch of the converter to the position corresponding to the tones contained in the sideband.

11. Set the AGC TIME switch of the converter to FAST.

12. Set the MONITOR switch of the converter to the appropriate channel.

NOTE: WHEN CHANGING FREQUENCY, PLACE THE CV-157 AFC SWITCH TO THE

**Table 4-5.—CV-157/URR Operating Controls, Indicators, and Functions**

| CONTROL OR INDICATOR | FUNCTION |
|---|---|
| ON/OFF Switch | Applies filament and plate voltages to the equipment when in the ON position. It is also a circuit breaker that serves as a protective device by automatically tripping to the OFF position if faulty circuits cause excessive current drain from the power source. |
| MONITOR Switch | In the A position, the audio intelligence in the converter A channel may be monitored. In the B position, the audio intelligence in the converter B channel may be monitored. |
| MONITOR GAIN Control | Varies the volume of the monitored signal. |
| SB SELECT Switch | In the counterclockwise position, (A-LSB, B-USB), the intelligence contained in the lower transmitted sideband is fed to channel A output and the intelligence contained in the transmitted upper sideband is fed to channel B output. In the clockwise position (B-LSB, A-USB), the outputs are reversed with the transmitted lower sideband appearing at channel B output and the upper sideband appearing at channel A. |
| A-VC | Controls the volume of channel A audio output to terminal equipment. It is adjusted with a screwdriver. |
| B-VC | Controls the volume of channel B audio output to terminal equipment. It is adjusted with a screwdriver. |
| VU-SELECT Switch | In A position, selects channel A audio output level to be measured by the VU METER. In the B position, selects channel B audio output level to be measured by the VU METER. |
| VU RANGE Switch | Changes the range of the VU METER (+10, 0, and -10). It is similar in operation to the R-390A/URR LINE METER switch. |
| SQUELCH Switch | Turns the squelch circuit ON and OFF. |
| AFC Switch | Activates the automatic frequency control circuits. This switch should be OFF when any tuning is done. |

Table 4-5.–CV-157/URR Operating Controls, Indicators, and Functions–Continued

| CONTROL OR INDICATOR | FUNCTION |
|---|---|
| AGC SELECT Switch | Five-Position automatic gain control function swi<br>1. REC - The associated receiver uses its own AG voltage. The converter has no control of the radio receiver's RF gain.<br>2. CAR - The 100 kHz IF converter carrier, with the modulation removed, is selected as the source of AGC voltage developed to control RF gain of the receiver (recommended for most uses).<br>3. LSB - The intelligence contained in the lower sideband is selected as the source of AGC voltage developed by the converter to control the RF gain of the associated receiver.<br>4. USB - The intelligence contained in the upper sideband is selected as the source of AGC voltage developed by the converter to control the RF gain of the associated receiver.<br>5. TSB - (Twin sideband and double sideband) the 100kHz converted IF carrier plus the sidebands are selected as the source of AGC voltage developed by the converter to control the RF gain of the associated receiver. |
| CARRIER SELECT Switch | Two-position switch which selects a 100kHz output to demodulate the intelligence present in sideban frequencies.<br>LC - 100 kHz output is from the local oscillator.<br>RC - 100 kHz output is reconditioned from the received signal. |
| SB AGC Control | The SIDEBAND AUTOMATIC GAIN CONTROL (SB AGC) varies the amount of voltage developed by the converter when the AGC SELECT switch is in the TSB, USB, or LSB positions. |
| AGC TIME Switch | Varies the time constant of the AGC voltage developed by the converter. |
| VERNIER Control | Tunes the converter heterodyne oscillator over a range of + or -2 kHz. |
| CARRIER COMPENSATOR Control | Varies the gain of the converter carrier section to adjust for various levels of carrier suppression at the transmitter. |

Table 4-5.—CV-157/URR Operating Controls, Indicators, and Functions—Continued

| CONTROL OR INDICATOR | FUNCTION |
|---|---|
| SQUELCH ALARM | The SQUELCH ALARM lights when the AGC circuit has been disabled because of the signal to noise ratio being too low for proper operation. This alarm operates only when the squelch control is in the ON position. |
| DRIFT ALARM | The DRIFT alarm lights to indicate that the signal has drifted + or -2 kHz, necessitating retuning of the signal. |
| AFC INDICATOR | The AFC INDICATOR lamp gives the visual indication that the AFC motor is on. |
| DRIFT INDICATOR | When the AFC is ON, the DRIFT INDICATOR gives a visual indication of the amount of signal drift. |
| LOW-PASS FILTER Switch | This two-position switch is internally located and normally is preset by maintenance.<br><br>IN - The output of the converter's AF band pass is limited to 3.5 kHz.<br><br>OUT - The output of the converter's AF band pass may go up to 6 kHz. |
| CARRIER LEVEL meter | Indicates the level of the reconditioned carrier. |

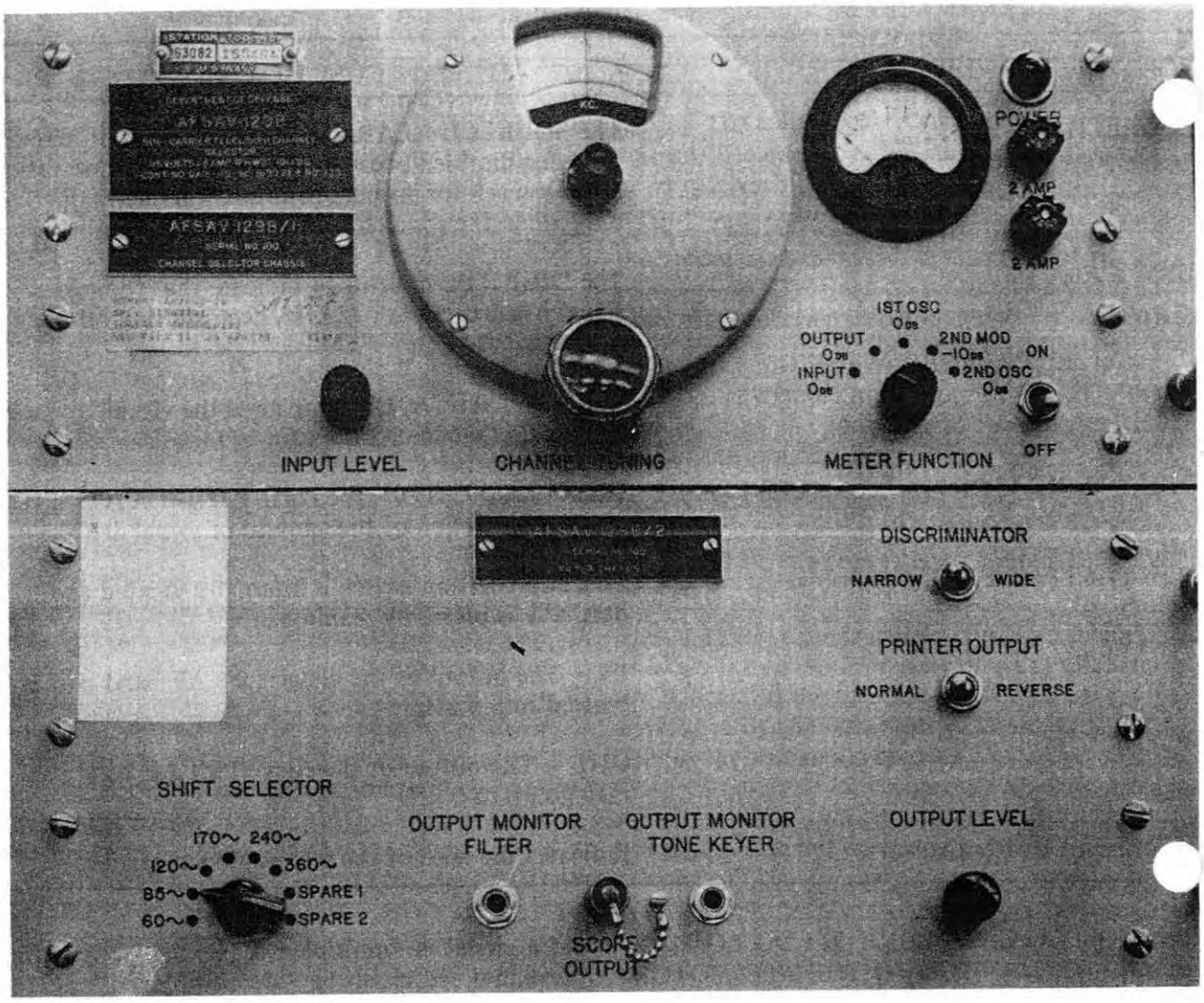
OFF POSITION. FAILURE TO DO SO MAY RESULT IN DAMAGE TO THE AFC MOTOR DRIVE ASSEMBLY.

## DEMULTIPLEXERS

Radio stations throughout the world are prevented from interfering with each other primarily by being assigned different carrier frequencies and by being limited to prescribed bandwidths around these carrier frequencies. The term "multiplexing" describes methods which allow two or more channels or canals of information to be transmitted on one carrier, thereby permitting each station to transmit more information within its alloted portion of the RF spectrum. The two general methods of multiplexing are FREQUENCY DIVISION (FDM) and TIME DIVISION (TDM). If a signal is "multiplexed" at the transmitting terminal, it must be "demultiplexed" at the receiving terminal before it can be put into an intelligible form. The most common FREQUENCY DIVISION demultiplexer used in the Naval Security Group is the AN/FGC-78 SUBCARRIER TELEGRAPH CHANNEL SELECTOR.

### AN/FGC-78 SUBCARRIER TELEGRAPH CHANNEL SELECTOR

The AN/FGC-78 (AFSAV-129) Subcarrier Telegraph Channel Selector (figure 4-19) is used to extract individual teletype signals from multitone (FDM) systems. The input is normally an audio frequency from a single sideband converter such as the CV-157/URR. The keyed d.c. (KDC) output is used to drive terminal teletype equipment, or it can be used for input into the




264.43

Figure 4-19.—AN/FGC-78 Subcarrier telegraph channel selector.

SN-398 Dual Digitizer for FLEXSCOP operations. In the operation of the AN/FGC-78, the operator tunes the Channel Selector through its ranges of multitones to select individual channels which may be narrowly or widely spaced in frequency. The unit will accomodate signals of narrow shifts, (60-120 Hz), or wideband shifts, (170-360 Hz). The AN/FGC-78 is designed for fixed station operation and not for mobile use.

### Controls and Functions

The AN/FGC-78 is comprised of two units: CHANNEL SELECTOR Unit and FILTER Unit. The controls and functions of each individual unit are listed in Tables 4-6 and 4-7. (Refer to figures 4-20 & 4-21.)

### Operating Procedures

The operating procedures described below are to be used when extracting individual channels from multitone (FDM) signals:

FILTER UNIT.–

1. Shift SELECTOR–Set this control to the setting that is equal to the frequency shift of the selected tone.

Table 4-6.–Channel Selector C-4895/FGC-78 Controls and Functions

| CONTROL | FUNCTION |
|---|---|
| CHANNEL TUNING Knob | Controls the variable oscillator frequency from 16 to 28 kHz. |
| INPUT LEVEL Knob | Controls the input amplitude. |
| METER FUNCTION Switch | Connects the meter to various check points: INPUT, OUTPUT, 1ST OSCILLATOR, 2ND MODULATOR, AND 2ND OSCILLATOR. |
| POWER Switch | Switches power ON or OFF. |

Table 4-7.–Filter F-846/FGC-78 Controls and Functions

| CONTROL | FUNCTION |
|---|---|
| SHIFT SELECTOR Switch | Selects the filter to be used on the translated signal. There are eight positions: 60, 85, 120, 170, 240, 360 and two spares. The position used will be determined by the frequency shift of the signal. |
| DISCRIMINATOR NARROW-WIDE Switch | Selects the proper discriminator transformer for frequency being translated: NARROW 60-120kHz; WIDE 170-360kHz. |
| OUTPUT LEVEL Knob | Adjusts the output level of the filtered signal displayed on the meter. |
| PRINTER OUTPUT Switch | NORMAL/REVERSE positions for control of the polarity of the output to the printers. |

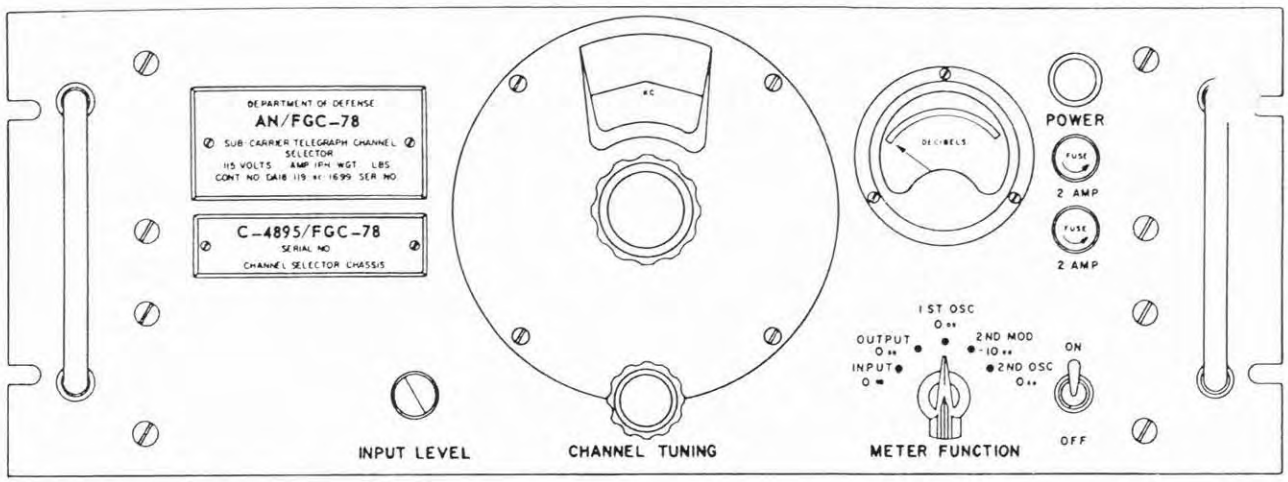
2. DISCRIMINATOR–Set to NARROW for tone shifts of less than 170 Hz; WIDE for tone shifts of greater than 170Hz.

3. PRINTER OUTPUT–Set as determined by signal polarity.

CHANNEL SELECTOR UNIT.–

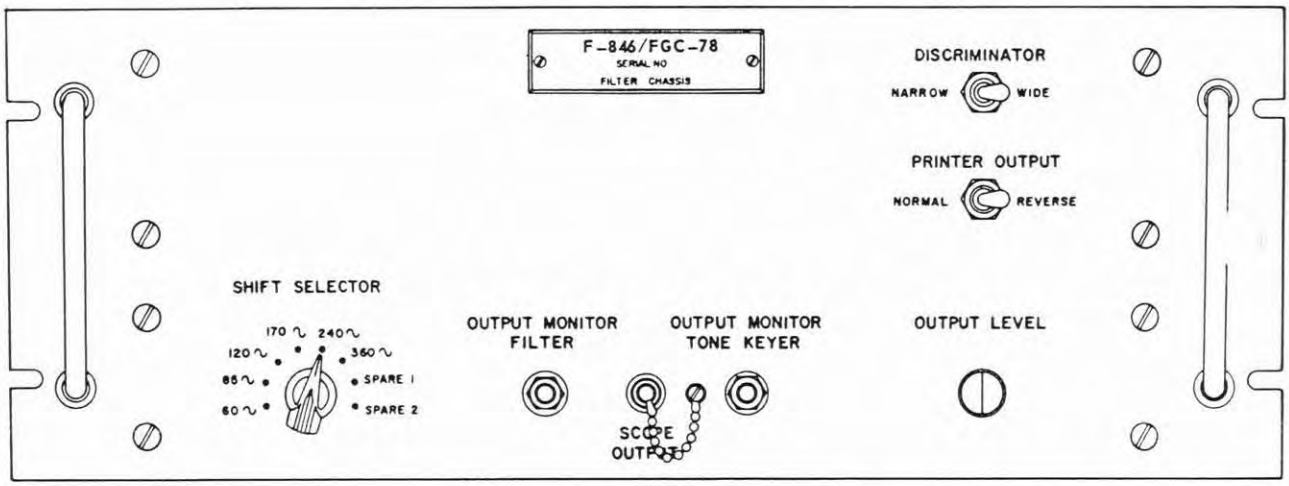
1. METER FUNCTION–Set and observe as follows:

a. 1ST OSCillator should indicate ØdB.




264.44

**Figure 4-20.—Channel selector unit C-4895/FGC-78 front panel.**




264.45

**Figure 4-21.—Filter unit F-846/FGC-78 front panel.**

b. 2ND OSCillator should indicate Ø dB.

NOTE: NOTIFY MAINTENANCE IF ABOVE OSCILLATOR OUTPUTS INDICATE OTHER THAN THE ABOVE LEVELS.

2. CHANNEL TUNING dial—Set to the desired frequency.

3. METER FUNCTION Switch—Set to INPUT position.

4. Adjust the CHANNEL TUNING dial for maximum deflection on the meter—if levels exceed ØdB, lower the RF GAIN on the R-390A/URR receiver.

5. Adjust the INPUT GAIN for near ØdB (for fading multitone signals, adjust slightly above ØdB).

6. Set METER FUNCTION switch to OUTPUT–adjust output to Ø dB.

7. Set METER FUNCTION switch to 2ND MOD (second modulator)–meter should indicate -1Ø dB

8. While monitoring the FILTER OUTPUT, locate an active tone channel.

9. Monitor the tone keyer output and adjust the TUNING dial for the best audible output or visual indication on an oscilloscope.

10. Perform the METER check again and make necessary adjustments for proper input and output levels.

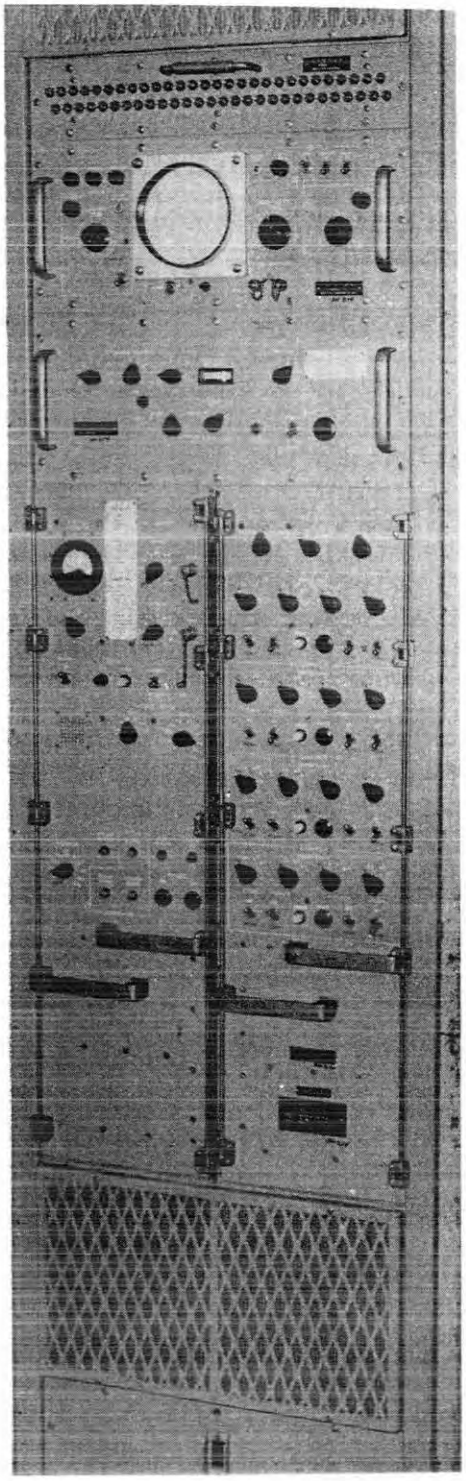
## AN/TCA-4 DIGITAL CONVERTER PROGRAMMING GROUP (KINDER)

The AN/TCA-4 (figure 4-22) is another common demultiplexer. This equipment is used primarily to separate time division multiplex (TDM) signals into individual channels and to perform signal translation functions. Demultiplexing, in this case, is the separation of channels contained in a time division multiplex (TDM) signal. Translation is the conversion of any unit code to another standard unit code, i.e., changing a 7 unit code to a 5 unit code. The AN/TCA-4 has the capability of processing one signal with a maximum of 56 equal length elements per cycle or, with the Applique section, two signals with a maximum of 28 equal length elements per cycle for each signal. (The Applique section will be discussed later in this chapter.) Input signals may be in the form of keyed tone (KT) or keyed direct current (KDC) within an element length range of 1 to 40 milliseconds. The AN/TCA-4 provides a maximum of ten output channels, in standard 5-unit teletype form, and a printing rate of 50 to 175 words per minute (WPM).

### Theory of Operation

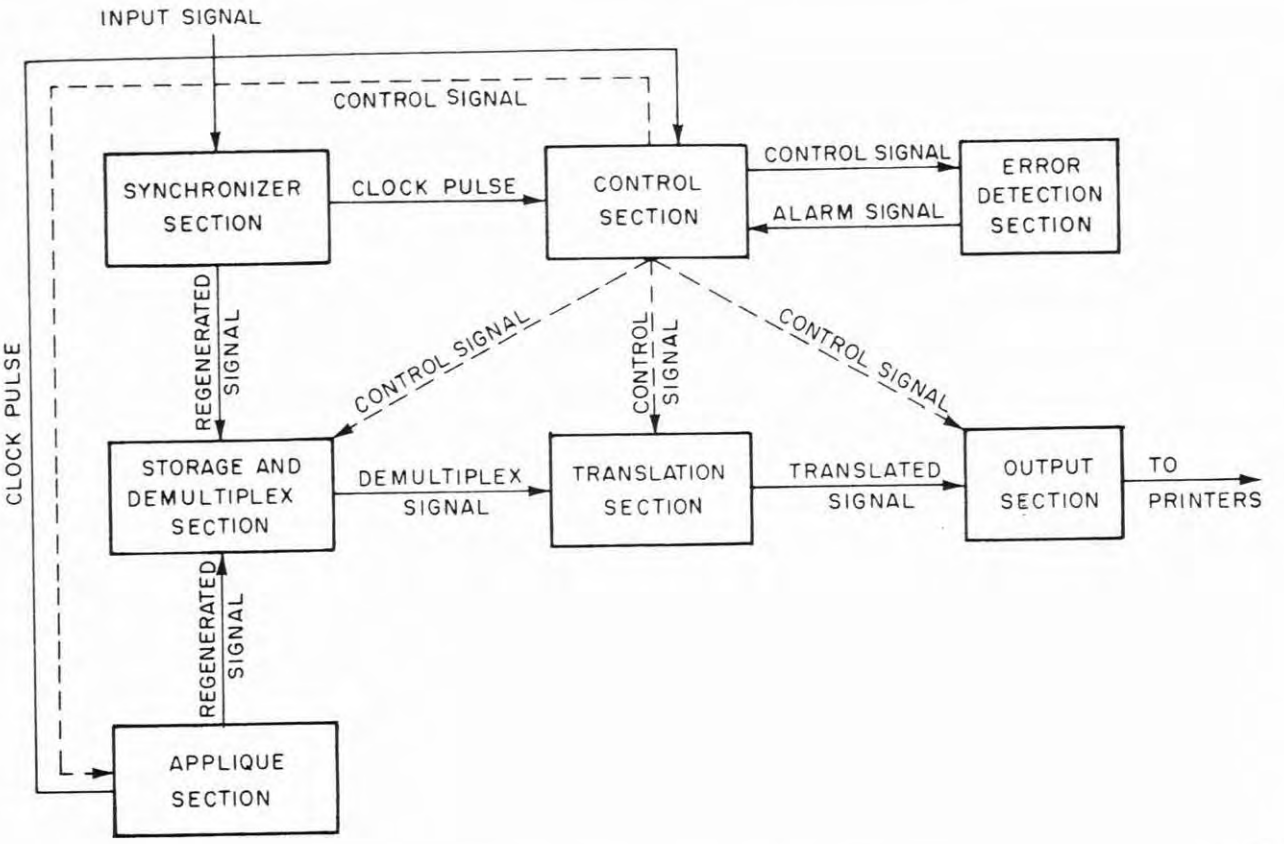
Functionally, the AN/TCA-4 is divided into seven sections (figure 4-23). These are: the Synchronizer; Storage and Demultiplexer; Translation; Output; Control; Error Detection, and; Applique Section.

SYNCHRONIZER SECTION.–The input data signal is first applied to the synchronizer



264.46

Figure 4-22.–AN/TCA-4 digital converter programming group (KINDER).




264 47

**Figure 4-23.—AN/TCA-4 block diagram.**

where it is regenerated into digital level signals. The synchronizer generates a clock pulse signal that provides synchronization of the equipment to the speed of the incoming signal. The clock pulse is then routed to the control section. The regenerated signal is passed to the storage and demultiplexing section.

STORAGE AND DEMULTIPLEXING SECTION.—The regenerated data signal is stored in the input storage register for one complete cycle and then demultiplexed and routed to the translation section.

TRANSLATION SECTION.—The function of this section is to convert the incoming signal to the standard five-unit teleprinter code. The signal, in converted form, is then applied to the output section.

OUTPUT SECTION.—The individual channels of the demultiplexed signal are stored in the output storage registers. Teleprinter start and stop elements are added to the five unit teleprinter signal and the composite signal is applied to the teleprinters.

CONTROL SECTION.—The clock pulse signal is used by the control section as a base to provide timing and control signals to all other sections of the equipment. The control section provides phasing of the equipment to the time division multiplex signal. The control signals produced by this section initiate the translation and output phases of operation.

ERROR DETECTION SECTION.—This section operates in conjunction with the control section. Its function is the detection of

erroneous or prohibited signals (incorrectly keyed characters, static characters, etc.). It activates alarm circuitry upon detection of an erroneous or prohibited signal and routes a signal to the control section. The control section then sends a "checked" pulse to the translation section. The character is either confirmed as being erroneous and routed to ground, or proved and routed on through the equipment. The control section then reactivates the translation and output phases of operation and normal operation continues.

APPLIQUE SECTION.–The function of the applique section is to increase the capability of the AN/TCA-4. It provides the capability of handling two independent input signals simultaneously. This section contains an applique converter section and synchronizer section. The applique synchronizer is functionally identical to the synchronizer section, providing synchronization, input data regeneration, and a baud-clock signal generation. The applique converter counts and stores the input digital bits and transfers them to the storage and demultiplexing section upon receipt of a control (checked) pulse from the control section. Once the two input signals are in the input storage register of the storage and demultiplexing section, they are treated as one signal having as many channels as the original signals combined.

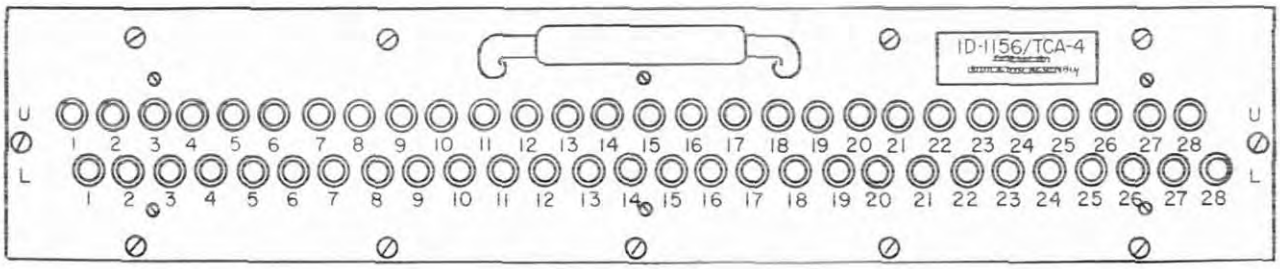
### Major Assemblies

The AN/TCA-4 is mounted in a single equipment rack. The Applique section is housed in a separate equipment rack. There are eight major assemblies contained in the AN/TCA-4. Figure 4-22 shows the AN/TCA-4 as it is normally installed with the Applique section and AN/UGC-33X paper tape printers.

POWER SUPPLY.–This unit is mounted in the topmost portion of the cabinet and supplies four separate d.c. operating voltages for the cabinet-mounted equipment. These voltages are adjustable from the front of the power supply by means of screwdriver controls (adjustments are performed by maintenance personnel). All fuses are mounted at the front of the power supply to facilitate replacement. The power supply is obstructed from view by an air filter placed on the front of the equipment.

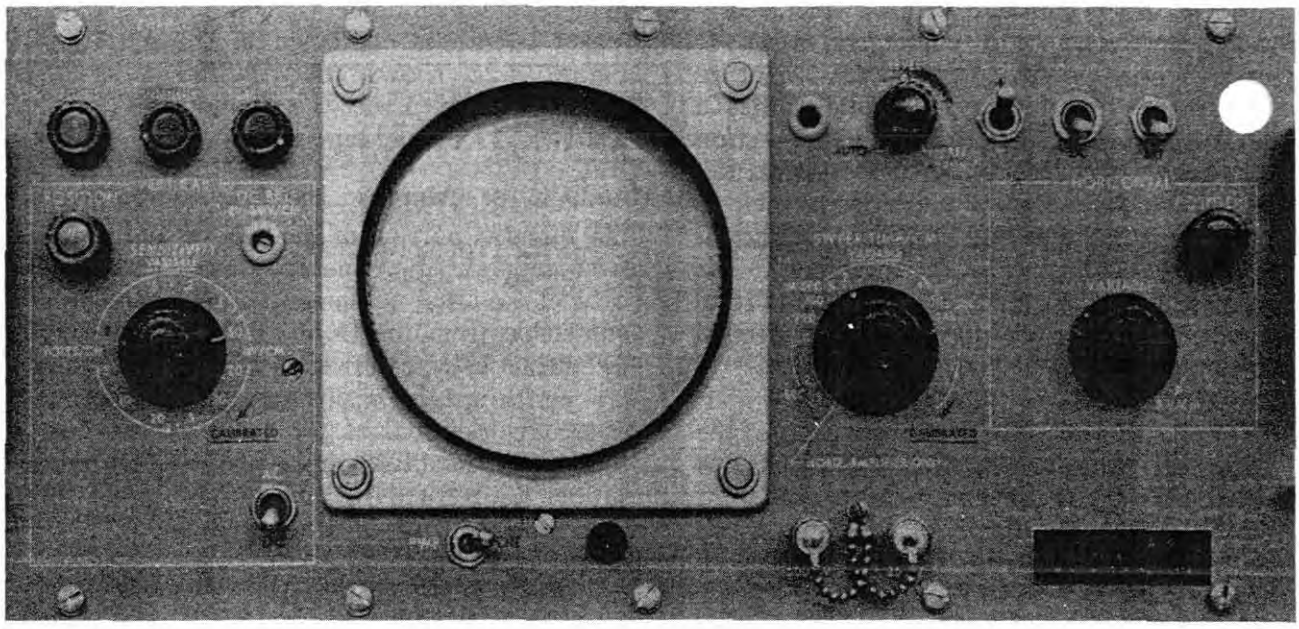
DATA DISPLAY PANEL.–The data display panel is mounted directly below the power supply and contains two rows of lamps, 28 lamps in each row. The indicator lamps are used to provide a visual indication of the input data bits stored at the beginning of each cycle of operation. The indicator lamps are illuminated to show the presence of an energized data bit after the signal has been demultiplexed. See figure 4-24.

OSCILLOSCOPE.–The Tektronix Model RM-504 is the oscilloscope used with the AN/TCA-4 (figure 4-25). This unit provides the operator with a means for monitoring the signal at various points throughout the equipment and aids in equipment set-up. It is also used by the maintenance force when performing equipment maintenance.




264.48

Figure 4-24.–AN/TCA-4 indicator unit.



264.49

Figure 4-25.—AN/TCA-4 oscilloscope unit.

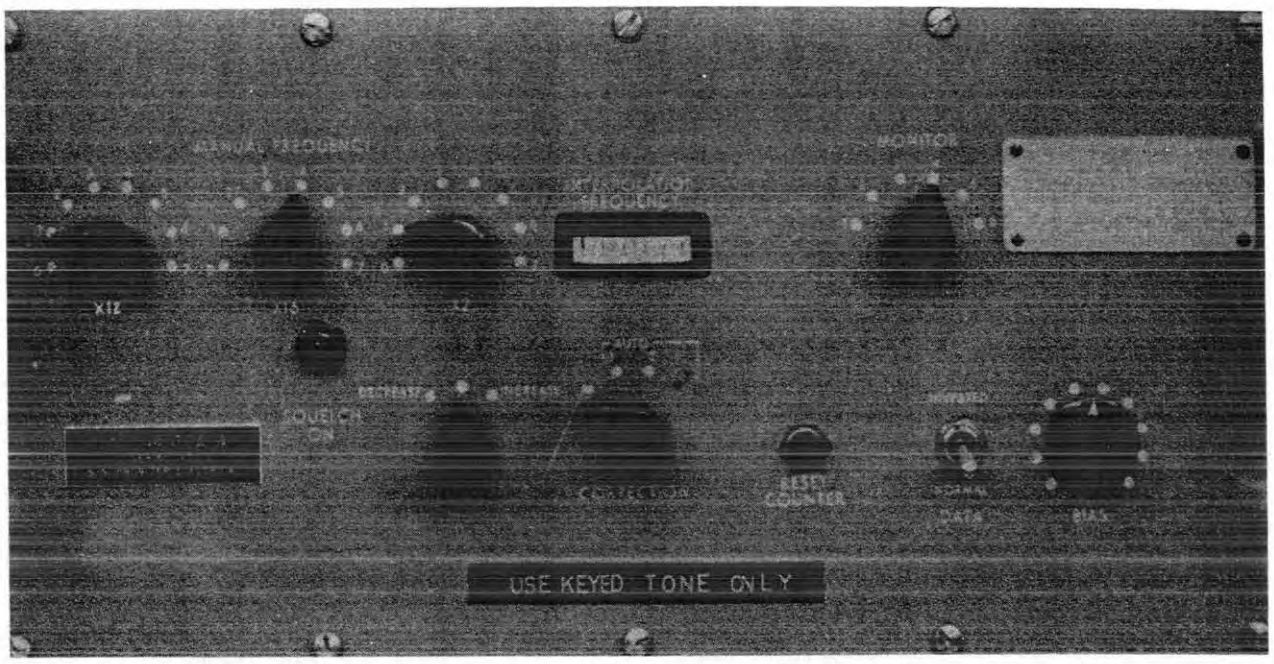
SYNCHRONIZER.—The Synchronizer is mounted below the oscilloscope unit and provides all the functions of the synchronizer section. The synchronizer is the heart of the AN/TCA-4. See figure 4-26.

LEFT DRAWER.—The left drawer (figure 4-27) is a slide mounted unit to permit its withdrawal for operational and maintenance functions. It contains all printed circuit module boards of the plug-in type. They are easily removed for maintenance and replacement purposes. These boards comprise the storage and demultiplexing output, error detection, and control circuitry. The REORDER plugboard is also contained in the left drawer. This is a locally prepared patched plugboard that provides the signal program for the AN/TCA-4. The REORDER plugboard is prewired to demultiplex the incoming signal. Programs for different signals are prewired on separate REORDER plugboards. Rapid changeover from one program to another is accomplished by removal of the REORDER plugboard from the left drawer and inserting the one programmed for the desired signal.

RIGHT DRAWER.—The right drawer (figure 4-28) is also slide mounted and contains 74 printed circuit module boards of the plug-in type. These boards provide individual c' nel sub-division and phasing of sub-divided cha..els. The TRANSLATOR plugboard is contained in this drawer. It is locally pre-patched for the operator and translates or converts codes to the standard five unit teleprinter code. Separate TRANSLATOR plugboards are required for each specific code.

BLOWER/FILTER UNIT.—The blower/filter panel circulates cooling air throughout the cabinet mounted assemblies. A main circuit breaker is located directly below the blower/filter panel at the bottom of the cabinet.

APPLIQUE UNIT.—This unit (figure 4-29), containing the applique synchronizer and applique converter, is mounted in a separate cabinet and enables the AN/TCA-4 to handle two, 28-element signals simultaneously. The applique synchronizer contains a separate power




264.50

Figure 4-26.—AN/TCA-4 synchronizer unit.

supply, which is the only difference between it and the cabinet mounted synchronizer. The applique unit CANNOT process any signal that is employing channel sub-division.

AN/UGC-33X PRINTER CONSOLE.—The data from the AN/TCA-4 is reproduced on the AN/UGC-33X (figure 4-30), a special printer configuration designed for use with the AN/TCA-4. It contains nine reperforator printers that reproduce a signal on five-level paper tape. Contained within the console is a vacuum system that collects the chad punched from the tape. Each printer has four separate inputs from each channel of the AN/TCA-4.

### Controls, and Functions

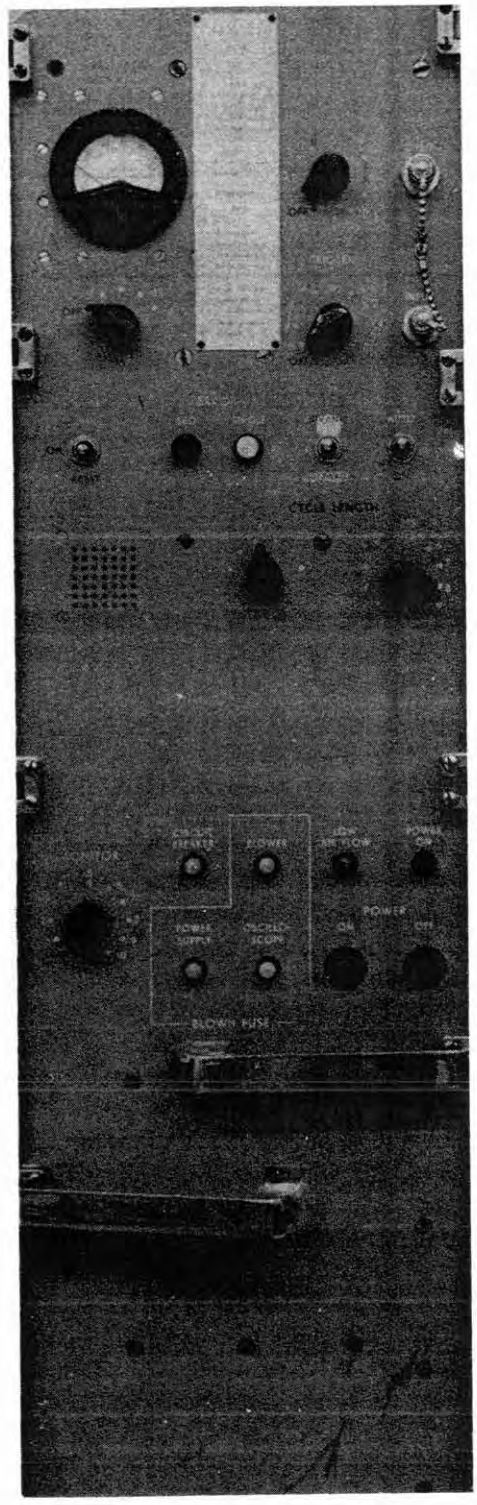
The controls, indicators, and their functions are presented unit by unit, from top to the bottom of the cabinet in tables 4-8 thru 4-12.

### Preliminary Operating Procedures

For preliminary operating procedures, the controls should be set as follows:

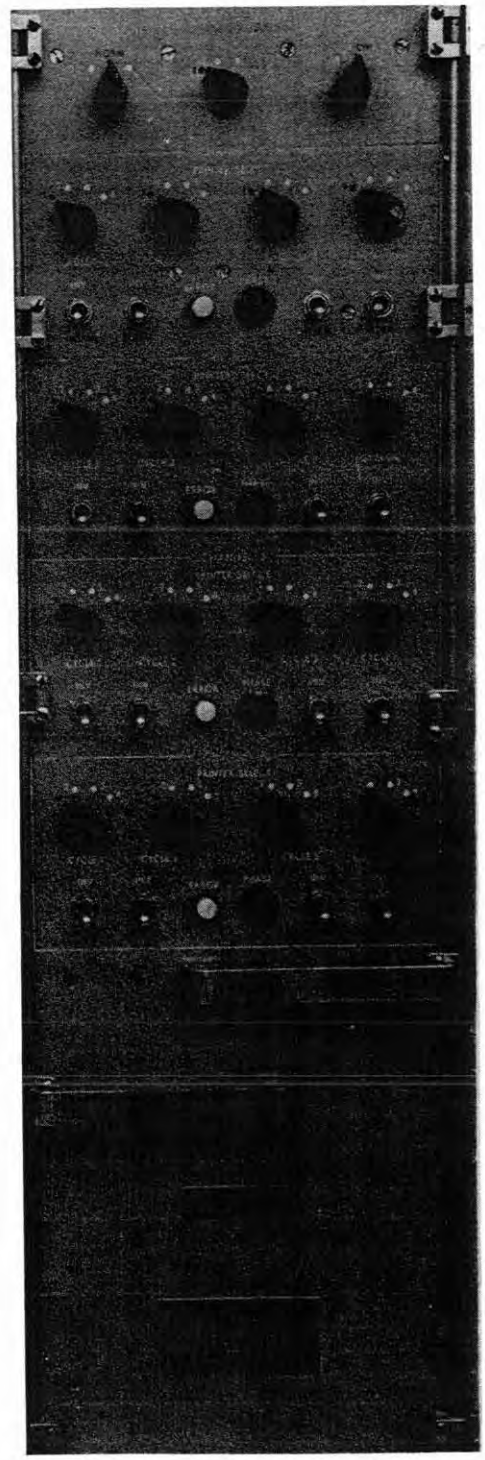
OSCILLOSCOPE Unit

| | |
|---|---|
| POWER Switch | ON |
| VERTICAL POSITION Control | Center Presentation on CRT |
| VERTICAL SENSITIVITY Switch | 2 Volts/CM |
| VERTICAL SENSITIVITY Variable | Fully Clockwise |
| AC/DC Toggle Switch | DC |
| SWEEP TIME/CM Switch | 1 MSEC |
| HORIZONTAL POSITION Control | Mid-scale |



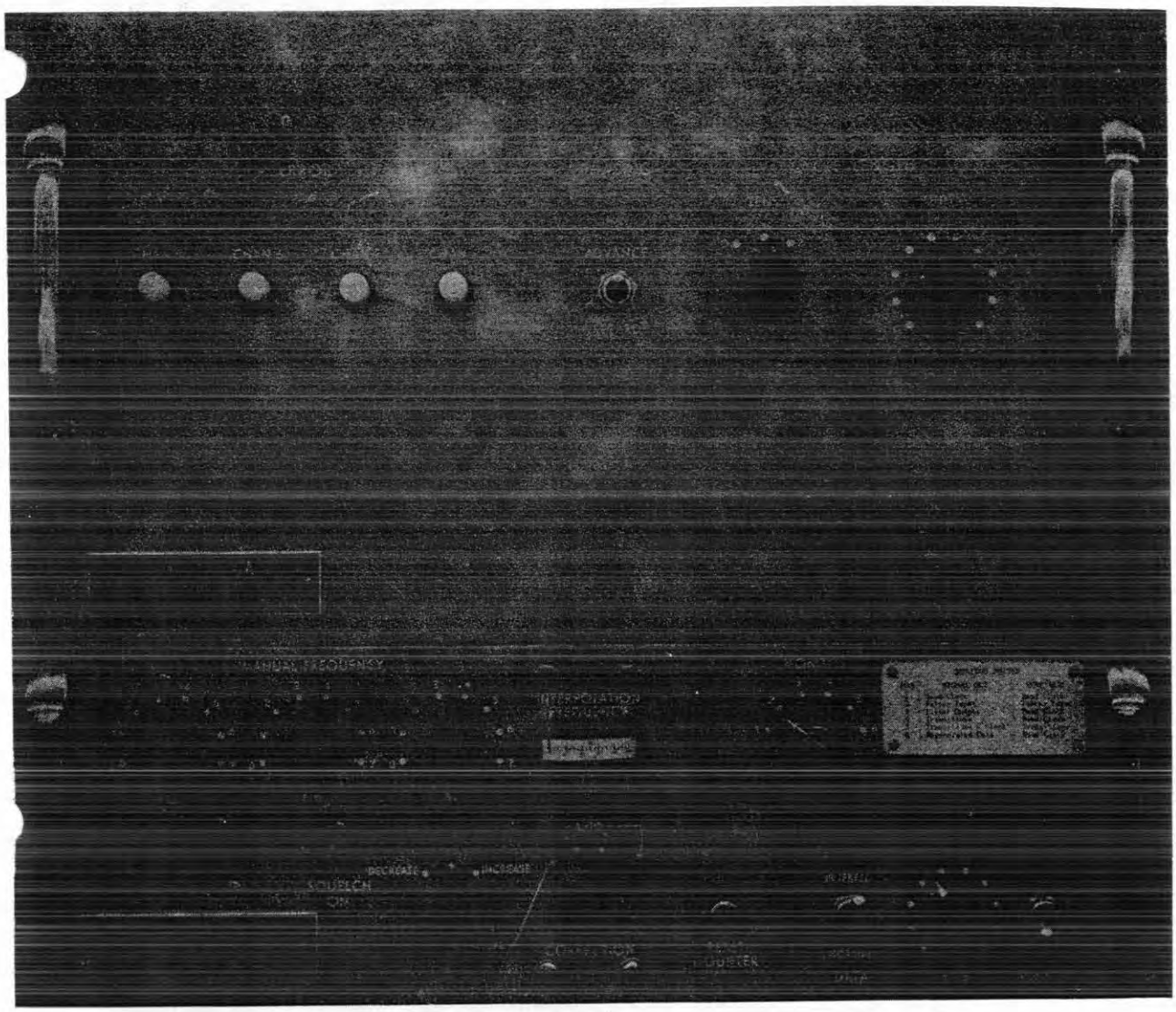

264.51

Figure 4-27.—AN/TCA-4 left-hand drawer.



264.52

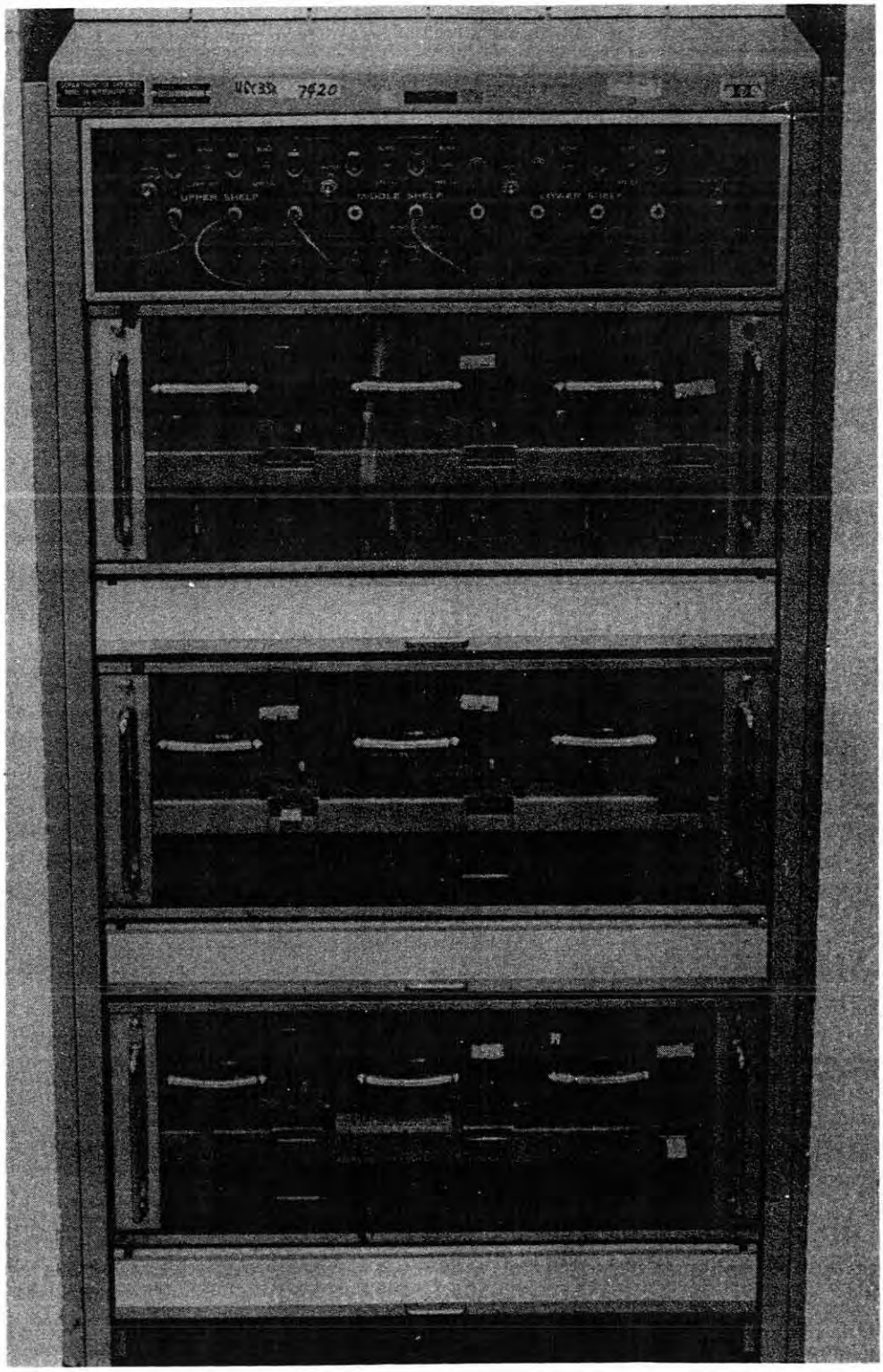
Figure 4-28.—AN/TCA-4 right-hand drawer.



264.53

**Figure 4-29.–AN/TCA-4 applique unit.**

| | |
|---|---|
| HORIZONTAL SWEEP TIME/CM VARIABLE | Fully clockwise |
| TRIGGER SOURCE Switch | EXT |
| TRIGGER COUPLING Switch | DC |
| TRIGGER SLOPE Switch | + |
| TRIGGER LEVEL | Free Run |
| FOCUS and INTENSITY Controls | Adjust to obtain a clear and concise presentation. |
| SCALE ILLUMINATION Control | Fully counterclockwise |
| SYNCHRONIZER UNIT | |
| BIAS Control | Mid-scale |




264.54

Figure 4-30.—AN/UGC-33X printer console.

**Table 4-8.—AN/TCA-4 Oscilloscope Unit Operating Controls, Indicators, and Functions**

| CONTROL OR INDICATOR | FUNCTION |
|---|---|
| FOCUS Control | Adjusts focus of spot image on CRT screen. |
| INTENSITY Control | Adjusts image of intensity on CRT screen. |
| SCALE ILLUMINATION Control | Adjusts graticule (vertical and horizontal lines) illumination. |
| TRIGGER LEVEL Control | Adjusts operating point of trigger for synchronizing image on CRT screen. When set to FREE RUN, sweep is not synchronized with vertical input signal; when set to AUTO, sweep is automatically synchronized with vertical input signal. |
| TRIGGER SLOPE | Selects synchronization with positive-going (+) or negative-going (-) signal. |
| TRIGGER COUPLING Switch | Selects external trigger signal coupling to trigger amplifier. |
| TRIGGER SOURCE Switch | Selects source of trigger signal; INT from vertical amplifiers, EXT from external trigger input. |
| HORIZONTAL POSITION Control | Permits horizontal positioning of image on the screen. |
| SWEEP TIME/CM Switch | Selects sweep rates for horizontal sweep. |
| SWEEP TIME/CM Variable Control | Adjusts for intermediate values of sweep time. |
| PWR/ON Switch | When set to ON, applies line power to the oscilloscope. |
| INDICATOR LIGHT | When lit, indicates line power to oscilliscope has been turned on. |
| AC/DC Switch | Selects signal coupling to vertical amplifiers; AC for coupling AC signal, DC for coupling DC signals. |
| VERTICAL SENSITIVITY Control | Selects vertical amplifier gain for CRT scale. |
| VERTICAL SENSITIVITY Variable Control | Adjusts vertical amplifier gain for intermediate values. |
| VERTICAL POSITION Control | Adjusts vertical positioning of image on CRT screen. |

**Table 4-9.—AN/TCA-4 Synchronizer Unit Operating Controls, Indicators, and Functions**

| CONTROL OR INDICATOR | FUNCTION |
|---|---|
| MANUAL FREQUENCY X 128 Switch | Changes baud clock output by 128 bits per second per increment. |
| X16 Switch | Changes baud clock output by 16 bits per second per increment. |
| X2 Switch | Changes baud clock output by 2 bits per second per increment. |
| INTERPOLATION FREQUENCY Meter | Provides a visual indication of synchronization between clock signal and input signal. |
| MONITOR Switch | Permits selection of internal signal and sync outputs to be applied to the oscilloscope unit as follows: |

| POSITION | SYNC SIGNAL SELECTED | SIGNAL DISPLAYED ON OSCILLOSCOPE |
|---|---|---|
| 1 | Baud Clock | Baud Clock |
| 2 | Baud Clock | Input data to filter |
| 3 | Baud Clock | Input data to filter |
| 4 | Baud Clock | Transition data signal |
| 5 | Input Data Squared | Transition data signal and Baud Clock Signal |
| 6 | Baud Clock | Regenerated data signal. |

| | |
|---|---|
| SQUELCH ON Lamp | Lights when squelching exists. |
| INCREASE/DECREASE Switch | Functions only when Correction switch is in the manual position. Permits manual increasing and decreasing of interpolation frequency for initial synchronization of the baud clock and input signal. |
| CORRECTION Switch | In the Manual position, disconnects automatic correction voltage. In Auto positions 1, 2, or 3, applies correction voltage to synchronizer for automatic synchronization. |
| RESET COUNTER Switch | Presets the interpolation frequency to its center position when the Correction is in the Manual position. |
| DATA Switch | Selects normal or inverted polarity for regenerated data. |
| BIAS Control | Permits the elimination of any mark or space bias on the input signal. |

Table 4-10.—AN/TCA-4 Left-Hand Drawer Operating Controls, Indicators, and Functions

| CONTROL OR INDICATOR | FUNCTION |
|---|---|
| POWER ON Switch | Applies main power to the unit. |
| POWER ON Lamp | Lights when main power is applied. |
| POWER OFF Switch | Removes main power from unit. |
| CIRCUIT BREAKER Lamp | Lights when circuit breaker is on. |
| LOW AIR FLOW Lamp | Lights when cabinet air circulation is low. |
| BLOWN FUSE Lamps | Lights when BLOWER, POWER SUPPLY, or OSCILLOSCOPE fuses are open. |
| MONITOR Switch | Permits printout of channels 1 through 10 on the monitor printer. |
| CYCLE LENGTH Switches | TENS-Selects tens-order of elements per cycle.<br>UNITS-Selects the Units-order of elements per cycle. |
| ALARM Switch | Controls error alarm. In the OFF position, removes alarm circuitry from equipment; RESET position silences audio alarm and resets alarm circuitry. |
| ERROR SEQUENTIAL Lamp | Indicates that the preset number of sequential errors has occurred. |
| ERROR SINGLE Lamp | Indicates that a signal error has occurred. |
| PHASING Switches | ADVANCE/RETARD-Selects manual phasing mode to be used.<br>AUTO-Indicates automatic phasing cycle. |
| VOLTAGE Monitor | Selects operating voltage to be monitored by Voltage Monitor Meter. |

Table 4-10.—AN/TCA-4 Left-Hand Drawer Operating Controls, Indicators, and Functions—Continued

| CONTROL OR INDICATOR | FUNCTION |
|---|---|
| OSCILLOSCOPE VERTICAL Switch | Selects signal for vertical input of the oscilloscope as follows:<br><br>POSITION — SIGNAL SELECTED<br>OFF — Grounded<br>1 — Synchronizer monitor signal<br>2 — Normal end cycle pulse<br>3 — 50kHz delayed clock pulse<br>4 — Serial oscillator output signal<br>5 — Inverted parallel command generator output<br>6 — Channel monitor output<br>7 — Channel pulses<br>8 — Applique synchronizer monitor<br>9 — Selected input from REORDER plugboard<br>10 — Signal from external vertical jack on left drawer |
| OSCILLOSCOPE TRIGGER Switch | Selects trigger source for oscilloscope as follows:<br><br>POSITION — SIGNAL SELECTED<br>OFF — Grounded<br>1 — Synchronizer Sync signal<br>2 — Normal end cycle pulse<br>3 — 50kHz delayed clock pulse<br>4 — Serial oscillator start signal<br>5 — Open<br>6 — Channel Monitor Output<br>7 — Channel pulses<br>8 — Applique synchronizer sync signal<br>9 — Selected input from REORDER plugboard<br>10 — Signal from external trigger jack on left drawer |
| INPUT JACK (Vertical) | External input jack to oscilloscope trigger through oscilloscope vertical switch. |
| INPUT JACK (Trigger) | External input jack for oscilloscope trigger through oscilloscope trigger switch. |

**Table 4-11.—AN/TCA-4 Right-Hand Drawer Operating Controls, Indicators, and Functions**

| CONTROL OR INDICATOR | FUNCTION |
|---|---|
| DATA MODE Switch | Selects data hold or sample functions. |
| CYCLE SAMPLE Switch | Selects which cycle data is sampled by Data Mode Switch action. |
| PRINTERS Switch | Controls output of equipment to external channel printers (AN/UGC-33X). |
| PRINTER SELECT Switch | Selects the printer to which the sub-divided data is applied for each sub-cycle of time for channels 1, 2, 3, and 4. |
| INV/NORM Switches | Selects the sub-cycle of the channel that will use inverted or normal polarity. |
| PHASE Switch | Controls phasing of the channel sub-cycles. |
| ERROR Lamps | Indicates error characters in respective channel. |

**Table 4-12.—AN/TCA-4 Applique Unit Operating Controls, Indicators, and Functions**

| CONTROL OR INDICATOR | FUNCTION |
|---|---|
| POWER Switch | Applies power to the Applique synchronizer and Applique converter. |
| POWER Indicator Lamp | Indicates that power to the Applique unit is being applied. |
| ERROR Lamps | Indicates an error character in the respective channel. |

NOTE: THE ADDITIONAL CONTROLS OF THE APPLIQUE SYNCHRONIZER ARE IDENTICAL IN FUNCTION WITH THE CONTROLS OF THE CABINET SYNCHRONIZER. THE CYCLE LENGTH, TENS, UNITS, AND PHASING SWITCHES OF THE APPLIQUE CONVERTER UNIT ARE IDENTICAL IN FUNCTION TO THE RESPECTIVE CONTROLS ON THE LEFT DRAWER.

| | | | |
|---|---|---|---|
| DATA Switch | Normal | MANUAL FREQUENCY X128 | Ø |
| CORRECTION Switch | Manual | | |
| | | INTERPOLATION FREQUENCY METER | Mid-scale (Press RESET counter) |
| MANUAL FREQUENCY X2 | Ø | | |
| MANUAL FREQUENCY X16 | Ø | MONITOR Switch | 1 |

| | |
|---|---|
| RIGHT-HAND DRAWER | |
| DATA MODE Switch | NORM |
| CYCLE SAMPLE Switch | 1 |
| PRINTERS Switch | OFF |
| PRINTER SELECT Switches | 1 |
| INV/NORM Switches | NORM |
| LEFT-HAND DRAWER | |
| VOLTAGE MONITOR Switch | OFF |
| MONITOR Switch | OFF |
| ALARM Switch | OFF |
| OSCILLOSCOPE VERTICAL Switch | 1 |
| OSCILLOSCOPE TRIGGER Switch | 1 |
| CYCLE LENGTH TENS | Ø |
| CYCLE LENGTH UNITS | Ø |

**Operating Procedures**

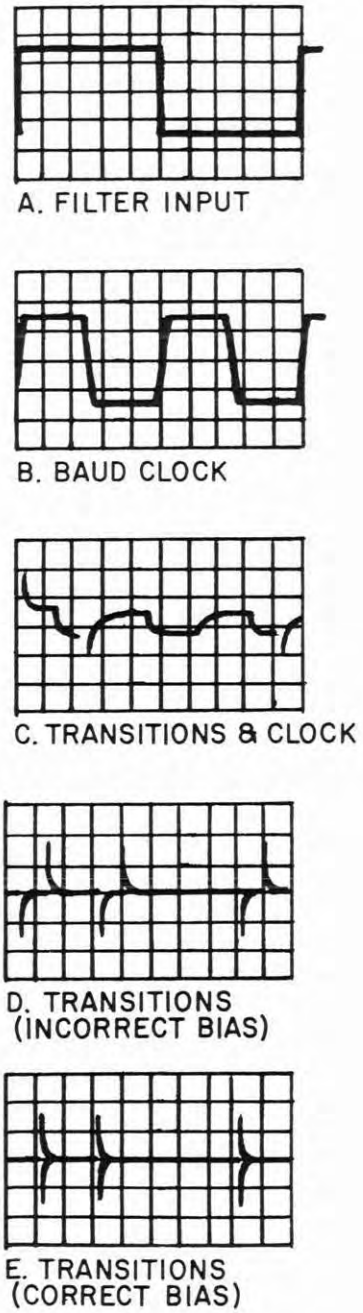
The following paragraphs describe the functional operation of the AN/TCA-4 equipments. In general, these procedures describe the sequence of events which occur when a particular control is operated, as well as its relationship with the overall operation of the equipment.

OSCILLOSCOPE AND SYNCHRONIZER PHASING.—Adjust the Oscilloscope and Synchronizer phasing as follows:

(1) Adjust the TRIGGER LEVEL control on the Oscilloscope counterclockwise until the trace begins to trigger on the face of the screen.

(2) Adjust the SWEEP TIME/CM switch and control so that two signal bauds are displayed across the face of the screen. (See waveform A of figure 4-31.)

(3) Adjust the MANUAL FREQUENCY X128, X16, and X2 switches on the Synchronizer unit so that two clock cycles are




264.55

**Figure 4-31.--AN/TCA-4 oscilloscope phasing waveforms.**

displayed across the face of the Oscilloscope screen. (See waveform B of figure 4-31.) If no trace appears, momentarily depress the RESET COUNTER switch on the Synchronizer unit.

(4) Set the MONITOR switch on the Synchronizer unit to position 5 and adjust the MANUAL FREQUENCY X2 switch to the position at which the clock trace on the Oscilloscope screen most nearly stops drifting. (See waveform C of figure 4-31.)

(5) Adjust the INCREASE/DECREASE switch on the Synchronizer unit to stop the clock trace from drifting. If the trace drifts toward the left, operate the switch to DECREASE; if the trace drifts toward the right, operate the switch to INCREASE.

(6) Set the CORRECTION switch on the Synchronizer unit to position 1. When the INTERPOLATION FREQUENCY METER indication stops drifting (5 to 15 minutes), set the CORRECTION switch to position 3.

(7) Set the MONITOR switch on the Synchronizer unit to position 4 and adjust the BIAS control so that the positive and negative spikes displayed on the Oscilloscope screen appear at the same horizontal positions. (See waveforms D and E of figure 4-31.)

(8) Set the MONITOR switch on the Synchronizer unit to position 6 to see that a signal is present.

CYCLE LENGTH CONTROL.–The equipment may handle up to 56 input data bits of information at one time. To select the number of input bits which will actually be processed during one cycle, the CYCLE LENGTH switches must be placed in the appropriate positions. Assume that the equipment is to process a train of 28 input bits per cycle. The CYCLE LENGTH switches must, then, be set for an input cycle length of 28. To accomplish this, the TENS switch is set to position 2, and the UNITS switch set to position 8. If the desired cycle length were 35, the TENS switch would have to be set to position 3, and the UNITS switch to position 5.

CHANNEL INVERTER CONTROL SELECTION.–For some modes of equipment operation, principally when processing a signal having a sync pattern, it is desirable that all channels operate with inverted input data signals.

In operations using sub-channeling, control of the channel inverters is accomplished by means of the INV/NORM Switches (for each cycle of each channel) located on the front panel of the RIGHT drawer. When it is desired that a specific sub-channel operate with inverted input data, the INV/NORM switch for that cycle (sub-channel) is set to INV. Suppose, for example, that all of the four PRINTER SELECT switches for main channel 1 were in position 1 (this, in effect, eliminates any sub-channelization for this main channel). Now, if it is desired that the main channel operate with inverted input data, all four of the INV/NORM switches for the channel 1 cycles must be placed in the INV position so that input data inversion occurs for all successive channel 1 scan times. Otherwise, when the equipment was actually processing channel 1 data during a cycle time that was not selected for inversion, the input data would not be correctly inverted, and the channel output data would consist of partly erroneous data.

SUB-CHANNEL CYCLE AND PRINTER SELECTION.–When processing signals containing sub-channeling, the PRINTER SELECT switches on the front panel of the RIGHT drawer permit selection of which printer shall receive the main channel output data for each cycle (sub-channel) time. It is possible to set these switches (for a particular main channel) so that only one printer receives the channel output data at all times, or so that each of the four printers receives the channel data for successive cycles of operation. If all of the four cycle switches for a particular channel are in position 1, then the output data for that channel will always be fed to the same printer (for that channel) during successive cycles. If each PRINTER SELECT switch is placed in the position corresponding to its CYCLE, (that is, the cycle 1 switch is in position 1, the cycle 2 switch is in position 2, etc.) then four separate outputs will provide distribution of the channel 1 data to four separate output jacks. Actually, each of the four printers receives output data only once for each four successive cycles.

Setting PRINTER SELECT switches permits distribution of a main channel output data to as many as four printers, or to two, three, or one. Suppose, for example, that the CYCLE 1 and CYCLE 2 switches were placed in position 1 and that CYCLE 3 and CYCLE 4 switches were placed in position 2; then the printer connected to the cycle 1 output connector would receive the channel output data during the cycle 1 and 2 scan times and the printer connected to the cycle 2 output connector would receive the channel output data during the cycle 3 and 4 scan times. The exact positioning of these cycle PRINTER SELECT Switches will depend upon the multiplexing plan used for the input data and the demultiplexing plan desired.

DATA HOLD AND CYCLE SAMPLE OPERATION.—For some conditions of equipment operation, it is desirable to hold the data display indications in the lamps of the Data Display Panel. This is done by placing the DATA MODE switch, on the front panel of the RIGHT Drawer, in either the HOLD or SAMPLE position. The HOLD position may be used in any type of operation. The SAMPLE position will normally be used only with sub-channeled data.

When the DATA MODE switch is set to HOLD, the lamps of the Data Display Panel will show steady indications after the next occurring end cycle pulse. They will display the data for that input multiplex cycle until the switch is again returned to its NORM position. Placing the switch in the SAMPLE position causes the lamps to display the data status of one of the four possible sub-channels (cycle) for four successive cycles of operation. The lamps will then change their condition to suit the next input data set for that sub-channel. For example, suppose the data for cycle 2 of the four main channels is to be displayed. The DATA MODE switch is set to SAMPLE and the CYCLE SAMPLE switch is set to position 2. The lamps will then display the data input present during cycle 2 and will change for each successive occurrence of cycle 2.

SUB-CHANNEL PHASING OPERATION.—When using sub-channels, it is necessary that phasing of the individual sub-channel for each main channel (1 thru 4) be performed, as well as phasing of the entire equipment. This sub-channel phasing is accomplished by use of the PHASE switc' or each channel on the front panel of the RI..T Drawer. Each time the PHASE switch is depressed, the sub-channels are displaced one cycle time with respect to the main channel input. Observe the output data being fed to each printer from a particular main channel and operate the PHASE switch for that channel until the data being printed out is correct for each of the printers attached.

MONITOR CHANNEL SELECTION.—Provision is made to monitor the output of any of the 10 channels by means of the MONITOR switch. For monitoring by an auxillary teleprinter, the printer is connected to the MONITOR connector on the Blower/Filter Panel and the MONITOR switch is set to the channel to be monitored. Oscilloscope monitoring of the output can be accomplished with the same switch. In this case, the OSCILLOSCOPE VERTICAL switch is set to position 6 (channel monitor output) and the final output signal of the selected channel will be observed.

ERROR AND ALARM CONTROL.—W n automatic error alarm operation is being u..d with the equipment, selection must be made of the number of sequential errors which must occur before the alarm will sound. This is done by opening the LEFT drawer and setting the SEQUENTIAL ERROR THRESHOLD switch to the desired position. For example, with this switch set to position 6, six sequential errors must occur before the alarm will sound. After the alarm threshold has been set, place the ALARM switch on the front panel of the LEFT drawer in the ON position; then, when the alarm sounds, it may be reset by setting the switch momentarily to its RESET position. With the ALARM switch in the OFF position, the sequential error alarm may be detected by the lighting of the ERROR SEQ lamp on the front panel of the left drawer.

OSCILLOSCOPE AND CHANNEL MONITOR SWITCHES.—For monitoring and checking the presence and waveforms of various signals within and external to the equipment,

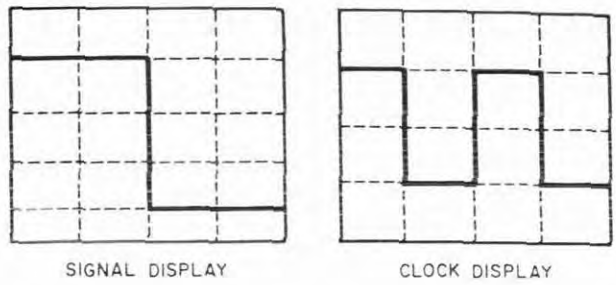
the OSCILLOSCOPE VERTICAL and TRIGGER switches and the MONITOR switch are provided on the front panel of the LEFT drawer. The MONITOR switch selects the individual inverted channel pulse signal when the OSCILLOSCOPE VERTICAL and TRIGGER switches are set to position 7. By rotating the MONITOR switch through all its positions, while the OSCILLOSCOPE VERTICAL and TRIGGER switches are set to position 7, each inverted channel pulse signal may be checked on the oscilloscope to see that it is occurring correctly in time and is of the correct waveform. By placing the OSCILLOSCOPE VERTICAL and TRIGGER switches in position 6, each output selected by the MONITOR switch may be observed on the OSCILLOSCOPE. The other positions of OSCILLOSCOPE VERTICAL and TRIGGER switches permit connection of other signals into the Oscilloscope for viewing.

OSCILLOSCOPE OPERATION.–The Oscilloscope operating procedures are given below: (These procedures are general in nature and provide the operator with an idea of how the Oscilloscope controls may be used to obtain a proper display and how the signal characteristics may be determined.)

a. Check to see that the Oscilloscope controls are set to the proper preliminary positions.

b. Select the signal to be displayed on the Oscilloscope by means of the OSCILLOSCOPE VERTICAL switch on the LEFT drawer (for normal operations both switches are set at position 1).

c. Adjust SWEEP TIME/CM switch to a suitable sweep rate so that a practical time base is obtained for the signal to be observed. Generally, the rate is selected to provide one or more complete waveforms across the face of the Oscilloscope screen when the Synchronizer MONITOR switch is set to position 2. After centering the presentation, the MONITOR switch may be changed to position 1 for setting up the clock signal. The clock signal is adjusted by use of the MANUAL FREQUENCY X128, X16, and X2 switches, in that order. The clock pulses should occur at twice the rate of the data signal. (see figure 4-32.)




264.56

Figure 4-32.–Data signal/clock pulses.

d. Observe the waveform on the Oscilloscope screen for the required signal characteristics. Adjust the VERTICAL SENSITIVITY control and SWEEP TIME/CM switch, as required, and reposition the image with the VERTICAL and HORIZONTAL POSITION controls. NOTE: WITH THE VERTICAL SENSITIVITY VARIABLE CONTROL AND THE SWEEP/CM CONTROLS SET TO THEIR CALIBRATED POSITIONS, THE GRATICULE ON THE OSCILLOSCOPE SCREEN MAY BE USED FOR MEASURING THE AMPLITUDE AND DURATION CHARACTERISTICS OF THE OBSERVED SIGNAL.

PRINTERS SWITCH.–In normal usage, the equipment feeds its output channel data to external teleprinting equipment connected to the CHANNEL connectors on the Blower/Filter panel. Control of the printers, as far as receipt of output data from the equipment is concerned, is by means of the PRINTERS switch on the front panel of the RIGHT drawer. When the switch is placed in the OFF position, the output data for all output channels is disabled simultaneously.

PHASING (FIVE-UNIT CODE SIGNALS).–While observing the top row of indicator lamps on the Data Display panel, set the DATA MODE switch to NORM to obtain the normal polarity of the signal as displayed on the indicator lamps.

Determine the position of signal element No. 1 as displayed on the top row of indicator lamps. Operate the PHASING

ADVANCE/RETARD switch on the LEFT drawer a sufficient number of times to cause element No. 1 of the signal to appear in lamp 1 of the upper row of the Data Display panel. Operating the switch to the ADVANCE position will cause the displayed signal to move to the right, while operation of the RETARD position will cause the displayed signal to move to the left. Set the PRINTERS switch on the RIGHT drawer to the ON position for print-out.

PHASING (SEVEN-UNIT CODE SIGNALS).—While observing ERROR lamps on the front panel of the RIGHT drawer, operate the PHASING ADVANCE/RETARD switch on the LEFT drawer a sufficient number of times to cause all error lamps to extinguish. Also observe sync or idle patterns on the Data Display panel.

When sub-channel operation is employed on a particular channel, every fourth cycle of that channel will normally be inverted. To compensate for this, set INV/NORM CYCLE 1 switch for the affected channel to INV and operate the PHASE switch for that channel until the ERROR lamp is extinguished.

In sub-channel operation, one or more of the four subcycles may be used to give sub-channel operating speeds of normally 15, 30, and 45 words per minute. To compensate for this, the equipment provides four printer output lines for each of the first four main channels, together with switches to select which of the four subcycles is to be routed out on any given line. To determine what conbination of sub-channeling is being employed, set the PRINTERS switch to ON. During traffic in the subdividing channel, observe the printer for that channel as follows:

(1) If valid traffic is being printed at a speed slower than 60 words per minute, switch the PRINTER SELECT CYCLE 1, 2, 3, and 4 switches for that channel to position 2 until, by the process of elimination, it is known which of the subcycles is being employed.

(2) Garbled traffic indicates that more than one sub-channel is active. In this case, switch PRINTER SELECT CYCLE 1, 2, 3, and 4 switches to position 2 until, by the process of elimination, it is known which of the subcycles is being used for each stream of traffic.

(3) Adjust PRINTER SELECT CYCLE 1, 2, 3, and 4 switches so that each stream of traffic is routed out on a different line. For example, if it is found that a 30 word-per-minute subchannel is employing cycles 1 and 3, the CYCLE 1 and 3 switches would be set to position 1. Cycles 2 and 4 switches would be set to positions other than 1. If four, 15 wpm sub-channels were employed, each PRINTER SELECT CYCLE switch would be set to positions 1, 2, 3, and 4.

APPLIQUE SYNCHRONIZER OPERATION.—The operation of the Applique Synchronizer is identical to the operation of the AN/TCA-4 Synchronizer, except that the POWER switch on the front panel is used for applying power to the Applique synchronizer.

APPLIQUE CONVERTER OPERATION.—Set the CYCLE LENGTH switches on the front panel of the Applique Converter to the cycle length to be employed. Phase the input signal with the AN/TCA-4 equipment. Observe the ERROR indicator lamps on the Applique Converter and operate the PHASING ADVANCE/RETARD switch until all the ERROR lamps are extinguished.

EQUIPMENT SHUTDOWN.—To shut down the equipment, it is necessary to only momentarily depress the POWER OFF switch on the LEFT drawer and place the POWER switch on the Applique Synchronizer to the OFF position.