TECHNICAL MANUAL

OPERATOR'S, ORGANIZATIONAL,

DIRECT SUPPORT

AND GENERAL SUPPORT

MAINTENANCE MANUAL

INCLUDING REPAIR PARTS AND

SPECIAL TOOLS LISTS

(INCLUDING DEPOT MAINTENANCE

REPAIR PARTS AND SPECIAL TOOLS)

FOR

FREQUENCY METERS AN/USM-159,

AN/USM-159A, AND AN/USM-159B

(NSN 6625-00-892-5360)

This copy is a reprint which includes current pages from Change 1.

HEADQUARTERS, DEPARTMENT OF T HE ARMY
OCTOBER 1975

WARNING

DANGEROUS VOLTAGES

exist in this equipment. Be extremely careful when working on the power supply circuit or the ac line connections during line power operation. Serious injury or death may result from contact with these points.

DON'T TAKE CHANCES!

TECHNICAL MANUAL
No. 11-6625-486-14&P

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 31 October 1975

OPERATOR'S ORGANIZATIONAL, DIRECT SUPPORT, AND GENERAL SUPPORT MAINTENANCE MANUAL INCLUDING REPAIR PARTS AND SPECIAL TOOLS LISTS (INCLUDING DEPOT MAINTENANCE REPAIR PARTS AND SPECIAL TOOLS) FOR FREQUENCY METERS AN/USM-159, AN/USM-159A, AND AN/USM-159B

(NSN 6625-00-892-5360)

Current as of June 1975

*This manual supersedes TM 11-6625-486-10, 26 April 1962, TM 11-6625-486-45, 26 June 1963, TM 11-6625-486-20P, 29 June 1973; and TM 11-6625-486-40P, 29 June 1973, including all changes.

LIST OF ILLUSTRATIONS

LIST OF TABLES

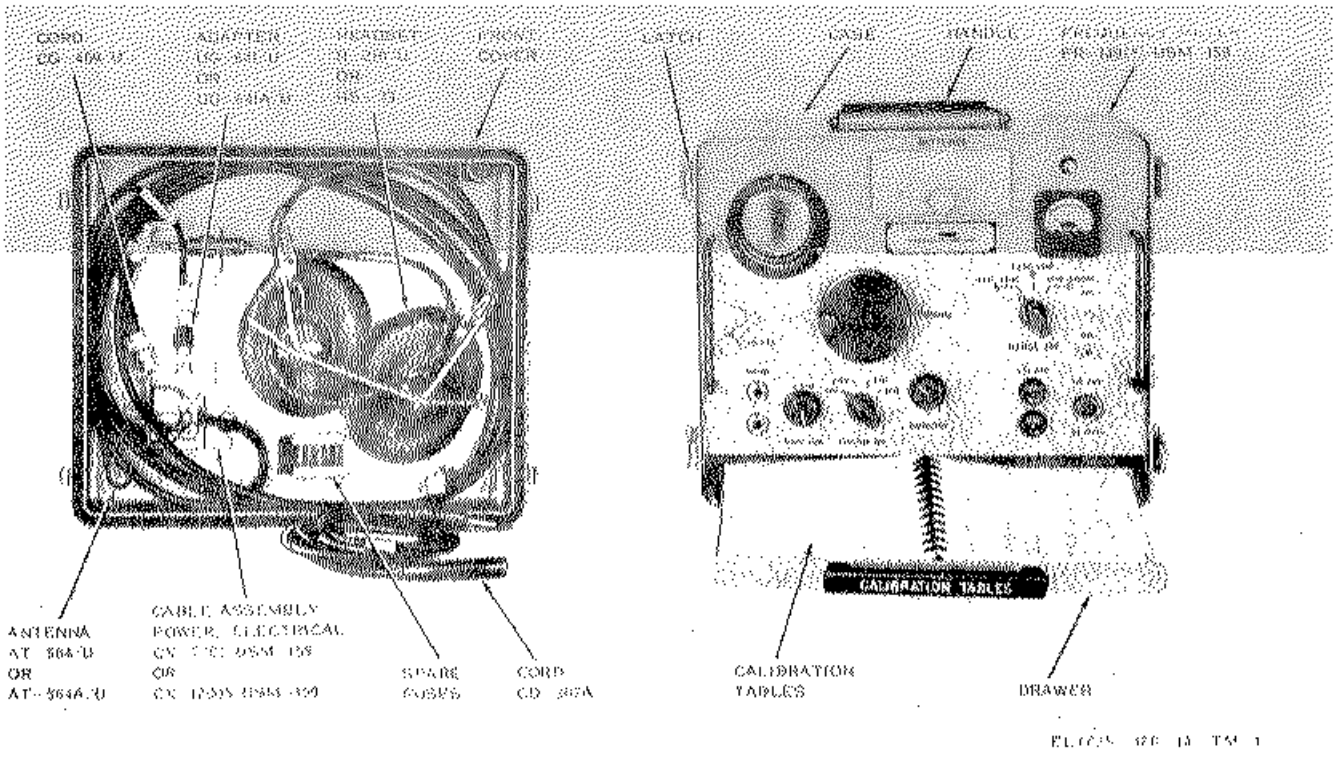

Figure 1-1. Frequency Meters AN/USM-159, AN/USM-159A, and AN/USM-159B

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1-1. Scope

This manual describes Frequency Meters AN/USM-159, AN/USM-159A, and AN/USM159B, and covers their installation and operation, and operator, organizational, and general support maintenance. There is no direct support maintenance authorized for this equipment. Official nomenclature followed by (*) refers to all models of the equipment; therefore, the above equipment will hereinafter be referred to as Frequency Meter AN/USM-159(*), and Frequency Meters FR-149/USM-)59, FR-149A/USM-159, and FR149B/USM-159 will be referred to as Frequency Meter FR-149(*)/USM-159, unless otherwise specified.

1-2. Forms and Records

a. Reports of Maintenance and Unsatisfactory Equipment. Maintenance forms, records, and reports which are to be used by maintenance personnel at all maintenance levels are listed in and prescribed by TM 38-750.

b. Report of Packaging and Handling Deficiencies. Fill out and forward DD Form 6 (Packaging Improvement Report) as prescribed in AR 700-58/NAVSUPINST 4030.29/AFR 71-13/MCO P4030.29A, and DSAR 4145.8.

c. Discrepancy in Shipment Report (DISREP) (SF 361). Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 55-38/NAVSUPINST 4610.33A/AFR 75-18/MCO P4610.19B, and DSAR 4500.15.

1-3. Destruction to Prevent Enemy Use

For destruction procedures for electronics equipment, refer to TM 750-244-2.

1-4. Administrative Storage

For procedures, forms and records, and inspections required during administrative storage of this equipment, refer to TM 740-90-1.

1-5. Calibration

For calibration procedures, refer to TB 11-6625-486-35/1.

1-6. Reporting of Equipment Publication Improvements

The reporting of errors, omissions, and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to Publications and Blank Forms) and forwarded direct to Commander, US Army Electronics Command, ATTN: AMSEL-MA-Q, Fort Monmouth, NJ 07703

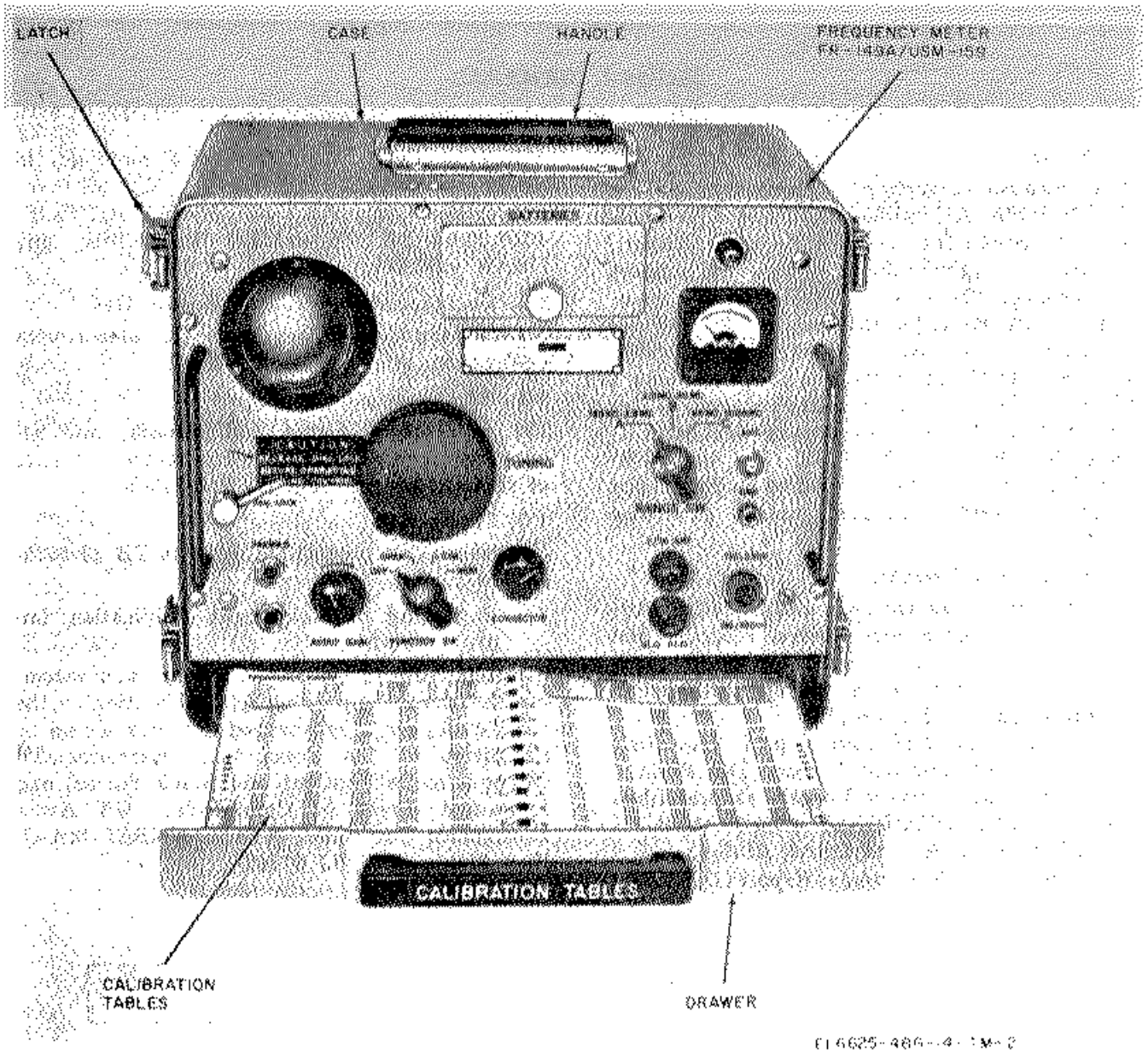

Figure 1-2. Frequency Meters FR-149/USM-159, FR-149A/USM-159, and FR-149B/USM-159.

Section II. DESCRIPTION AND DATA

1-7. Purpose and Use

Frequency Meters AN/USM-159, AN/USM159A, and AN/USM-159B (fig. 1-1) are precision instruments used to measure radiofrequencies (rf) in the range from 125 kilohertz (kHz) to 1,000 megahertz (MHz). They can also be used as signal generators to provide modulated or unmodulated signals for testing and calibrating radio equipment. A system of checkpoints is provided to check the calibration of the instrument throughout its operating range.

1-8. Description

A description of the components of Frequency Meter AN/USM-159(*) is given below.

a. Frequency Meter FR-149(*)/USM-159. The frequency meter is transistorized throughout and can be operated from six Batteries BA-30 that supply 9 volts direct current (dc), or from a powerline source of 115 to 230 volts alternating current (ac), 50 to 450 Hertz (Hz). Automatic switchover from batteries to ac power is accomplished internally. All operating controls and connectors are on the front panel. The meter dial is an illuminated filmstrip with three ranges of frequencies calibrated in fundamentals. Crystal checkpoints, with arrows indicating the direction of the nearest checkpoint, are also in the filmstrip. Component parts of the frequency meter are housed within a rectangular metal case. When not in use, or during transport, a front cover protects the panel controls and provides an immersionproof seal. The front cover has space for storing the headset, antenna, rf cable, adapter power cable, and spare fuses. The calibration tables, which contain condensed operating instructions, and a list of fundamental frequencies and selected harmonics produced by the frequency meter, are on a sliding panel under the frequency meter controls.

b. Antenna AT-564(*)/U. The insulated, hooked end of the antenna is placed near the equipment being tested.

c. Cord CG-409E/U. The rf cable connects the antenna to the frequency meter ANT. jack.

d. Adapter UG-641(*)/U. The adapter adapts the frequency meter ANT. jack to a pigtail clamp connector for use with a suitable cable to connect the frequency meter to remote equipment.

e. Cable Assembly, Power, Electrical CX7782/USM-159 or CX-12005/USM-159. The power cable connects the power receptacle on the front panel to the source of ac power.

f. Headset H-216/U or HS-33. The headset is a low-impedance type for connection to PHONE jacks.

g. Cord CD-307A. The headset extension cable is used to extend the Headset HS-216/U cord an additional 5 feet.

h. Additional Equipment Required. Six batteries BA-30, not supplied with the equipment, are required for dc operation.

1-9. Differences Between Models

Frequency Meters AN/USM-159A and AN/USM-159B are similar to Frequency Meter AN/SUM-159. Information in this manual applies to all models unless otherwise specified. For exterior differences, refer to figures 3-1 and 3-2.

1-10. Tabulated Data

Frequency range:
- Range A ..... 125 kHz to 2.5 MHz (125 to 250 kHz on fundamentals).
- Range B ..... 2.5 to 65 MHz (2.5 to 5 MHz on fundamentals).
- Range C ..... 65 to 1,000 MHz (65 to 130 MHz on fundamentals).

Frequency readout ..... Direct readout in fundamentals on calibrated filmstrip, magnified and lighted.

Input and output signals:
- Input sensitivity ..... With an rf input signal of 0.1 volt, an af output of 0.05 mw is obtained.
- Output level ..... 100 uv minimum across an external 50-ohm resistive load. 40 uv at harmonics.
- Accuracy ..... 0.01% when temperature is between -4°F to +125°F (-20°C to +52°C).
- Internal modulation ..... 900 Hz ± 300.

Number of transistors ..... 12.

Power requirements:
- Battery operation ..... 9 volts dc, 50 ma (Battery BA-30(6)).
- Ac line operation ..... 115 to 230 volts ac, 50 to 450 Hz.

Weight ..... 28 pounds.

1-11. Items Comprising an Operable Equipment

The items comprising an operable equipment are listed in table 1-1.

Table 1-1. Items Comprising an Operable Equipment

NSN	Qty	Item	Dimensions (in.)			Weight
			Height	Width	Depth	(lb)
6625-00-892-5361	1	Frequency Meter FR-149(*)/USM-159 Consisting of:	11-1/4	12-15/16	11-1/2	26
6625-00-889-1279	1	Antenna AT-564(*)/U			12	
5995-00-542-6221	1	Cord CG-409E/U			12	
5935-00-930-7461	1	Adapter UG-641(*)/U				
5965-00-892-3353	1	Headset H-216/U or HS-33				
5995-00-889-0553	1	Cable Assembly, Power, Electrical CX-7782/USM-159 or CX-12005/USM-159			96	
5995-00-196-9564	1	Cord CD-307A			60	

CHAPTER 2

SERVICE UPON RECEIPT AND INSTALLATION

Section I. SERVICE UPON RECEIPT OF MATERIEL

2-1. Unpacking

a. Packaging Data. When packed for shipment, the components of Frequency Meter AN/USM-159(*) are placed in a carton and packed in a wooden box. A typical shipping box and its contents are shown in figure 2-1. The dimensions of the box are 14 by 14 by 15 inches.

b. Removing Contents.

(1) Cut and fold back the metal straps.

(2) Use a nailpuller to remove the nails from the top and one side of the box. Remove the top and one side. Do not pry them off; prying may damage the equipment.

(3) Open the waterproof barrier which covers the carton inside the box. Remove the carton.

(4) Open the carton and the moisture-vaporproof barrier within the carton. Remove the inner corrugated carton. Open the inner carton and remove the contents.

2-2. Checking Unpacked Equipment

a. Inspect the equipment for damage incurred during shipment. If the equipment has been damaged, report the damage on DD Form 6 (para 1-2).

b. Check the equipment against the component listing in the operator's manual and the packing slip to see if the shipment is complete. Report all discrepancies in accordance with the instructions of TM 38-750. The equipment should be placed in service even though a minor assembly or part that does not affect proper functioning is missing.

c. Check to see whether the equipment has been modified. (Equipment which has been modified will have the MWO number on the front panel, near the nomenclature plate.) Also check to see whether all currently applicable MWOs have been applied. (Current MWOs applicable to the equipment are listed in DA Pam 310-7.)

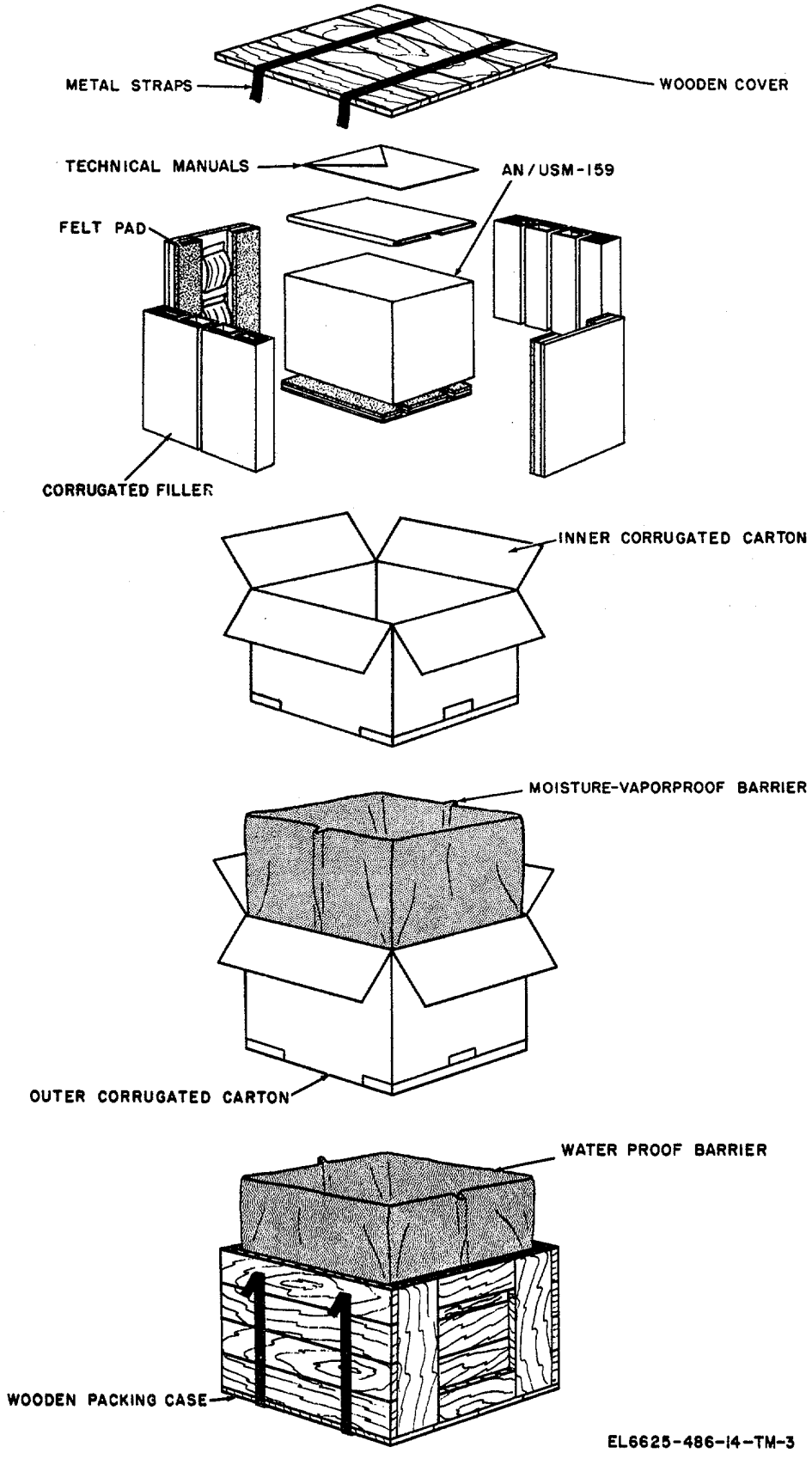

Figure 2-1. AN/USM-159 (*), packing diagram.

Section II. INSTALLATION

2-3. Installation of Equipment

The location of the frequency meter is not limited to any particular area or climatic condition. Provide adequate shelter to prevent water, dirt, and sand from entering the unit when the front cover is off. Maximum operating accuracy will be obtained if the frequency meter is operated in surrounding temperature within the range of - 4 °F. to +125 °F(--20 °C to +52 °).

2-4. Installation of Batteries

(fig. 2-2)

Six Batteries BA-30 are to be installed in a metal drawer at the top of the frequency meter front panel (marked BATTERIES). A rectangular metal plate covers the drawer opening. Install the batteries as follows:

a. Loosen the knob that secures the metal plate and pull the drawer out of the front panel.

b. Observe the battery polarity diagram printed on the top of the drawer. Lift the top cover of the drawer and insert the six batteries in the same polarity sequence as indicated in the battery diagram.

c. Replace the drawer and tighten the knob.

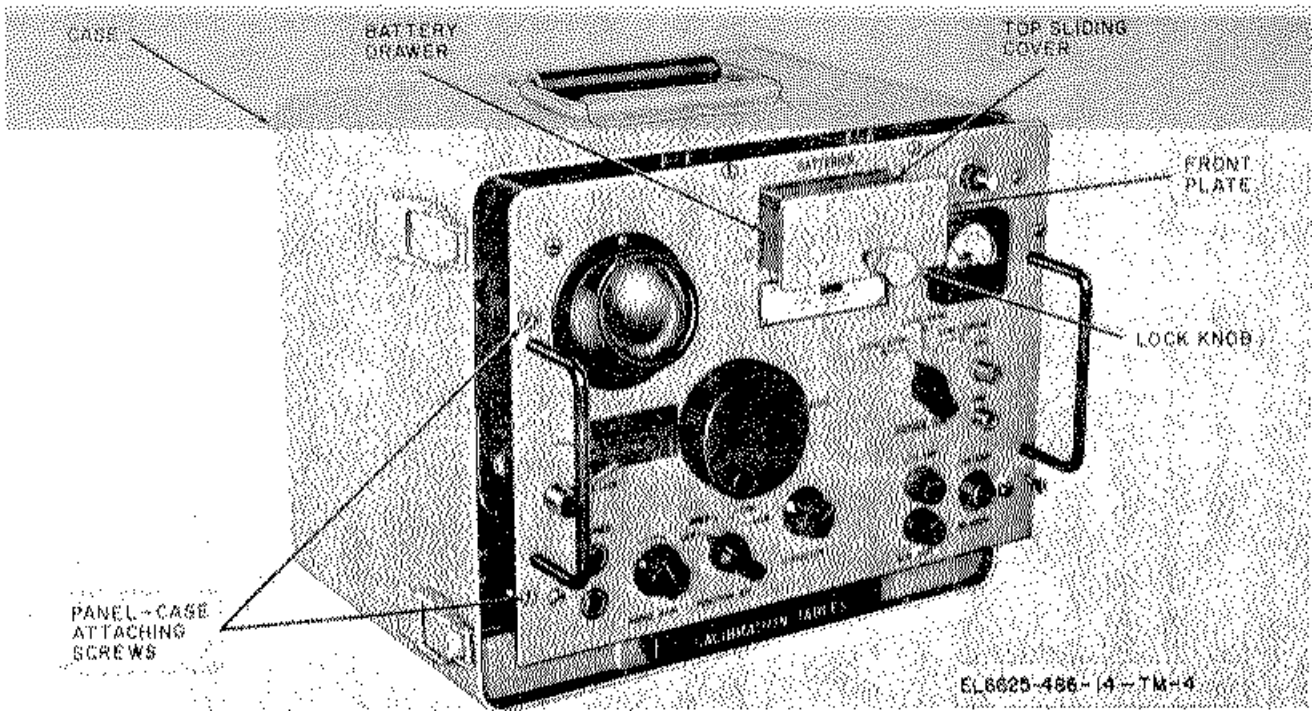

Figure 2-2. FR-149(*)/USM-159, battery compartment, with case partly removed.

CHAPTER 3

OPERATING INSTRUCTIONS

Section I. CONTROLS AND INDICATORS

3-1. Operator's Controls

A listing of the controls used by the operator is found in table 3-1. The controls and indicators are all located on the front panel, and are illustrated in figures 3-1 and 3-2.

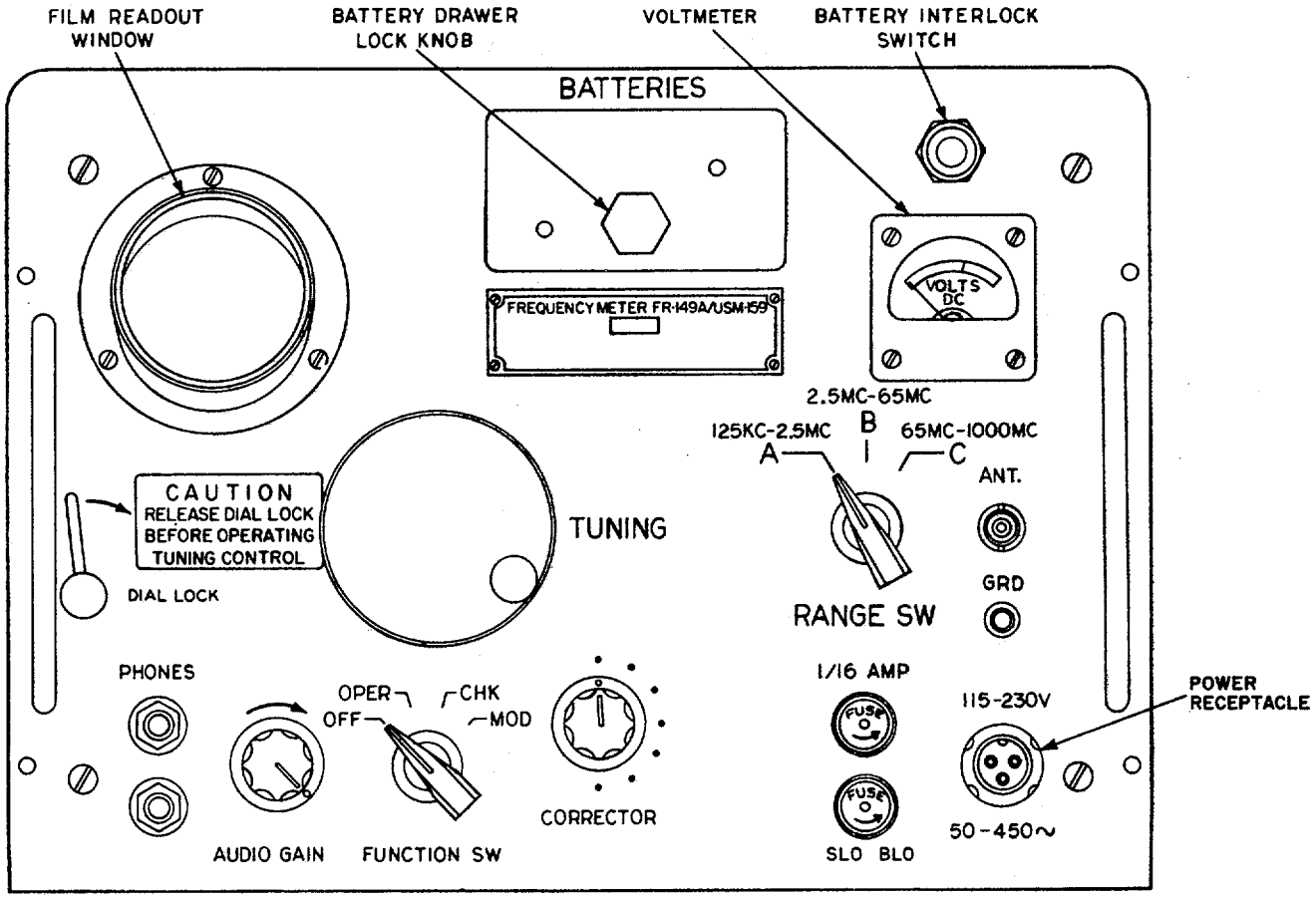

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Figure 3-1. FR-149/USM-159, controls and indicators.

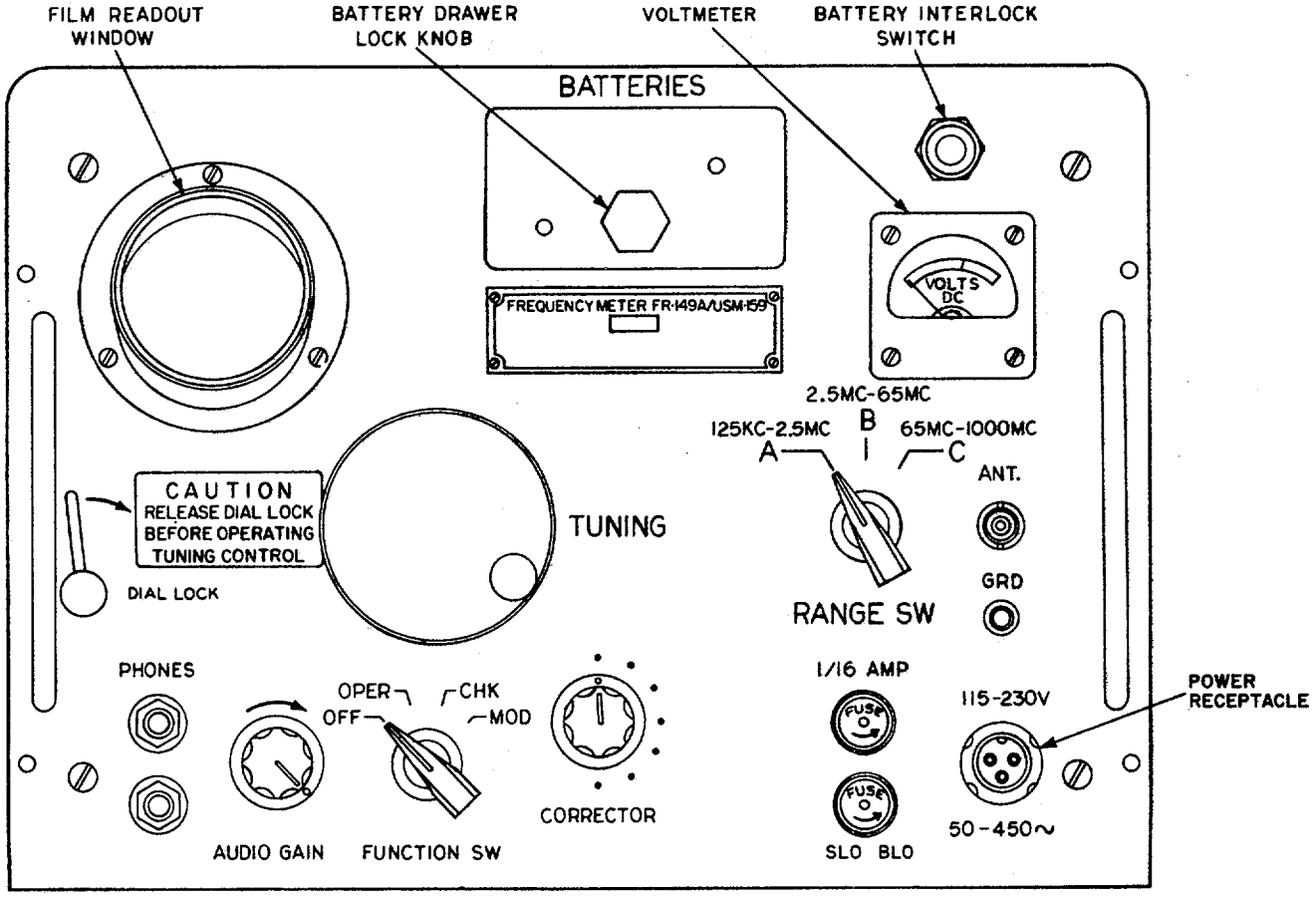

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Figure 3-2. FR-149A/USM-159 and FR-149B/USM-159, controls and indicators.

Table 3-1. Operator Controls and Indicators

Control, indicator, or connector	Function
FUNCTION SW	Selects function that frequency meter is performing. *Switch position* — *Action* OFF — Turns frequency meter off. OPER — Permits use of vfo to determine frequency of unknown signals received by frequency meter, or to radiate a signal for test purposes. CHK — Turns on internal crystal calibrator. Permits checking vfo frequency against crystal calibrator and crystal checkpoints on filmstrip. MOD — Modulates rf signal with 900 Hz.
AUDIO GAIN control	Adjusts audio output to headset.
TUNING control	Permits tuning vfo to desired frequency within range selected by RANGE SW. Frequencies appear on lighted filmstrip.
DIAL LOCK	When turned clockwise, locks TUNING control.
Power receptacle	Used to connect power cable to frequency meter.
CORRECTOR control	Adjusts frequency of vfo to coincide with crystal checkpoints printed on filmstrip. Internal crystal calibrator is turned on when FUNCTION SW is set to CHK.
RANGE SW	Selects one of three frequency ranges and operates a mask that covers all frequency ranges printed on filmstrip, except range in use. *Switch position* — *Action* 125KC-2.5MC A — When used with TUNING control, allows tuning of frequency meter from 125 kHz to 2.5 MHz. 2.5MC-65MC B — When used with TUNING control, allows tuning of frequency meter from 2.5 to 65 MHz. 65MC-1000MC C — When used with TUNING control, allows tuning of frequency meter from 65 to 1,000 MHz.

Table 3-1. Operator Controls and Indicators

Control, indicator, or connector	Function
Voltmeter	Monitors dc output voltage of battery or ac-operated power supply. Meter has red and green scales. Indication in green area means that operating voltage is sufficient; if meter indicates in red area, do not operate equipment.
ANT. connector	Antenna is plugged into this connector.
PHONES jacks	Headset is plugged into either one of these jacks.
Battery interlock switch	Disconnects battery power from frequency meter when front cover is in place.
Film readout window	Portion of filmstrip in use is visible in this window.
GRD connector	Used for connecting frequency meter to an electrical ground.

Section II. OPERATION UNDER USUAL CONDITIONS

3-2. Preliminary Starting Procedure

Perform the following steps before operating the frequency meter:

a. If operating on ac power, plug the power cable into the front panel power receptacle and ac power source. If operating on batteries, do not plug the power cable into the ac power source.

b. Plug the headset into one of the PHONES jacks.

c. Turn the FUNCTION SW to CHK. No warmup time is necessary.

NOTE

To avoid signal radiation, do not connect the frequency meter antenna.

d. Note that the voltmeter indicates in the green area of the scale and filmstrip is lighted.

CAUTION

Unlock dial lock before turning TUNING control; otherwise, undue stress might cause loss of calibration.

e. Turn the RANGE SW to any range. Adjust the TUNING control until a crystal checkpoint (horizontal arrow on the filmstrip, fig. 3-3) coincides with the hairline indicator in the readout window. An audio tone will be heard in the headset as the checkpoint is approached.

NOTE

Vertical arrows point in the direction of the nearest crystal checkpoint.

f. Adjust the AUDIO GAIN control for a comfortable volume level as heard in the headset. Adjust the CORRECTOR control for a zero beat.

g. If the above results are not obtained, refer to table 4-4.

CAUTION

Do not couple the frequency meter antenna directly to the output of a transmitter is feeding a nonradiating load, place the hooked part of the frequency meter antenna near the transmitter oscillator coil or tank circuit. If the transmitter is feeding an antenna, place the frequency meter antenna in the radiated field.

h. Connect the frequency meter antenna to the ANT. connector and place near the signal to be measured. Turn the FUNCTION SW to OPER.

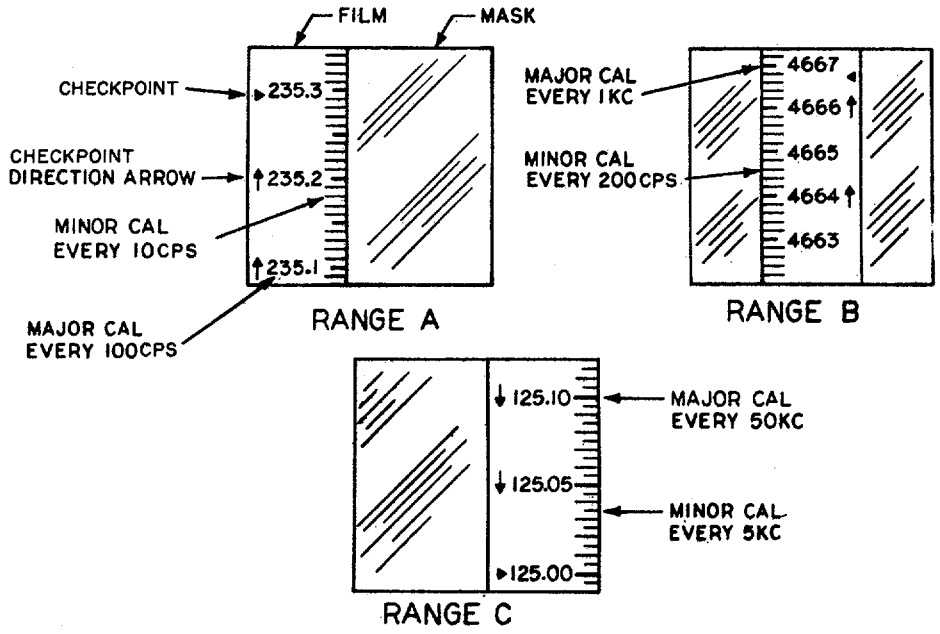

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Figure 3-3. Interpretation of filmstrip.

3-3. Operating Procedure

a. General. The frequency meter uses two variable frequency oscillators (vfo) to cover the range between 125 kHz and 1,000 MHz. In each range, the vfo covers, in fundamentals, only a portion of the frequency range. RANGE A covers 125 to 250 kHz in fundamentals. The other frequencies (250 to 2.5 kHz) are obtained by the use of harmonics of the vfo frequency. RANGE B (2.5 to 5.0 MHz in fundamentals) and RANGE C (65 to 130 MHz in fundamentals) operate in a similar manner. The filmstrip is calibrated in fundamentals only. By using the calibration tables (fig. 3-4), any frequency desired (within the range setting) can he obtained.

b. Setting Meter Dial to Desired Frequency. The frequencies printed on the filmstrip are calibrated in kilohertz and hertz for RANGE A and RANGE B, and in megahertz and kilohertz for RANGE C. All frequencies represent fundamentals. Sections of filmstrip showing major and minor calibration marks, crystal checkpoint direction arrows, and typical checkpoints are shown in figure 3-3. Note that RANGE A has major calibration marks every 100 Hz, and minor calibration marks every 10 Hz. RANGE B has major calibration marks every 1 kHz, and minor calibration marks every 200 Hz. RANGE C has major calibration marks every 50 kHz and minor calibration marks at 5 kHz intervals. Set the dial to the desired frequency as follows:

(1) Assume that a frequency setting of 235,240 Hz (235.24 kHz or 0.23524 MHz) is desired.

(2) Set the RANGE SW to RANGE A.

(3) Adjust the TUNING control until the major calibration mark representing 235.2 is under the hairline indicator.

(4) Start from major calibration mark 235.2, count four minor calibration marks upward, and set 235.24 under the hairline indicator.

FREQUENCY RANGE

181.0KC	TO	184.4KC	/	.1810MC	TO	.1844MC
362.0KC	TO	368.8KC	/	.3620MC	TO	.3688MC
724.0KC	TO	737.6KC	/	.7240MC	TO	.7376MC
1448.0KC	TO	1475.2KC	/	1.4480MC	TO	1.4752MC

RANGE A

FREQUENCY			
181.0	362.0	724.0	1448.0
181.1	362.2	724.4	1448.8
181.2	362.4	724.8	1449.6
181.3	362.6	725.2	1450.4
181.4	362.8	725.6	1451.2
181.5	363.0	726.0	1452.0
181.6	363.2	726.4	1452.8
181.7	363.4	726.8	1453.6
181.8	363.6	727.2	1454.4
181.9	363.8	727.6	1455.2
182.0	364.0	728.0	1456.0
182.1	364.2	728.4	1456.8
182.2	364.4	728.8	1457.6
182.3	364.6	729.2	1458.4
182.4	364.8	729.6	1459.2
182.5	365.0	730.0	1460.0
182.6	365.2	730.4	1460.8
182.7	365.4	730.8	1461.6
182.8	365.6	731.2	1462.4
182.9	365.8	731.6	1463.2
183.0	366.0	732.0	1464.0
183.1	366.2	732.4	1464.8
183.2	366.4	732.8	1465.6
183.3	366.6	733.2	1466.4
183.4	366.8	733.6	1467.2
183.5	367.0	734.0	1468.0
183.6	367.2	734.4	1468.8
183.7	367.4	734.8	1469.6
183.8	367.6	735.2	1470.4
183.9	367.8	735.6	1471.2
184.0	368.0	736.0	1472.0
184.1	368.2	736.4	1472.8
184.2	368.4	736.8	1473.6
184.3	368.6	737.2	1474.4
184.4	368.8	737.6	1475.2

25

EL6625-486-14-TM-8

Figure 3-4. FR-149(*)/USM-159, calibration tables.

c. Setting Frequency Meter to Desired Harmonic Frequency. The calibration tables are multiplication tables that give the harmonic multiples of the basic fundamental frequencies (125 to 250 kHz, 2.5 to 5.0 MHz, and 65 to 130 MHz) on the filmstrip. The top of each page in the calibration tables (fig. 3-4) gives the frequencies covered on that page. The left-hand column of these tables gives the fundamental frequencies covered by the filmstrip. The other columns give harmonic frequencies covered by the range in use. In figure 3-4, the harmonics given are the second, fourth, and eighth. The harmonics given will be different for each range. If these tables are lost, the harmonic frequencies of any given dial setting can be found by multiplying the fundamental

readout frequency by the desired harmonic number. Conversely, the correct dial setting for any given harmonic frequency can be found by dividing the harmonic frequency by any number that will give a fundamental frequency within the range of the frequency meter filmstrip. In general, use the lowest harmonic number that will yield the desired frequency.

3-4. Determining Local Transmitter Frequency When Approximate Frequency is Known

a. Set the RANGE SW to the appropriate frequency range. If the frequency is not in the fundamental frequencies (125 to 250 kHz, 2.5 to 5.0 MHz, or 65 to 130 MHz) covered by the RANGE in use, find the frequency in an harmonic column in the calibration tables and obtain the filmstrip setting from the FREQUENCY column (para 3-3 c). If not using the calibration tables, divide by a number to obtain a frequency in the fundamental range of the filmstrip.

b. Set the FUNCTION SW to CHK.

NOTE

When performing the check procedure, do not connect the frequency meter antenna.

c. Adjust the TUNING control to bring the checkpoint (nearest to the desired fundamental frequency) under the hairline indicator. Adjust the CORRECTOR control for a zero beat.

CAUTION

Do not couple the frequency meter antenna directly to the transmitter output. The correct separation between the transmitter and the frequency meter antenna will depend on the amount of power being radiated. Place the frequency meter antenna far from the transmitter, and then start moving the antenna closer for the desired result.

d. Set the FUNCTION SW to OPER and connect the frequency meter antenna to the ANT. connector and place the antenna near the transmitter.

e. Tune the frequency meter in the immediate area of the estimated frequency and listen for an audio beat note. If several beat notes are heard, tune the frequency meter to the strongest beat note; then, tune the frequency meter on both sides of this frequency for a zero beat.

f. If necessary, locate the frequency found in e above, in the FREQUENCY column of the calibration tables. At the intersection of this frequency and the harmonics column, read the frequency of the signal being measured. If the calibration tables are not used, multiply by the number used in a above.

3-5. Determining Local Transmitter Frequency When Approximate Frequency is Unknown

a. Use either an absorption-type wavemeter or radio receiver to determine the approximate frequency, and then follow the procedure given in paragraph 3-4. If the above equipment is not available, follow the procedures given in b through m below.

CAUTION

Do not couple the frequency meter antenna directly to the transmitter output. The correct separation between the transmitter and the frequency meter antenna' will depend on the amount of power being radiated. Place the frequency meter antenna as far away from the transmitter as possible, and then start moving the antenna closer for the desired result.

b. Set the FUNCTION SW to OPER and connect the frequency meter antenna to the ANT. connector. Place the antenna near the transmitter.

c. Turn the frequency meter TUNING control from the high end of the range toward the low end and listen for strong beat notes. Select the two adjacent beat notes that have the loudest sound and zero beat on each adjacent beat note. Record the filmstrip frequencies for these two points.

d. When several beat notes are heard, it indicates that consecutive harmonics of the vfo are beating against the unknown frequency; for example, if the unknown frequency is 120 MHz, the fifth harmonic of 24 MHz, the fourth harmonic of 30 MHz, and the third harmonic of 40 MHz would be heard.

e. Take the two zero beat points recorded in c above and substitute these two frequencies in the following equation:

$$F_x = \frac{F_1 \times F_2}{F_2 - F_1}$$

F_x = Unknown frequency

F_2 = Highest zero beat point

F_1 = Lowest zero beat point

NOTE

Always use the exact frequencies indicated on the filmstrip.

If F_1 and F_2 are expressed in kilohertz, F_x will be in kilohertz.

If F1 and F2 are in megahertz, Fx will be in megahertz.

f. To verify the frequency found above,, find two other zero beat points and substitute these values in the equation above.

NOTE

As an example of using the formula, consider the case where beat notes are obtained at 30, 40, and 60 MHz. The two loudest beat notes are obtained at 40 and 60 MHz. Substituting these two frequencies in the formula we obtain:

$$F_x = \frac{60 \times 40}{60 - 40} = \frac{2400}{20} = 120 \text{ MHz}$$

g. Set the RANGE SW to the appropriate range for the frequency found above.

h. If the frequency found above is not in the fundamental frequencies covered by the RANGE in use, find the estimated transmitter frequency in an harmonic column in the calibration tables and obtain the fundamental frequency to be set on the filmstrip (para 3-3*c*). If not using the tables, divide the estimated transmitter frequency by the appropriate number to obtain a frequency in the fundamental range of the dial.

i. Set the FUNCTION SW to CHK.

NOTE

When performing the check procedure, do not connect the frequency meter antenna.

j. Adjust the TUNING control to bring the checkpoint (nearest to the desired fundamental frequency) under the hairline indicator. Adjust the CORRECTOR control for a zero beat.

k. Set the FUNCTION SW to OPER and connect the frequency meter antenna to the ANT. connector and place the antenna near the transmitter.

l. Tune the frequency meter in the immediate area of the desired fundamental frequency and listen for an audio beat note. If several notes are heard, tune the frequency meter to the strongest beat note; then, tune the frequency meter on both sides of this frequency for a zero beat.

m. If the transmitter frequency computed in e above was a fundamental frequency of the range being used, then the reading obtained in *l*, above gives the exact transmitter frequency directly. If the transmitter frequency computed in e above was a harmonic in the range being used, the fundamental frequency obtained in *l* above is located in the calibration tables and the exact transmitter frequency is obtained from the appropriate harmonic column. If the transmitter frequency computed in *e* above was a harmonic in the range being used and the calibration tables are not being used, the fundamental frequency obtained in l above is multiplied by the appropriate harmonic number (h above) to determine the exact transmitter frequency.

3-6. Determining Frequency of Distant Transmitter

This measurement requires the use of a radio receiver in conjunction with the frequency meter. If the transmission is continuous wave (cw), use either a receiver with a beat-frequency oscillator (bfo) (*a* below) or a regenerative receiver (*b* below). If the transmission is other than cw, tune in the transmitter signal. Determine the approximate frequency from the receiver dial.

a. If the transmission is cw and a receiver with a bfo is used, proceed as follows:

(1) Turn on the bfo.

(2) Tune the receiver to a zero beat.

(3) Note the approximate frequency.

(4) Turn off the bfo before proceeding.

b. If the transmission is cw and a regenerative receiver is used, proceed as follows:

(1) Turn up the regeneration control until the receiver oscillates.

(2) Tune the receiver for zero beat.

(3) Note the approximate frequency.

(4) Turn down the regeneration control before proceeding.

c. Set the RANGE SW according to the frequency found above. If the frequency is not in the fundamental frequencies covered by the RANGE in use, find the fundamental frequency in the calibration tables (para 3-3*c*). If not using the calibration tables, divide by the appropriate number to obtain a frequency in the fundamental range of the dial.

d. Set the FUNCTION SW to CHK.

NOTE

When performing the check procedure, do not connect the frequency meter antenna.

e. Adjust the TUNING control to bring the checkpoint (nearest the desired fundamental frequency) under the hairline indicator. Adjust the CORRECTOR control for zero beat.

f. Set the FUNCTION SW to OPER. Connect the frequency meter antenna to the ANT. connector and place the antenna close to the receiver antenna lead.

g. While listening to the receiver through the receiver headset or loudspeaker, tune the frequency meter in the region of the receiver frequency setting until a beat note or whistle is heard; then, tune the frequency meter for a zero, beat or as near to a zero beat as possible.

h. If the transmitter frequency obtained in g above was a fundamental frequency of the range being used, then the reading obtained in *g* above

gives the exact transmitter frequency directly. If the transmitter frequency obtained in g above was a harmonic in the range being used, the fundamental frequency obtained in g above is located in the calibration tables and the exact transmitter frequency is obtained from the appropriate harmonic column (para 3-3*c*). If the transmitter frequency obtained in g above was a harmonic in the range being used and the calibration tables are not being used, the fundamental frequency obtained in g above is multiplied by the appropriate harmonic number (*c* above) to determine the exact transmitter frequency.

3-7. Tuning Transmitter to Desired Frequency

a. Set the RANGE SW to the proper range. If the frequency is some harmonic multiple of the frequencies covered by the frequency meter dial, consult the calibration tables to determine the frequency meter dial setting (para 3-3*c*). If the calibration tables are not used, divide by the appropriate number to obtain a frequency covered by the frequency meter dial.

NOTE

When performing check procedure, do not connect the frequency meter antenna.

b. Set the FUNCTION SW to CHK. Use the CORRECTOR control and calibrate frequency meter at the checkpoint nearest the fundamental frequency obtained in a above; the, set the FUNCTION SW to OPER and the dial to the desired fundamental frequency.

CAUTION

Do not couple the frequency meter antenna directly to the transmitter output. The correct separation between the transmitter and the frequency meter antenna will depend on the amount of power being radiated. Place the frequency meter antenna far from the transmitter, and then start moving the antenna closer for the desired result.

c. Connect the frequency meter antenna to the ANT. connector. Place the frequency meter antenna near the transmitter oscillator circuit to be tuned.

d. Tune the transmitter for a zero beat in the frequency meter headset. If it is impossible to obtain a true zero beat, tune the transmitter to the middle of the audio beat note. No appreciable error will result.

3-8. Tuning CW Receiver to Desired Frequency

a. Set the RANGE SW to the proper range. If the desired frequency is some harmonic multiple of the fundamental frequencies covered by the filmstrip, consult the calibration tables to determine the frequency meter dial setting (para 3-3*a*).

If the calibration tables are not used, divide by the appropriate number to obtain a fundamental frequency covered by the frequency meter dial.

b. Set the FUNCTION SW to CHK and calibrate the frequency meter at the checkpoint nearest the desired fundamental frequency by tuning for a zero beat.

c. Set the FUNCTION SW to OPER and the frequency meter filmstrip to the desired fundamental frequency.

d. Connect the frequency meter antenna to the *ANT. connector. Place the frequency meter antenna near the receiver.*

e. If the receiver has a bfo, turn it on. Tune the receiver for a beat note from the frequency meter. Be sure that you are tuned to the frequency meter signal by turning the FUNCTION SW to OFF and then back to OPER. Tune the receiver to zero beat.

NOTE

When tuning a receiver with a bfo, it is often difficult to get true zero beat. If this occurs, tune the receiver to the middle of the beat note.

f. If a regenerative receiver is used, advance the regeneration control until the receiver oscillates. Tune the receiver for a zero beat.

3-9. Tuning Receiver with No Means of Producing Beat Note

a. Set the RANGE SW to the proper range. If the desired frequency is some harmonic multiple of the fundamental frequencies covered by the frequency meter dial, consult the calibration tables to determine the frequency meter dial setting (para 3-3*c*). If the calibration tables are not used, divide by the appropriate number to obtain a fundamental frequency covered by the frequency meter dial.

b. Set the FUNCTION SW to CHK and calibrate the frequency meter at the checkpoint nearest the desired fundamental frequency.

NOTE

When performing check procedure, do not connect the frequency meter antenna.

c. Set the frequency meter dial to the desired fundamental frequency, and the FUNCTION SW to MOD.

d. Connect the frequency meter antenna to the ANT. connector. Place the frequency meter antenna near the receiver and tune the receiver for the loudest audio tone in the receiver headset or loudspeaker.

3-10. Determining Frequency to Which Receiver is Tuned

a. Set the RANGE SW to the proper range. If the desired frequency is some harmonic multiple of the fundamental frequencies covered by the filmstrip, consult the calibration tables to determine the filmstrip setting (para 3-3*c*). If the calibration tables are not used, divide by the appropriate number to obtain a fundamental frequency covered by the filmstrip.

b. Set the FUNCTION SW to CHK and calibrate the frequency meter at the checkpoint nearest to the estimated fundamental frequency.

NOTE

When performing check procedure, do not connect the frequency meter antenna.

c. Set the FUNCTION SW to OPER. Connect the frequency meter antenna to the ANT. connector and place the frequency meter antenna near the receiver.

d. If the receiver has bfo, turn it on. Tune the frequency meter for a zero beat in the receiver headset or loudspeaker.

e. If the receiver has no bfo, set the frequency meter FUNCTION SW to MOD and tune the frequency meter for maximum indication on the receiver S meter or for maximum audio in the receiver headset or loudspeaker.

f. Read the frequency meter filmstrip and, if necessary, locate this frequency in the FREQUENCY column of the calibration tables. At the intersection of this frequency and the harmonics column, read the frequency being measured. If the tables are not used, multiply by the number found in a above.

3-11. Stopping Procedure

a. Turn the FUNCTION SW to OFF.

b. Unplug the headset from the PHONES jack.

c. Disconnect the antenna and the power cable and place them in the cover.

d. Replace the front cover.

Section III. OPERATION UNDER UNUSUAL CONDITIONS

3-12. Operation in Arctic Climates

Subzero temperatures and climatic conditions associated with cold weather may hamper the efficient operation of electronic equipment. Follow the instructions and precautions given below for operation under such condition.

a. Keep the equipment warm and dry. If the equipment is not kept in a heated enclosure, construct an insulated box for its protection.

b. Be sure that the equipment has been warmed up sufficiently before use. The transistorized frequency meter may need several minutes, depending on the temperature of the surrounding air.

c. When equipment which has been exposed to the cold is brought into a warm room, it will sweat until it reaches room temperature. When the equipment has reached room temperature, dry it thoroughly.

3-13. Operation in Desert Climates

The main problem with electronic equipment in desert areas is the large amount of sand and dust that lodge in moving parts and mechanical assemblies. Cleaning and servicing intervals shall be shortened according to local conditions.

3-14. Operation in Tropical Climates

In tropical climates, electronic equipment may be installed in tents, or huts, or, when necessary, in underground dugouts. When equipment is installed below ground, and when it is set up in swamp areas danger of moisture damage is more acute than normal in the tropics. Ventilation is usually very poor, and the high relative humidity causes condensation on the equipment whenever its temperature becomes lower than the surrounding air. To counteract this condition, place lighted electric bulbs under the equipment.

CHAPTER 4

OPERATOR'S AND ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

Section I. TOOLS AND EQUIPMENT

4-1. General

Tools and equipment required for operator and organizational maintenance are listed in appendix C.

Section II. PREVENTIVE MAINTENANCE CHECKS AND SERVICES

4-2. General

To insure that the frequency meter is always ready for operation, it must be inspected systematically so that defects can be discovered and corrected before they result in serious damage or failure. The necessary preventive maintenance checks and services to be performed are listed in tables 4-1, 4-2, and 4-3. The item numbers indicate the sequence of and minimum inspection required. Defects discovered during operation of the unit will be noted for future correction to be made as soon as operation has ceased. Stop operation immediately if a deficiency is noted during operation which would damage the equipment. Record all deficiencies, together with the corrective action taken, in accordance with TM 38-750.

D--Daily *Table 4-1. Operator's Preventive Maintenance Checks and Services* *W--Weekly*
Time required: 0.5 *Time required: 0.2*

Interval and sequence no.		Items to be inspected procedure	Work time (M H)
D	W		
1		COMPLETENESS Check to see that the equipment is complete (table 1-1).	0.1
2		EXTERIOR SURFACES Clean the exterior surfaces, including the panel and meter glass. Check the meter and film readout glasses for cracks.	0.1
3		CONNECTORS Check the tightness of all connectors.	
4		CONTROLS AND INDICATORS While making the operating checks (item 5) observe that the mechanical action of each knob, dial, and switch is smooth and free of external or internal binding, and there is no excessive looseness. Also, check the meter for sticking or bent pointer.	
5		OPERATION Operate the equipment according to table 4-4.	0.3
	1	CABLES Inspect cords, cables, and wires for chafed, cracked, or frayed insulation. Replace connectors that are broken, arced, stripped, or excessively worn.	0.1
	2	HANDLES AND LATCHES Inspect handles, latches, and hinges for looseness. Replace or tighten as necessary.	
	3	METAL SURFACES Inspect exposed metal surfaces for rust and corrosion. Clean and touch up paint as required.	0.1
	4	BATTERY COMPARTMENT Inspect the batteries for leakage. Check the compartment for corrosion.	

Table 4-2. Organizational Monthly Preventive Maintenance Checks and Services

M - Monthly
Total time required: 0.4

Sequence No.	ITEM TO BE INSPECTED Procedure	Worktime (M/H)
1	PLUCKOUT ITEMS Inspect seating of pluckout items.	0.1
2	JACKS Inspect jacks for snug fit and good contact.	
3	TERMINAL BLOCKS Inspect terminal blocks for loose connections, and cracked or broken insulation.	0.1
4	RESISTORS AND CAPACITORS Inspect the resistors and capacitors for cracks, blistering, or other defects.	
5	GASKETS AND INSULATORS Inspect gaskets, insulators, bushings, and sleeves for cracks, chipping, and excessive wear.	0.1
6	VARIABLE CAPACITORS Inspect variable capacitors for dirt, corrosion and deformed plates.	
7	INTERIOR Clean interior of chassis and cabinet.	0.1

Table 4-3. Organizational Quarterly Preventive Maintenance Checks and Services

Q--Quarterly
Total time required: 0.3

Sequence No.	ITEM TO BE INSPECTED Procedure	Worktime (M/H)
1	PUBLICATIONS Check to see that all publications are complete, serviceable, and current.	0.1
2	MODIFICATIONS Check DA Pam 310-7 to determine if new applicable MWOs must be applied immediately. All NORMAL MWOs must be scheduled.	0.1
3	SPARE PARTS Check all spare parts for general condition and method storage. There should be no evidence of overstock, and all shortages be on valid requisitions.	0.1

Section III. TROUBLESHOOTING

4-3. Visual Inspection

a. When the equipment fails to perform properly, visually check all the items listed below. Do not check the fuses ((3) below) with ac power on.

(1) Setting of switches and controls.

(2) Equipment power source (batteries or ac).

(3) Burned-out fuses (usually indicates some other fault). Be sure that proper fuses are used (para 4-7).

(4) Headset, cables, connections, and insulations.

(5) Voltmeter for evidence of sticking by tapping the meter.

(6) Front panel battery power interlock switch.

b. If the above checks do not locate the trouble, proceed to the operational checks.

4-4. Operational Checks

a. General. Table 4-4 will help the operator to locate the trouble quickly. The corrective measures are used to repair this trouble. If the measures suggested do not restore normal equipment performance, troubleshooting is required by a higher category maintenance repairman. Note on the repair tags what corrective measures were taken and how the equipment performed at the time of failure.

b. Procedure. Perform the preliminary operating procedures (para 3-2); then, perform the checks given in table 4-4, in the order given. Observe the equipment in operation and perform any corrective measures necessary.

Table 4-4. Operational Checks (Troubleshooting)

Action	Normal indication	Corrective measures
1. Set FUNCTION SW to CHK.	Voltage indicates in green area of voltmeter scale.	Check meter for jammed needles by gently tapping meter face. Check batteries.
	Portion of film not covered by mask is lighted.	Check fuses. If operating on ac power, check power cable and ac source. Higher category maintenance is required.
2. Set RANGE SW to RANGE A. Plug headset into PHONES jack.	Loud whistles heard in headset when frequency meter is turned near a crystal checkpoint.	Check headset. Check headset extension cable. Higher category maintenance is required.
3. Tune frequency meter to nearest crystal checkpoint and adjust CORRECTOR control for a zero beat.	Zero beat obtained on checkpoint.	Higher category maintenance is required.
4. Set RANGE SW to RANGE B and RANGE C and repeat step 3.	Zero beat obtained on checkpoint.	Higher category maintenance is required.
5. Set FUNCTION SW to OPER. Connect antenna to ANT. jack.	Whistles heard in nearby radio receiver when frequency meter tuning is varied.	Higher category maintenance is required.
6. Set FUNCTION SW to MOD.	A modulated rf signal is heard in headset.	Higher category maintenance is required.

Section IV. MAINTENANCE OF FREQUENCY METER

4-5. Cleaning

Inspect the exterior of the frequency meter, the front panel, and the interior of the front panel cover. All surfaces should be clean and free of dust, dirt, grease, and fungus.

a. Remove dust and loose dirt with a clean, soft cloth.

WARNING

The fumes or trichloroethane are toxic. Provide thorough ventilation whenever used. DO NOT use near an open flame. Trichloroethane is not flammable, but exposure of the fumes to an open flame or hot metal forms highly toxic phosgene gas.

b. Remove grease, fungus, and ground-in dirt from the case with a cloth dampened (not wet) with trichloroethane.

c. Remove dust or dirt from plugs and jacks with a soft brush.

CAUTION

Do not press on the meter face when cleaning. Damage to the equipment may result.

d. Clean the front panel, meter face, readout window, and controls, using a soft clean cloth. If necessary, dampen the cloth with water or mild detergent, for more effective cleaning.

e. Clean all cables and power cord with a clean, soft cloth.

4-6. Touchup Painting

a. Clean rust and corrosion from metal surfaces by lightly sanding them with fine sandpaper. Brush two thin coats of paint on the bare metal to protect it from further corrosion.

CAUTION

Do not use steel wool on electronic equipment. Minute metal particles may enter the case and cause internal shorting.

b. Paints and procedures used shall be in accordance with TB 746-10.

4-7. Replacement of Fuses

Replace the fuses as follows:

a. Press in the fuseholder and turn in counterclockwise. Pull the fuseholder out to expose the effective fuse.

b. Remove the blow fuse from the fuseholder cap and install a new fuse.

NOTE

Be sure that the fuse is rated at 1/16 ampere, 125 volts, type 3AG, slo-blo.

c. Press the fuseholder cap into the fuseholder and turn it clockwise to lock.

CHAPTER 5

FUNCTIONING OF EQUIPMENT

5-1. General

(fig. 5-1)

Frequency Meter AN/USM/159 (*), which is a transistorized heterodyne type, covers three frequency ranges: 125 kHz to 2.5 MHz (125 kHz to 250 kHz on fundamentals), 2.5 to 65 MHz (2.5 to 5.0 MHz on fundamentals), and 65 to 1,000 MHz (65 to 130 MHz on fundamentals). The fundamental frequency is read directly from a calibrated filmstrip, and the appropriate harmonic is obtained by a multiplication of the film readout frequency by the harmonic number desired. Signal paths are shown in the block diagram (fig. 5-1) and are described in *a* through *h* below. For complete circuit details, refer to the overall schematic diagram.

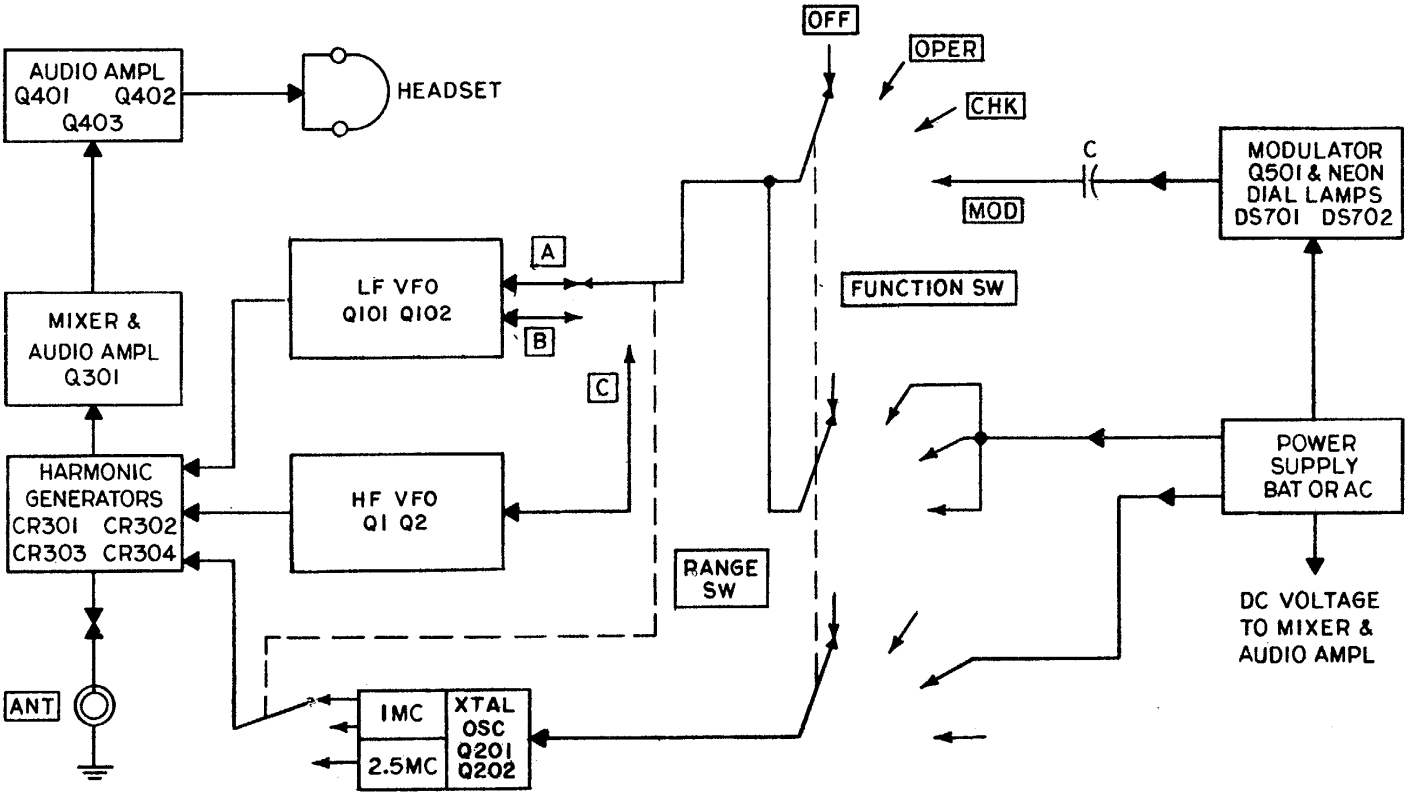


Figure 5-1. FR-149(*)/USM-159, block diagram.

a. Crystal Oscillator. The crystal oscillator circuit uses two transistors and two crystals. One crystal is accurately set at 1 MHz and the other at 2.5 MHz. The setting of the RANGE SW determines which crystal is used. Strong harmonics of the crystal oscillator output signal are obtained by the application of the signal to the harmonic generators. The 1-MHz crystal provides a minimum of 22 crystal checkpoints for calibrating the variable frequency oscillator (vfo) in ranges A and B. The 2.5-MHz crystal supplies a minimum of 27 crystal checkpoints for range C. No power is applied to the crystal oscillator until the FUNCTION SW is placed at CHK.

b. Low Frequency Vfo. The low frequency vfo contains two transistors and generates fundamental frequencies that may be varied over a range of 125 to 250 kHz in range A, and 2.5 to 5.0 MHz in range B. Usable harmonics in both ranges cover frequencies up to 65 MHz and are obtained in the harmonic generating circuit.

c. High Frequency Vfo. The high frequency vfo contains two transistors and generates fundamental frequencies that may be varied over a range of 65 to 130 MHz. Harmonics up to 1,000 MHz are produced in the harmonic generating circuit.

d. Harmonic Generators. The harmonic generator circuit produces harmonics for the variable frequency oscillators or crystal oscillator in addition to serving as a high frequency heterodyne mixing network. The input signals may be either of the following:

(1) Either vfo signal and any signal received by the meter antenna (when the FUNCTION SW is set to OPER).

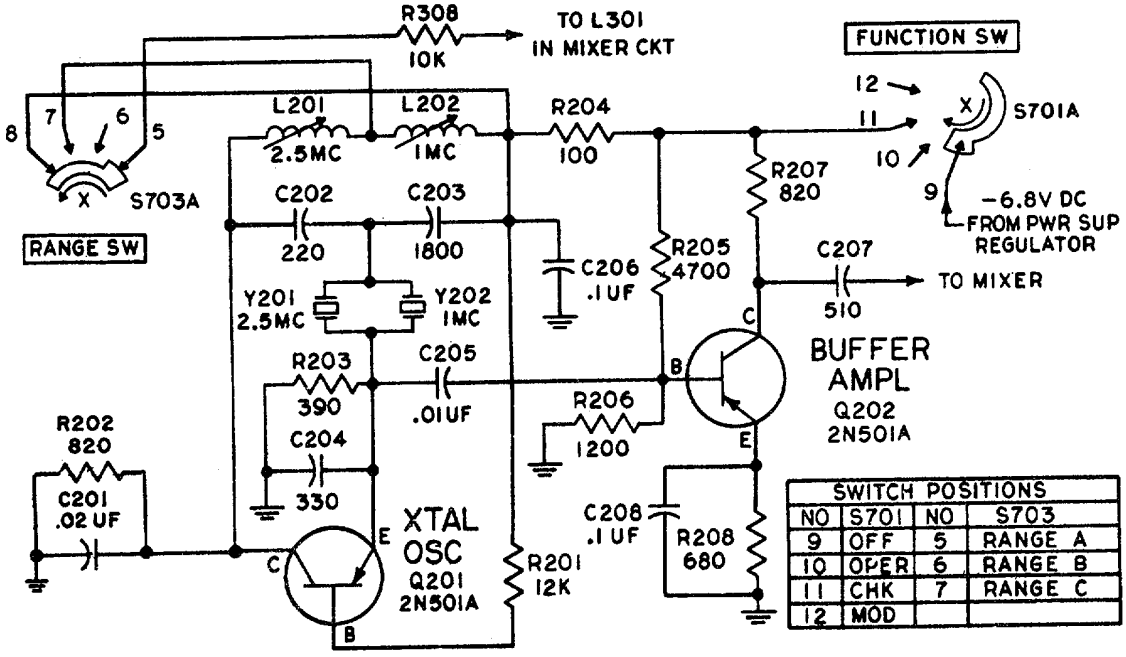
(2) Either vfo signal and the crystal oscillator signal (when the FUNCTION SW is set to CHK).

e. Mixer and Audio Amplifier. The mixer and audio amplifier circuit, using a transistor, functions as a low frequency heterodyne mixer and audio preamplifier. The input signals, which consist of sum and difference frequencies plus harmonics, are heterodyned together to produce a beat difference frequency which is within the audio range.

f. Audio Amplifier. The audio amplifier circuit uses three transistors to amplify the heterodyne beat note (audio) received from the mixer so that it may be heard in the headset.

g. Modulator and Dial Lamp Power Circuit. The modulator and dial lamp power circuit contains one transistor which functions as a 900-hertz audio oscillator to modulate either vfo and supply 900-hertz ac power for two neon lamps. The lamps light the filmstrip. Modulating voltage is superimposed on the vfo direct current supply when the FUNCTION SW is set to MOD.

h. Power Supply. The power supply operates on either alternating current or batteries and provides regulated and unregulated dc power for all transistor circuits.



NOTE

▭ **INDICATES EQUIPMENT MARKING.**

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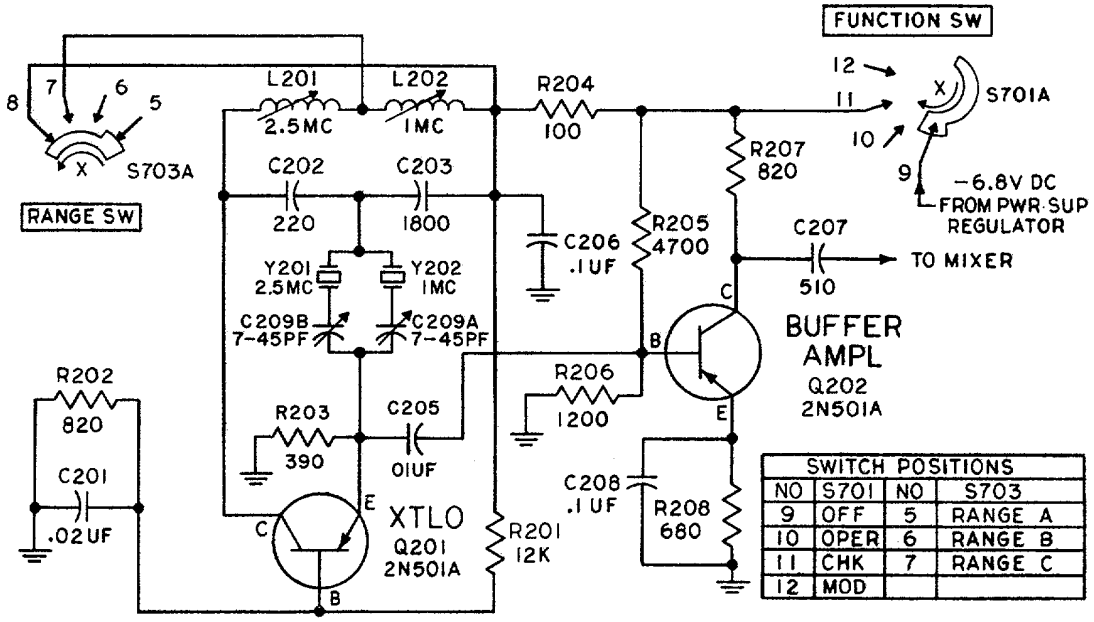
Figure 5-2. FR-149/USM-159, crystal oscillator, schematic diagram.



NOTE

▭ **INDICATES EQUIPMENT MARKING.**

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Figure 5-3. FR-149A/USM-159 and FR-149B/USM-159, crystal oscillator, schematic diagram.

5-2. Crystal Oscillator Circuit

(fig. 5-2 and 5-3)

a. The crystal oscillator provides crystal check frequencies at either 1- or 2.5-MHz intervals throughout the fundamental ranges of the meter. Use of these signals with associated checkpoints printed on the filmstrip permits correction of the dial to the original calibration settings. Two crystals are used in the oscillator circuit. Switching coil L202 in or out of the tank circuit permits selection of either the 1- or 2.5-MHz frequency by use of the RANGE SW. The 1-MHz crystal (Y202) is used in the tank circuit, formed by capacitors C202 and C203 in parallel with L201 and L202. In the 2.5-MHz operation, the 2.5-MHz crystal (Y201) is used with capacitors C202 and C203 in parallel with L201. The coils are slug-tuned and permit amplitude peaking. Trimmer capacitors C209A and C209B (Not in AN/USM-159) allow adjustment of crystals Y201 and Y202, respectively, to the exact frequency.

b. In figure 5-2 and 5-3, transistor Q201 operates as a Colpitts oscillator. Oscillation takes place from the collector to the emitter through the tank circuit and emitter connection to the two crystals. The junction connection of C202 and C203 serves the same purpose as a center tap on the tank circuit. Each crystal forms a parallel resonant circuit with maximum impedance at resonance. If either crystal is removed and an equivalent resistance (approximately 400 ohms) is substituted, the circuit will oscillate at its free-running frequency.

c. The collector of Q201 receives voltage through switch S701 (CHK position), decoupling resistor R204, and coils L201 and L202. Bypass capacitor C206 keeps radiofrequency out of the power supply and grounds one side of the tank circuit for rf. The base of Q201 is forward-biased by the current flowing through voltage divider R204, R201, and R202. Capacitor C201 decouples the base and (in AN/USM-159 only) stabilizes collector current. Resistor R203 and capacitor C204 stabilize emitter current and provide impedance matching between the emitter-follower output circuit and buffer amplifier Q202. Amplifier Q202 isolates the oscillator and prevents circuit loading. Forward base bias is furnished by R205 and R206. Resistor R208 supplies emitter bias, and capacitor C208 bypasses rf. The output signal of Q202 appears at collector load resistor R207 and is applied through C207 to the mixer circuit. The connection of resistor R308 to the RANGE SW (range A) (in AN/USM-159 only) provides diode biasing voltage in the mixer circuit.

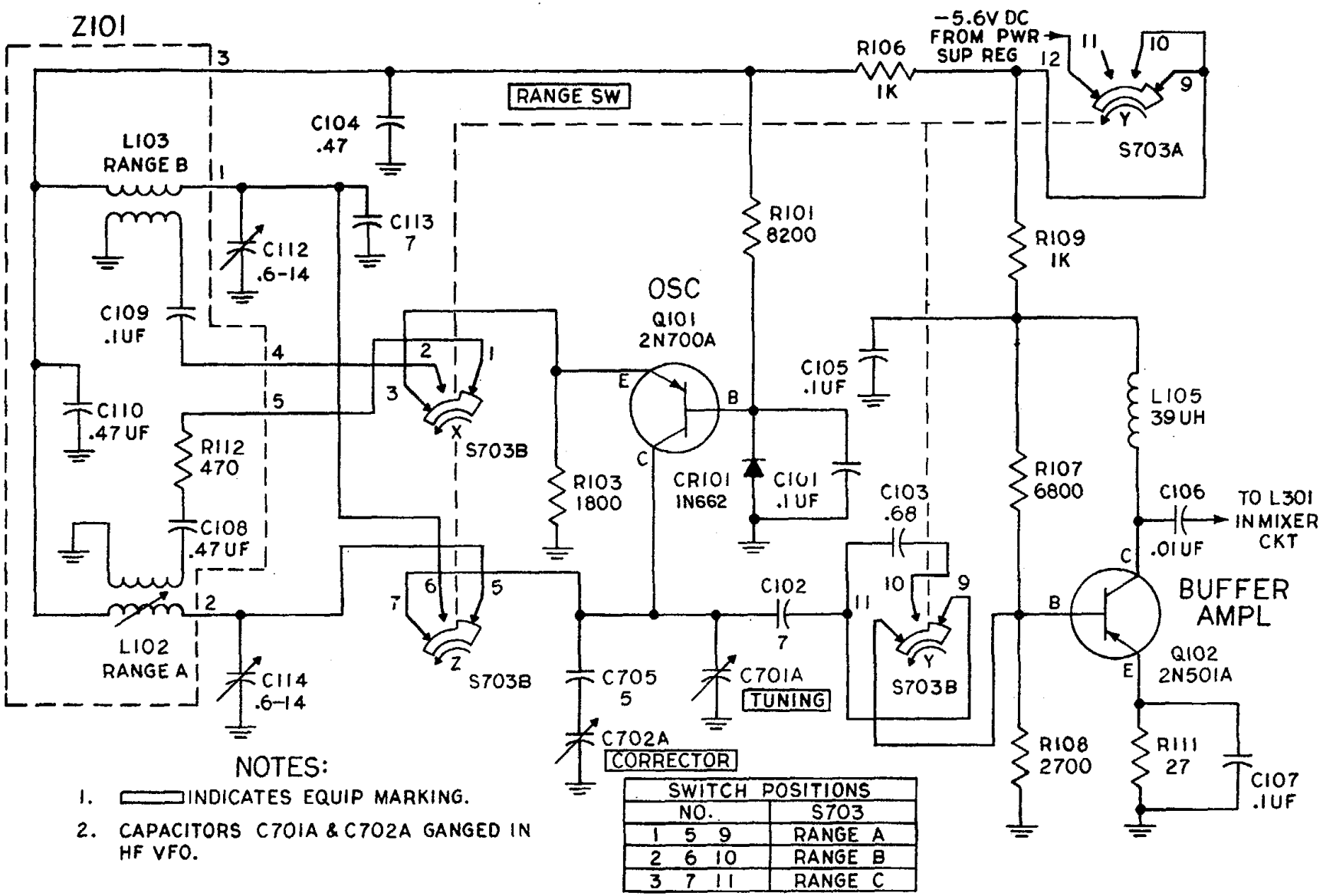

Figure 5-4. FR-149/USM-159 low frequency oscillator schematic diagram.

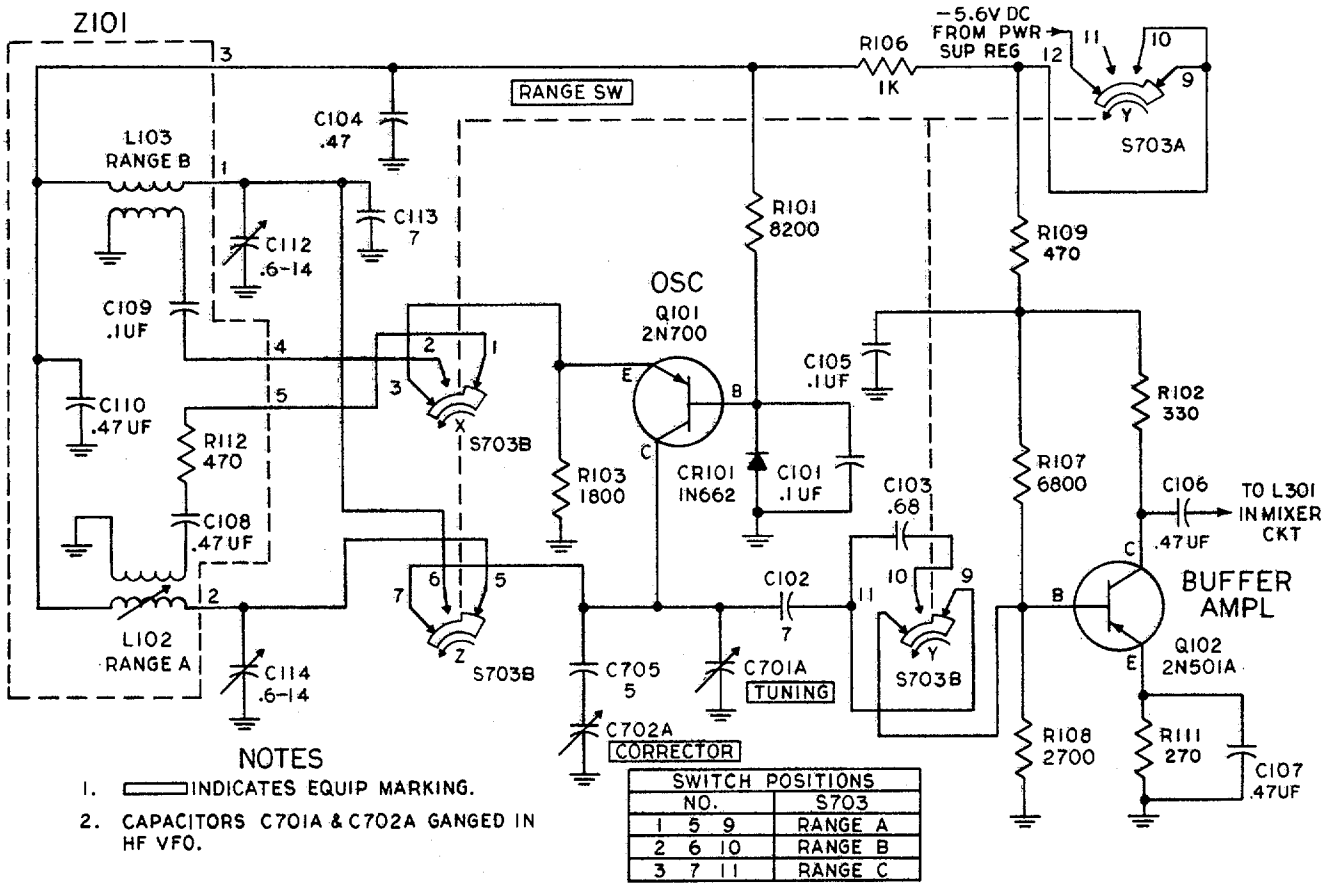

Figure 5-5. FR-149A/USM-159 and FR-149B/USM-159 low frequency oscillator, schematic diagram.

5-3. Low Frequency Oscillator Circuit
(fig. 5-4 and 5-5)

a. The low frequency oscillator circuit, which is transistorized, is the vfo used for ranges A and B. It consists of a tunable oscillator stage Q101 and buffer amplifier Q102. The oscillator produces fundamental frequencies that may be varied from 125 to 250 kHz in range A, and 2,500 to 5,000 kHz (5 MHz) in range B. Harmonics extend up to 2.5 MHz in range A, and 65 MHz in range B. The filmstrip is calibrated directly in fundamentals for range A (125 to 250 kHz), and range B (2,500 to 5,000 kHz). A mask, operated by the RANGE SW, covers all filmstrip ranges except the range in use.

b. The oscillator circuit of Q101. is the transistor counterpart of a vacuum-tube tickler feedback oscillator. The positive feedback signal is obtained between the collector and emitter through the primary and secondary windings of coils L102 and L103. One section of RANGE SW S703 switches the collector of Q101 to the appropriate primary winding, and the other section of S703 switches the emitter to the proper feedback winding. Capacitor C701A, connected to the collector of Q101, is the main TUNING capacitor which is used to tune each coil over its range. Capacitor C702A is labeled CORRECTOR on the front panel and enables the operator to bring the oscillator to its correct frequency. Fixed capacitor C705 acts as a series padder for C702A. Trimmer capacitors C112 and C114 adjust vfo tracking at the high end of the ranges. The primary inductance of L102 is adjusted for low end tracking by a slug. Low end tracking of L103 is preset during manufacture. Capacitors C108 and C109 provide emitter coupling for the feedback signals. Resistor R112 decreases the feedback signal in range A. Tank circuit bypass capacitors C104 and C110 have similar functions. These two capacitors are necessary because of lead length inductance between decoupling resistor R106 and the tank circuit. These capacitors keep rf out of the power supply in addition to preventing 900-hertz modulating voltage from being applied to the oscillator.

c. The emitter of Q101 is terminated by R103 which provides emitter bias and impedance matching for the feedback windings. Resistor R101 and CR101 from a

voltage divider which supplies base bias. Diode CR101 is used to stabilize collector current. Conduction of the diode provides a constant value of forward base bias. Capacitor C101 bypasses rf. The oscillator output signal is taken from the collector and applied through coupling capacitor 102 and S703 to buffer amplifier Q102. When switch S703 is in the A position, only C102 is used; when S703 is in the B position, C103 is connected in 'series with C102 to reduce the coupling capacitance since less coupling is required for this range.

d. Buffer amplifier Q102 prevents oscillator circuit loading and ettenuates the signal to the proper level required by the mixer circuit. During the MOD function, modulation is applied to Q102 through R109. Capacitor C104, C110, and R106 filter out the medulation before it is applied to Q101. The base of Q102 is forward-biased by the current flowing through voltage divider R109, R107, and R108. Capacitor C105 and R109 form a decoupling circuit. Peaking coil L105, which is the collector load impedance, provides high frequency compensation for Q102 (in AN/USM-159 only). R102 is the collector load for Q102 (in AN/USM159 only). The collector output signal is applied through C106 to the mixer circuit. Resistor R111 prevents emitter current from exceeding a safe value, and capacitor C107 bypasses rf.

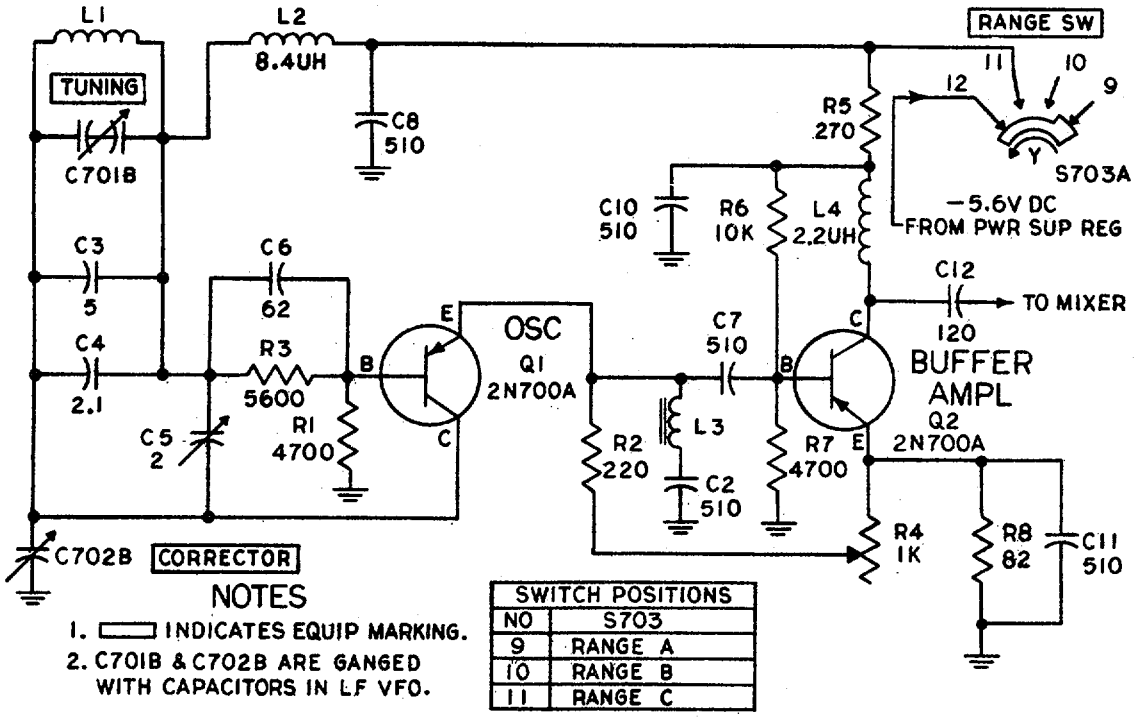

Figure 5-6. FR-149/USM-159 high frequency oscillator, schematic diagram.

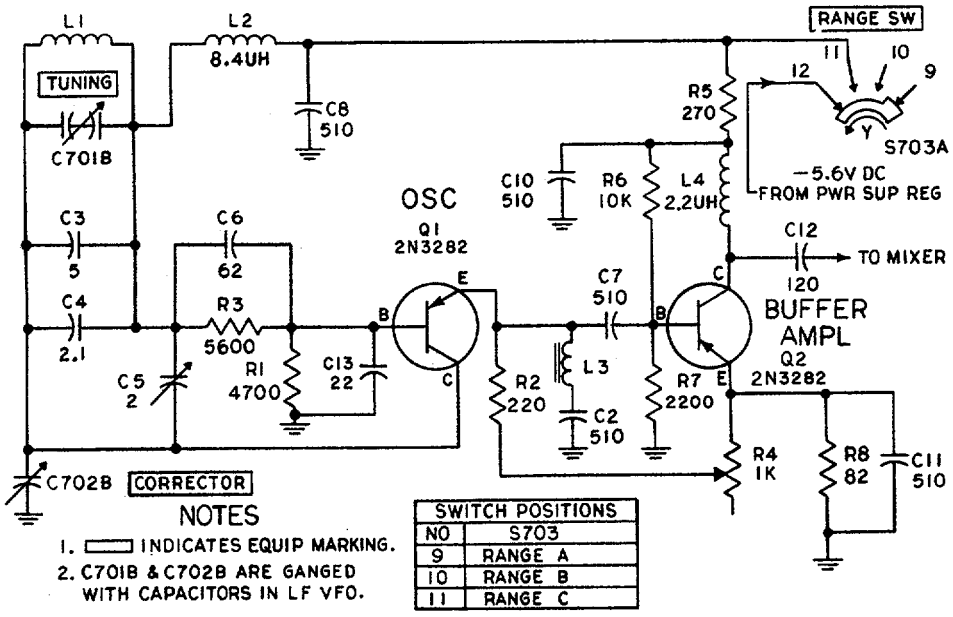

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Figure 5-7. FR-149A/USM-159 and FR-149B/USM-159, high frequency oscillator, schematic diagram

5-4. High Frequency Oscillator
(fig. 5-6 and 5-7)

a. The high frequency oscillator, which is a transistorized oscillator, is the vfo for range C. It produces fundamental frequencies that may be varied from 65 to 130 MHz and harmonics up to 1,000 MHz. The variable capacitors, labeled TUNING and CORRECTOR, are mechanically linked to similar capacitors in the low frequency vfo. A segment of the filmstrip is calibrated in fundamentals for range C. When this range is in use, a mask covers the other two ranges.

b. The high frequency oscillator circuit consists of Colpitts oscillator Q1 followed by buffer amplifier Q2. Positive feedback is obtained between the collector and base circuits formed by the tank circuit. For tuning purposes, the oscillator tank circuit is formed by the parallel-resonant combination of coil L1, and split-stator capacitor C701B. The midpoint of this tuning capacitor electrically forms a center tap on coil L1. The effective tuning range is padded by capacitors C3, C4, and C5. Variable capacitor C702B (labeled CORRECTOR) and L1 form a series-resonant circuit to adjust tuning over a limited range.

c. The collector of Q1 is supplied voltage through S703A, rf choke L2, and L1. Bypass capacitor C8 and choke L2 form a low-pass filter to keep rf out of the power supply. Choke L2 presents a high reactance to rf and prevents grounding of the feedback signal at the junction of L1 and L2. The resistance-capacitance (rc) combination of R3 and C6 and (not in AN/USM-159) C13 adjusts the feedback signal while R3 and R1 provide forward base bias. The collector current and operating stability of Q1 are maintained at close limits by connection of the emitter through R2 and R4 to the emitter of Q2. This series connection between the two emitters constitutes a current feedback loop. Since the emitter-follower output signal of Q1 is applied through C7 to the base of Q2, the phase of the input signal (positive or negative) will tend to decrease or increase the emitter current flowing through R8. This current change will be reflected on the emitter bias of Q1 and cause the correct change in bias to stabilize collector current. The oscillator output signal that appears at the collector of Q2 will be at a constant amplitude. Potentiometer R4 sets the minimum value of emitter bias and collector current for Q1. Inductor L3 and C2 remove spurious frequencies. Actually, inductor L3 is not a coil but a short length of wire inside a piece of ferrite material which contributes the required inductance. At the frequencies to be rejected, L3 has minimum reactance (equal to a straight piece of wire) and permits these frequencies to be bypassed through C2. For desired frequencies, L3 behaves as an iron-core rf choke and presents reactance.

d. Buffer amplifier Q2 isolates the oscillator circuit and amplifies the signal. The collector of Q2 receives voltage through S703, power supply decoupling resistor R5, and high frequency peaking coil L4. Capacitor C10 bypasses rf and base bias is established by R6 and R7. Emitter resistor R8 prevents emitter current from exceeding a safe value and capacitor C11 bypasses rf.

The output signal of Q2 is applied through C12 to a mixer circuit. During modulation, both the oscillator and buffer stages are modulated by pulsing the dc supply voltage at a 900-Hz rate. The reactance of bypass capacitors C8 and C10 at 900 Hz is sufficient to prevent the bypassing of audio frequencies while still providing an effective rf bypass.

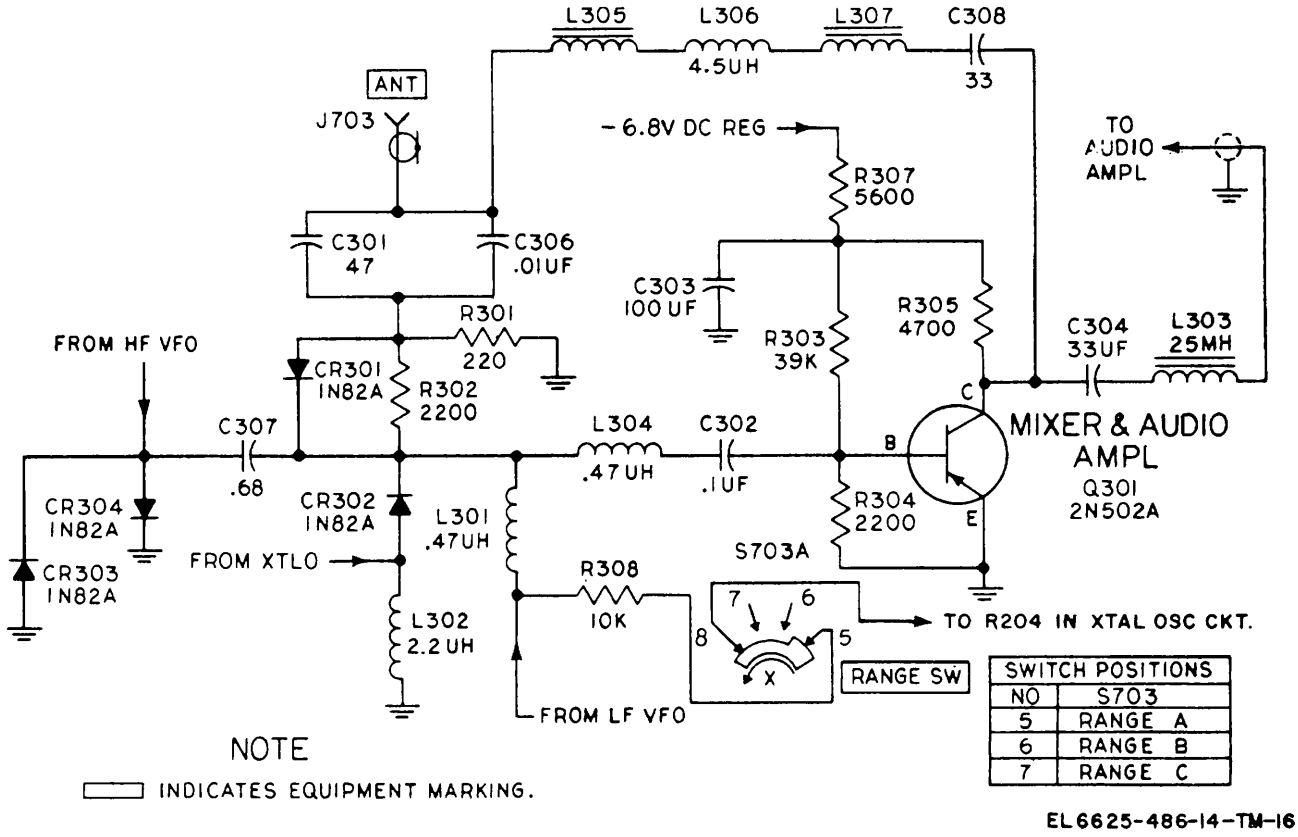


Figure 5-8. FR-149/USM-159, mixer circuit, schematic diagram.

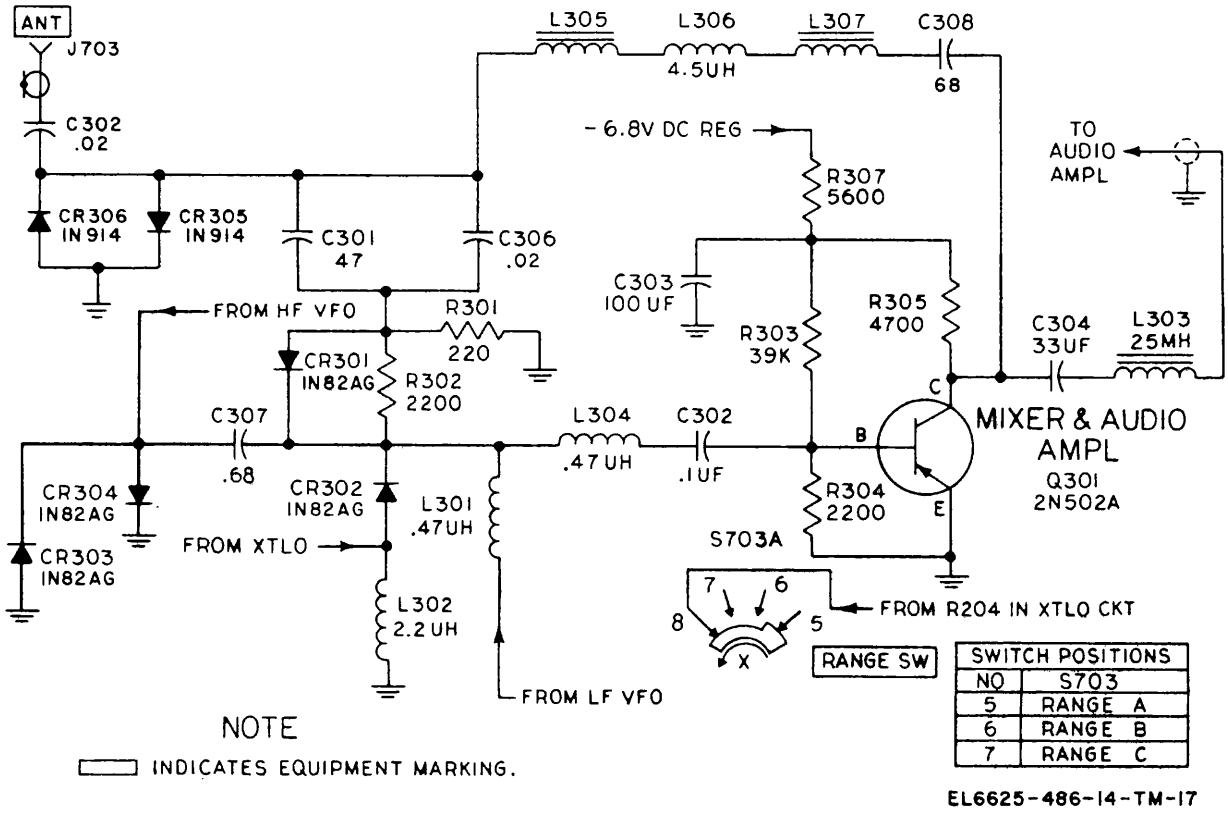


Figure 5-9. FR-149/USM and FR-149B/USM-159 mixer circuit, schematic diagram.

5-5. Mixer Circuit

(fig. 5-8 and 5-9)

The mixer circuit performs the heterodyning function and generates harmonics for the crystal oscillator and the variable frequency oscillators. Crystal diodes generate harmonics and a transistor functions as a mixer and audio preamplifier. During operation of the meter, the mixer circuit receives dc power continuously.

a. Harmonic Generator Function.

(1) *High frequency vfo signal*. The vfo output signal is composed of strong fundamental frequencies and some higher order harmonics of lesser amplitudes. To generate sufficient harmonics up to 1,000 megahertz, the vfo output signal is squared. This is accomplished by diodes CR303 and CR304 which clip the negative and positive portions of vfo signal. Diode CR303 clips the negative going portion and diode CR304 clips the positive portion. The square wave, rich in harmonics up through the tenth harmonic, passes through C307 to the mixing network. Capacitor C307 removes the dc component. The rf portion of vfo signal passes through the stray capacitance associated with CR301 and is radiated out of the ANT. jack through C301. Although diode CR301 may cause some negative dc rectification of vfo signal with a tendency to produce additional harmonics, these affects are small in comparison with the stray capacitance of CR301 which is sufficient to pass high frequency rf. Resistors R301 and R302 provide constant input and output impedances for the meter overall frequency ranges. Capacitor C301 couples high frequencies and C306 serves a similar function for lower frequencies. The circuit including L305, L306, L307, and C308 does not influence high frequency output signals appearing at the ANT jack (*b* (2) below).

(2) *Low frequency vfo signal.* The low frequency vfo develops strong fundamental frequencies and some high order harmonics of lesser amplitudes. The desired harmonics up to 65 megahertz are produced by harmonic generating diode CR301. The vfo signal, applied through isolating coil L301, causes the diode to conduct on the negative going portion of signal and produce harmonics (the nonlinear characteristics of a diode produce harmonics). At the fundamental frequencies, very little signal will pass through the stray capacitance of CR301 or R302. As a result, the output of CR301 will constitute a pulsating dc signal rich in harmonics. The ac component of the signal passes through C301 or C306 to the ANT. jack. Diode CR301

will also conduct but will not affect the useful output of vfo signal.

(3) *Crystal Oscillator signal*. During the crystal calibrate or CHK function, the signal is injected at the junction of CR302 and L302. These two components function as a ringing circuit for generating either a 1-MHz or 2.5-MHz harmonic spectrum. Diode CR302 conducts and introduces positive going pulses into the mixer network. When calibrating the high frequency vfo, the positive half-cycle of oscillator signal will add to a similar polarity of vfo signal and cancel an opposing polarity. When calibrating the low frequency vfo, the oscillator signal will act in the same manner as for the high frequency vfo signal. The mixing of vfo and crystal oscillator signals produces a sufficient number of crystal checkpoints for ranges B and C without using an external source of diode biasing voltage for CR302; however, on range A, it was necessary in the AN/USM-159 to use some bias. This is accomplished by taking negative voltage (0.08 volt) from the crystal oscillator circuit and feeding it through S703, R308, and L301, to the cathode of CR302. This voltage causes CR302 to generate more harmonics. Although diode CR301 has a tendency to oppose the crystal oscillator signal, higher order harmonics will pass through the stray capacitance of CR301 and be radiated from the meter antenna the same as a vfo signal.

b. Mixer Functions.

(1) *High frequency mixing.* The high frequency mixing of signals in the diode network produces complex waveforms containing the fundamental frequencies, plus their sum and difference frequencies, plus harmonics. During frequency measurement, the unknown input signal is applied through either C301 or C306 and CR301 where the signal heterodynes against the internal vfo signal and produces a difference frequency within the audio range. Since diode CR301 is an harmonic generator for an input signal as well as an outgoing vfo signal, a number of other frequencies are also developed. In the diode mixing network, all high-order harmonics are removed by low-pass filter L304 and C302. The remaining low frequencies (including audio) are applied to the base of Q301, a low frequency mixer.

(2) *Low frequency mixing.* Transistor Q301 is a low frequency mixer and high-gain audio preamplifier. The base of Q301 is forward-biased through voltage divider R307, R303, and R304. With the emitter grounded, Q301 operates like a forward-biased diode followed by a direct-coupled amplifier. A negative going input signal will cause a positive going output signal to appear at collector load resistor R305. Low frequency heterodyning in Q301 and diode rectification action develops rf, af, and dc signals at the collector. The audio signal fed to the main audio amplifier is recovered by coupling capacitor C304 and audio choke L303 which, in addition to removing the dc component, presents a high impedance to rf while still allowing audio signals to pass through. Low frequency rf signals, appearing at the collector of Q301, are fed back to the ANT. jack through C308, L307, L306, and L305 for the purpose of reinforcing harmonic frequencies developed by the low frequency vfo on range A. The impedance of this network is such that the desired frequencies will pass from Q301 to the ANT. jack but neither range B or C vfo frequencies will pass in the reverse direction. Although L305 and L307 appear to be iron-core chokes, they are not chokes in the ordinary sense. Each inductor is not a coil but a short length of wire (lead of L306) inside a piece of ferrite material which contributes inductance at certain frequencies. For passage of desired frequencies, the inductors present no appreciable rf resistance; whereas, at higher frequencies, the inductors behave as iron-core rf chokes and present maximum rf reactance.

c. Overload Protection. The network consisting of C309, CR305, and CR306 in the AN/USM-159A and AN/USM-159B (fig. 5-9) acts to prevent damage to mixer diode CR301 and other components in the mixer circuit if high amplitude transients are accidentally applied to ANT. jack J703. C309 blocks dc, but passes rf components. CR305 and CR306, connected parallel with opposing polarity, act as shunting resistances to transients of either polarity when the applied amplitude exceeds the diode forward breakdown voltage of approximately 0.7 volt. Signals in the normal amplitude range of the mixer are not affected since the resistance of both diodes is high when the applied voltage remains below the forward breakdown voltage.

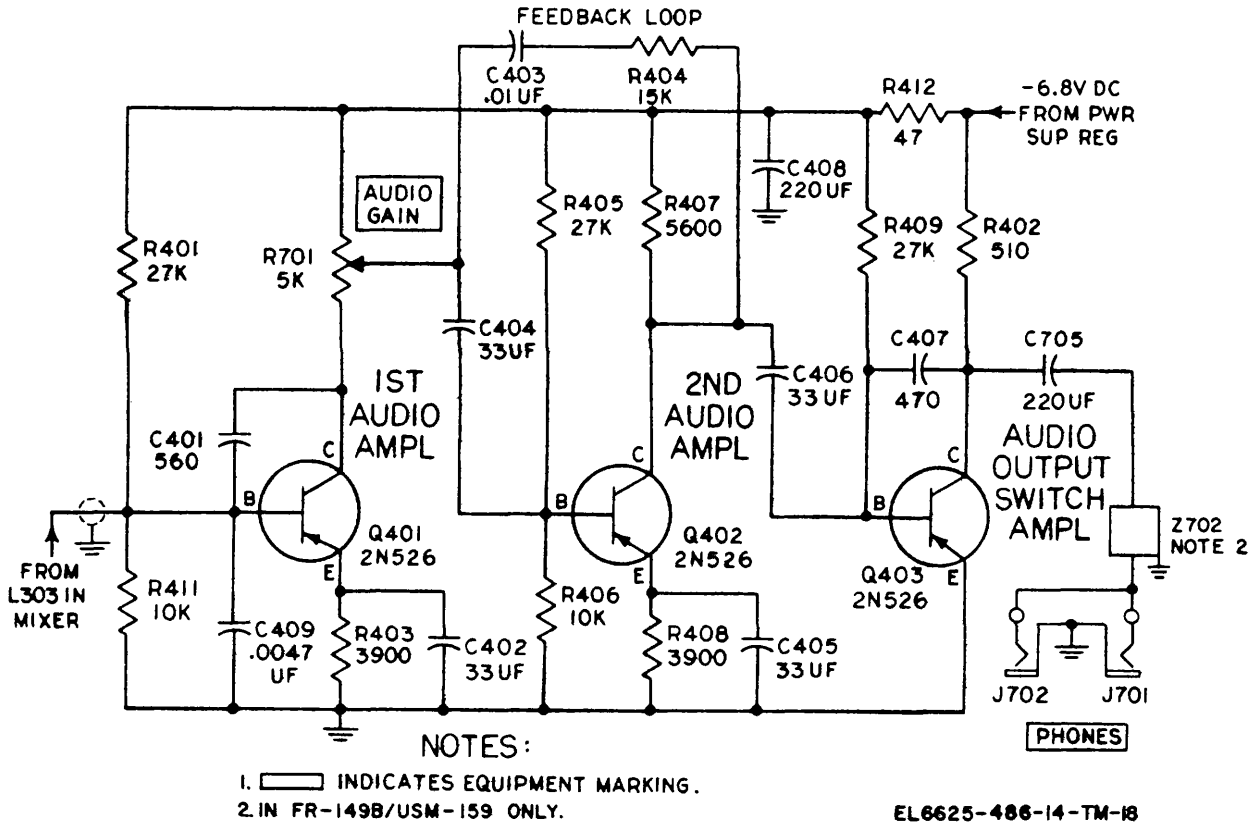


Figure 5-10. FR(*)/USM-159 audio amplifier, schematic diagram.

5-6. Audio Amplifier Circuit
(fig. 5-10)

a. The transistorized audio amplifier receives the mixer signal and amplifies the signal to headphone level. The first two stages of the amplifier follow general circuit practice for incorporation of a feedback loop. This loop is completed from the collector of Q402 back to the AUDIO GAIN control which is the collector load resistor for Q401. The combination of R701, C403, and R404 increases the gain of these two stages for the audiofrequencies while sharply reducing the gain for other frequencies.

b. The base of transistor Q401 is forward-biased by a voltage divider consisting of R401 and R411. Capacitor C401 supplies negative feedback and C409 bypasses undesirable frequencies. Emitter bias is furnished by R403. Capacitor C402 bypasses audio frequencies. The applied mixer signal causes variations in the collector current of Q401 which is applied through coupling capacitor C404 to Q402. Forward base bias in this stage is provided by resistors R405 and R406. Emitter bias is provided by R408 which is bypassed by C405. The amplified audio signal appears at collector load resistor R407 and is directed through C406 to Q403.

c. Transistor Q403 has the emitter grounded and its base receives sufficient forward base bias voltage through R409 to cause saturation. In this condition, the collector conducts at maximum current through load resistor R402 in the absence of an input signal and partially-ceases conduction with a positive going input signal. It operates like a switch which is normally on. With no input signal (beat note), only noise will be heard in the headset. When a beat note is present, Q403 will partially cease conduction and result in a sufficient decrease in noise level so that only the beat note will be heard. In this respect, the circuit functions as a noise limiter. The transistor stage has negative feedback stabilization from collector to base through capacitor C407. Decoupling resistor R412 and capacitor C408 keeps audio out of the power supply. Capacitor C410 couples the collector output signal (through filter Z702 (AN/USM-159B only)) to the PHONES jacks. The PHONES jacks are nonshorting type and, without the headset plugged in, the collector of Q403 looks into an open load circuit.

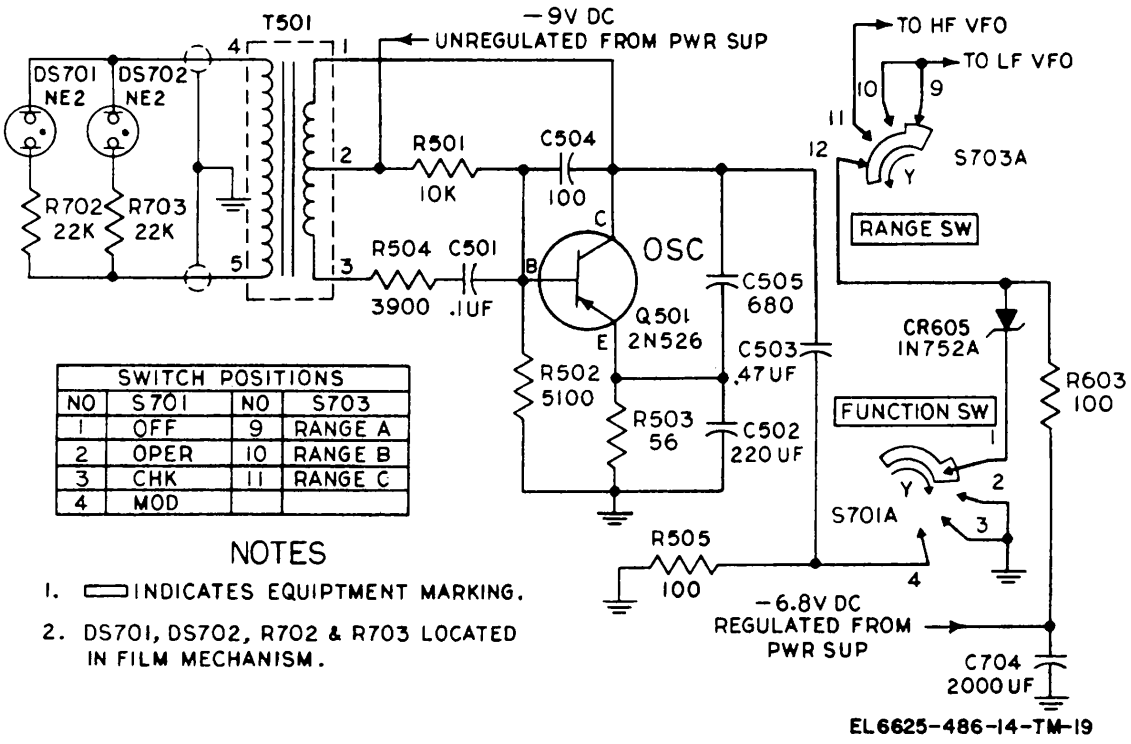


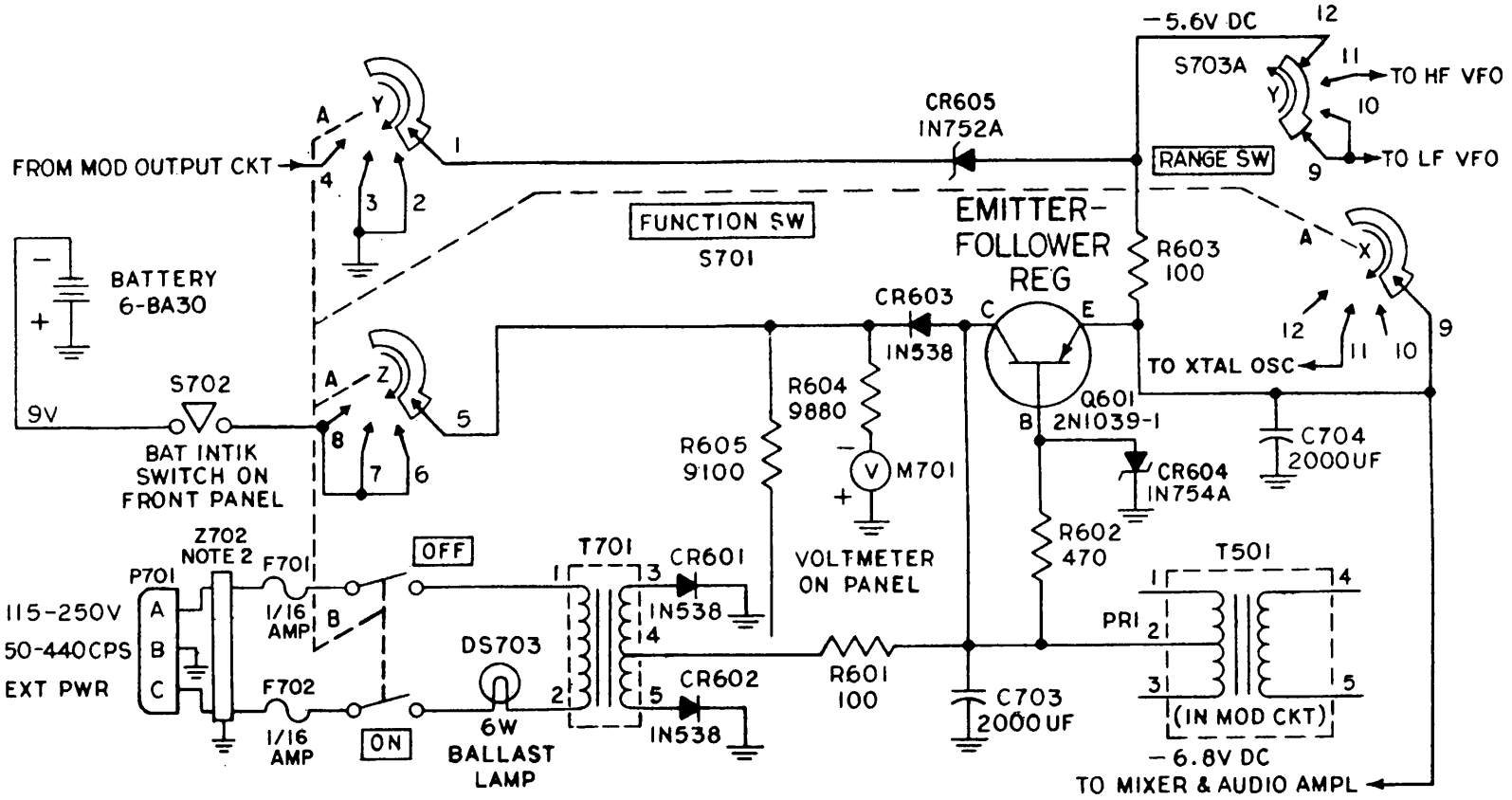
Figure 5-11. FR-149(*)/USM-159 modulator and dial lamp power circuit, schematic diagram.

5-7. Modulator and Dial Lamp Power Circuit
(fig. 5-11)

a. The modulator is a transistorized 900-Hz oscillator. The modulator amplitude modulates the vfo dc supply and provides ac power for two neon dial lamps in the filmstrip mechanism. This circuit receives operating power at all times except when unit power is off. Modulation is supplied when FUNCTION SW S701 is set to MOD and the appropriate vfo is selected by RANGE SW S703.

b. The oscillator circuit is the transistorized version of a Hartley oscillator. Feedback necessary for oscillation takes place from the collector to the base of Q501 through transformer T501, R504, and C501. Frequency of oscillation is determined by C501 and T501. The center tap on the primary winding of T501 is located to provide an impedance match between the collector and base circuits. With this arrangement, T501 acts like an auto transformer. Voltage stepup action through the secondary of T501 applies ac voltage to neon lamps I702 and I1703. Current is limited by R702 and R703.

c. The collector of Q501 receives unregulated dc voltage from the T501 center tap. Forward base bias is established through R501 and R502. Emitter bias resistor R503 limits emitter current to a safe value. Capacitor C502 bypasses audio frequencies to ground. Harmonic frequencies existing at the collector of Q501 are bypassed through capacitor C505. Capacitor C504 connected between the collector and emitter is for stabilization purposes. The 900-Hz collector output signal is directed through coupling capacitor C502 to contact 4 of FUNCTION SW S701. The collector of Q501 is terminated in resistor R505 to provide a constant load resistance and prevent changes in load current with different positions of S701. When switch S701 is in the MOD position, modulation is applied to the vfo supply voltage through Zener diode CR605 and RANGE SW S703. With the FUNCTION SW S701 in any other position, diode CR605 is grounded and causes it to function as a regulator for the variable frequency oscillators.



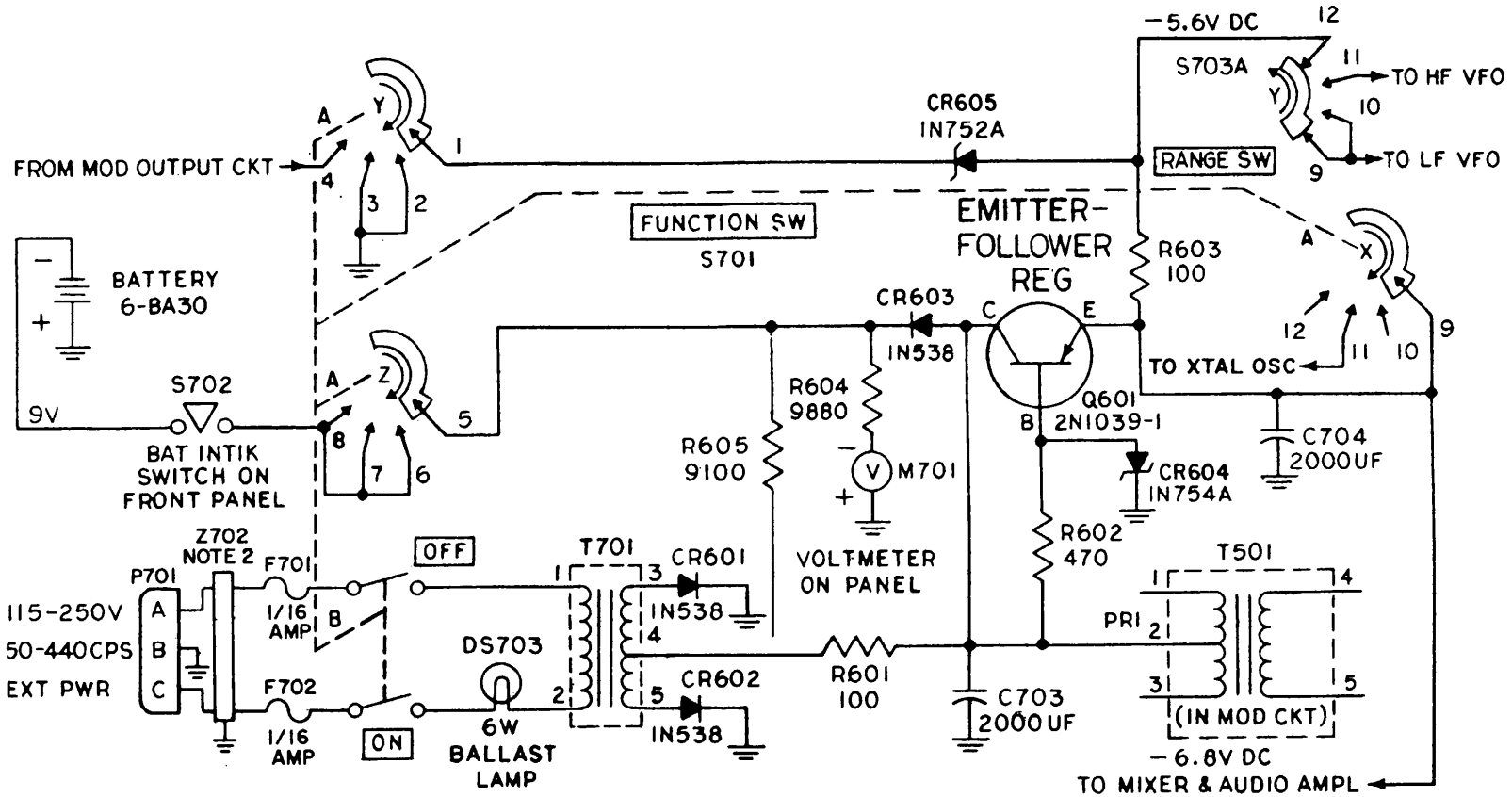
SWITCH POSITIONS			
NO	S701	NO	S703
1, 5, 9	OFF	9	RANGE A
2, 6, 10	OPER	10	RANGE B
3, 7, 11	CHK	11	RANGE C
4, 8, 12	MOD		

NOTES

1. ▭ INDICATES EQUIPMENT MARKING.
2. IN FR-149B/USM-159 ONLY.

EL6625-486-14-TM-20

Figure 5-12. FR-149/USM-159 regulated power supply and voltage distribution circuit, schematic diagram.



SWITCH POSITIONS			
NO	S701	NO	S703
1, 5, 9	OFF	9	RANGE A
2, 6, 10	OPER	10	RANGE B
3, 7, 11	CHK	11	RANGE C
4, 8, 12	MOD		

NOTES

1. ▭ INDICATES EQUIPMENT MARKING.
2. IN FR-149B/USM-159 ONLY.

EL6625-486-14-TM-20

Figure 5-13. FR-149A/USM-159 and FR-149B/USM-159 regulated power supply and voltage distribution circuit, schematic diagram.

5-8. Regulated Power Supply and Voltage Distribution Circuit

(fig. 5-12 and 5-13)

The unit power supply operates from self-contained flashlight batteries that supply 9 volts dc or 115 to 250 volts ac external power. Automatic switchover from batteries to ac is accomplished internally. A plunger-type interlock switch, connected in series with the batteries on the front panel, prevents battery drain when the unit front cover is closed. The front panel voltmeter monitors power supply output voltage for either battery or ac operation. The power supply provides regulated and unregulated voltages for all circuits in the meter. Power supply operation for batteries or ac line power is explained in *a* and *b* below.

a. Battery Operation.

(1) During battery operation, 9 volts dc is applied through battery interlock switch S702 (closed when front cover is removed) and switch S701A to diode CR603. This negative voltage passes through CR603 and is applied to the collector of emitter-follower regulator Q601. Unregulated voltage is taken from this point and directed to transformer T501. All other voltages are regulated by Q601. Transistor Q601 is connected as a series regulator with unregulated voltage applied to the collector and regulated voltage taken from the emitter. Resistor R602 provides forward base bias and Zener diode CR604 sets the level and regulating range.

(2) If emitter load current increases, the output voltage will drop (become less negative) in proportion to the voltage drop across Q601. This voltage drop is sensed by the base as a decrease in forward bias and causes Q601 to increase its internal resistance. The transistor then conducts less and tends to hold a constant output voltage. If emitter load current drops (output voltage decreases), the increase in forward base bias causes Q601 to decrease its internal resistance and increase voltage. The regulated output voltage is filtered by C704 and applied directly to the audio amplifier circuit and through switch S701A to the crystal oscillator. The variable frequency oscillators receive voltage through decoupling resistor R603 and switch S703D. In all positions of the FUNCTION SW, except MOD, Zener diode CR605 regulates the vfo voltage. With the switch set to MOD, the vfo voltage is modulated at 900 Hz rate.

b. Ac Line Operation.

(1) With the FUNCTION SW in any position except OFF, ac line voltage is applied through front panel receptacle P701, (through filter Z701 (AN/USM-159B only)) fuses F701 and F702, and line ballast lamp DS703 to T701. The ballast lamp limits the current in the T701 primary circuit. The secondary voltage is applied to full-wave rectifiers CR601 and CR602. Negative dc voltage is taken from the center tap of T701 and applied through deocupling resistor R601 to the regulator and T501. With this voltage, Q601 operates in the same manner as described for battery operation (*a* (1) above). The unregulated voltage is filtered by C703.

(2) The entire power supply output voltage is impressed on the anode of diode CR603 and, since the polarity of this voltage is opposite to that required for conduction, CR603 cannot conduct. This diode is used to switch from battery power to ac line power while the batteries remain connected in the circuit. Regardless of ac or battery operation, battery voltage is impressed on the cathode of CR603 and would normally pass through the diode. The main difference between ac and battery operation is that with ac operation, the negative voltage on the anode of CR603 us equal to, or slightly greater than, that applied to the cathode side. Diode CR603 acts like an open switch and cannot conduct.

(3) The power supply output voltage is also directed through resistor R605 to resistor R604 and voltmeter M701. Resistor R605 drops the voltage to 9 volts which is the same as the battery voltage. Although this voltage is added to the battery voltage from switch S701A, it has no affect on the batteries since the battery voltage is also 9 volts. Voltmeter M701 is basically a 0- to 1- milliampere meter converted to measure 10 volts full-scale with multiplier resistor R604. This panel meter provides a relative indication of battery voltage or. power supply rectified voltage. The meter has red and green scale divisions, with the red section starting at zero and the green section starting at 6.5 volts. Normal indication is approximately three-fourths of the green section. In figures 5-12 and 5-13, note that if battery operation is desired, the power cable must be unplugged from either the panel receptacle or the ac power source; otherwise, either the panel receptacle or the ac power source; otherwise, the unit will operate on ac power instead of batteries.

CHAPTER 6

GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

Section I. GENERAL

6-1. Voltage and Resistance Measurements

a. The frequency meter is transistorized. Observe all precautions given to prevent transistor damage. Make voltage and resistance measurements in the equipment only as specified. When measuring voltages, use tape or sleeving to insulate all but the extreme tip of the test prod.

CAUTION

A momentary short circuit can ruin the transistor; for example, if the bias is shorted out, excessive current between the emitter and the base would ruin the transistor. When resistance measurements are made on the transistor leads, the multimeter battery can destroy the transistor. For all resistance measurements, use only Multimeter TS-352B/U. Set the multimeter range to RX100. Any other range may damage the transistor.

b. Location of parts are given in figures 6-1 through 6-6.

c. Be sure that the power is on for voltage measurements, and off for resistance or continuity checks.

6-2. Equipment Test Points

The location and purpose of all circuit board test points are outlined in table 6-1. The exact location and the voltages are given in the references in the *Physical location* column.

6-3. Dc Resistances of Transformers and Coils

a. Before making resistance measurements of the windings, determine that the faulty operation is because of a defective transformer or coil. To do this, follow the troubleshooting procedures and make voltage and resistance checks.

b. Bear in mind that, because of rather broad winding tolerances during manufacture, resistances may vary from one transformer or coil to another; the table values are average values.

c. The dc resistances of the transformers and coils in the frequency meter are listed in table 6-2.

d. Location of parts are given in figures 6-1 through 6-6.

Table 6-1. Equipment Test Points

Test point	Physical location	Purpose
TP101	Low frequency vfo circuit board (fig. FO-2 (2) or FO-3 (2))	Measuring voltage drop across R106 (collector and base current of Q101).
T'P102		Measuring voltage drop across R109 (collector and base current of Q102).
TP201	Crystal oscillator circuit board (fig. FO-2 (1) or FO-3 (1)	Measuring emitter voltage of Q201 or rf signal output.
TP202		Buffer amplifier Q202 rf output.
TP301	Mixer circuit board	Measuring rf output signal of high frequency vfo.
TP302	(fig. FO-2 (1) or FO-3 (1)	Measuring diode CR302 biasing voltage on range A. Measuring rf output signal of low frequency vfo.
TP303		Voltage supply of Q301.
TP401	Audio amplifier circuit board	Q401 emitter bias.
TP402	(fig. FO-2 (1) or FO-3 (1)	Q402 emitter bias.
TP403		Q403 collector voltage.
TP501	Modulator circuit (fig. FO-2 (1) or FO-3 (1)	Q501 collector voltage. Measuring 900-hertz output signal.
TP502		Q501 emitter bias.
TP601	Power supply circuit board (fig. FO-2 (2) or FO-3 (2)	Q601 collector voltage. Voltage on anode of switching diode CR603. Modulator voltage supply.
TP602		Q601 base voltage.
TP603		Q601 emitter voltage.
TP604		Measuring vfo supply voltage.

Table 6-2. Dc Resistances of Transformers and Coils

Condition	Terminals or points of measurement	Transformer or coil	Ohm
RANGE SW in A. Resistance measured through terminals 5 and 7 of S703.	Primary of L102 in lf vfo coilbox.	TP101 and collector of Q101. 2-3 of Z101.	40
RANGE SW in B. Resistance measured through terminals 6 and 7 of S703.	Primary of L103 in lf vfo coilbox.	TP101 and collector of Q101. 1-3 of Z101.	0.5
RANGE SW in A position.	L303 on mixer circuit board.	Start to finish.	9
	L201 in crystal oscillator.	Start to L202 connection.	1
	L202 in crystal oscillator.	Start to L201 connection.	6
	L301, L304 in mixer.	Start to finish.	Less than 1
	T501 in modulator	1-2	10
		1-3	20
		4-5	1,300
	T701 power transformer.	1-2	500
		3-4	60
		3-5	120
	L2 in hf vfo.	Start to finish.	2,000

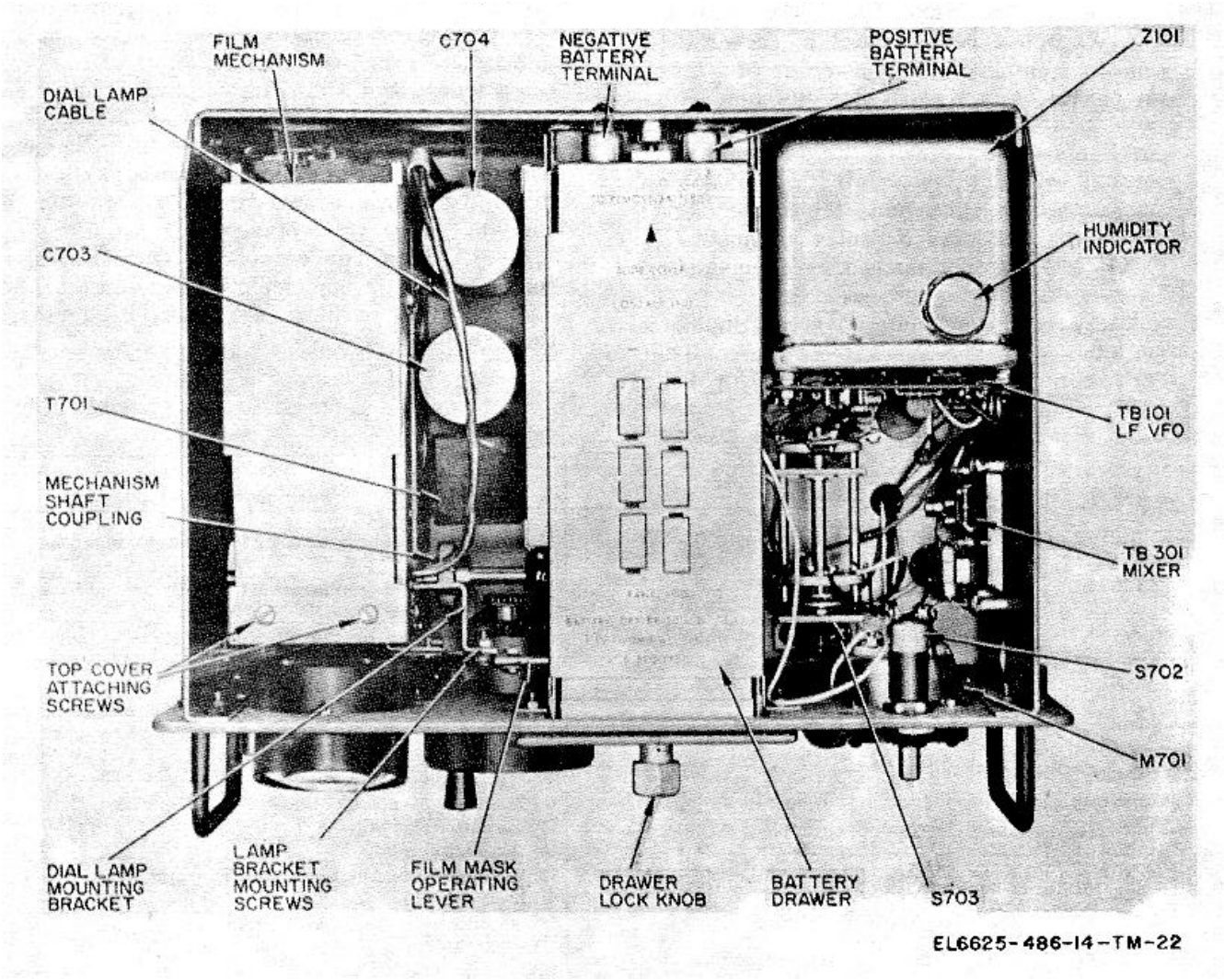


Figure 6-1. Frequency Meter FR-149(*)/USM-159, location of parts, top view.

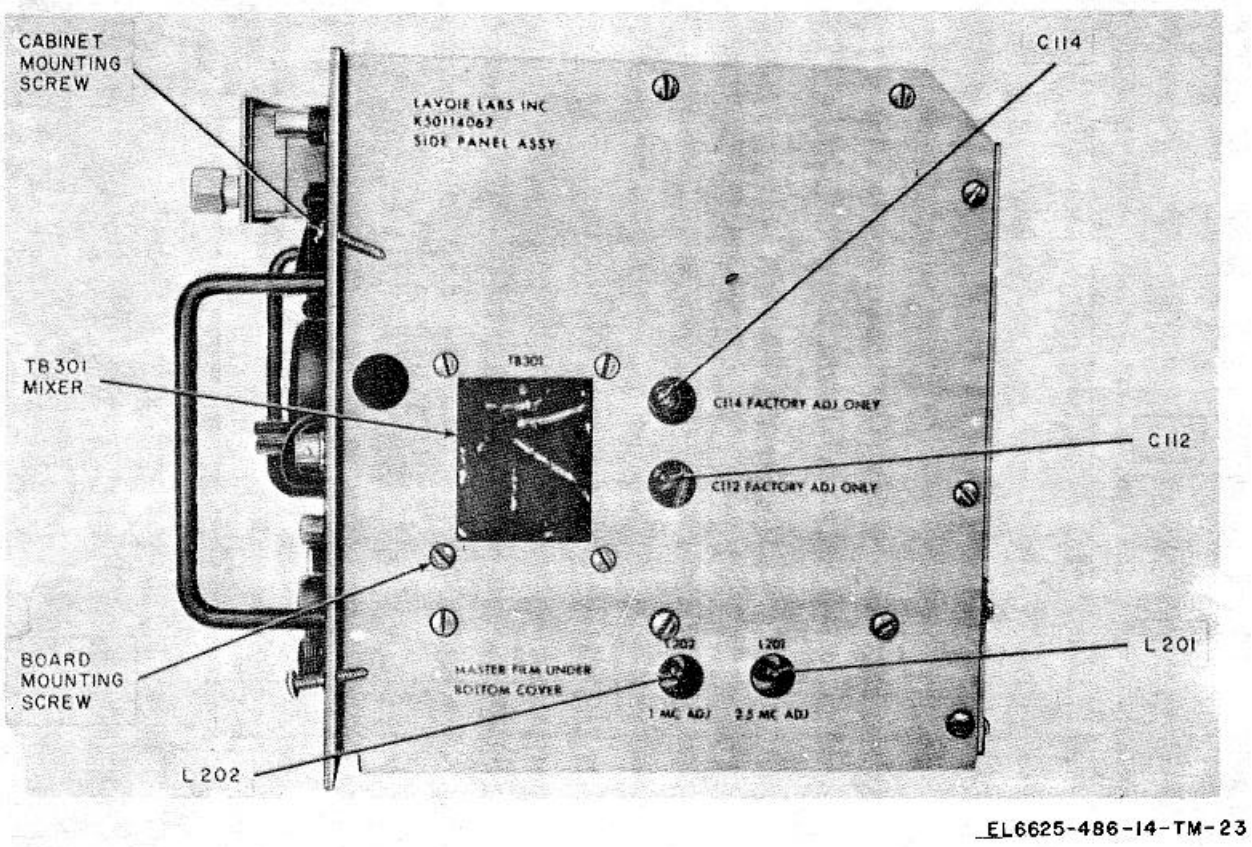


Figure 6-2. Frequency Meter FR-149(*)/USM-159, location of parts, right-side view.

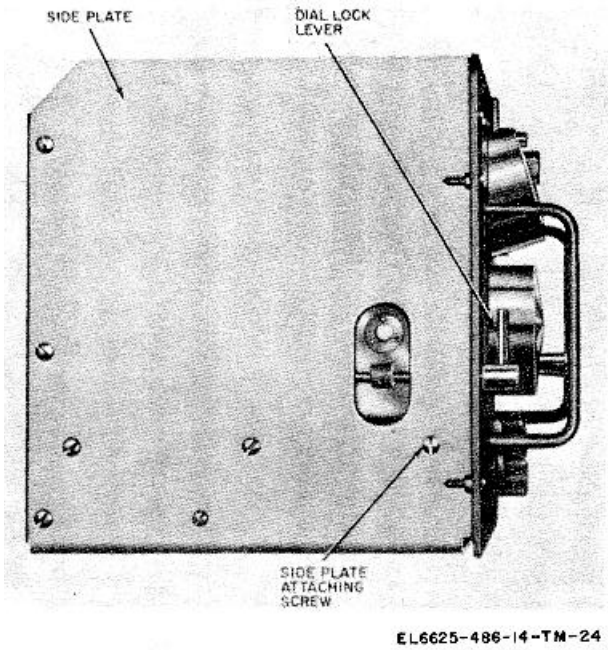


Figure 6-3. Frequency Meter FR-149(*)/USM-159, location of parts, left-side view.

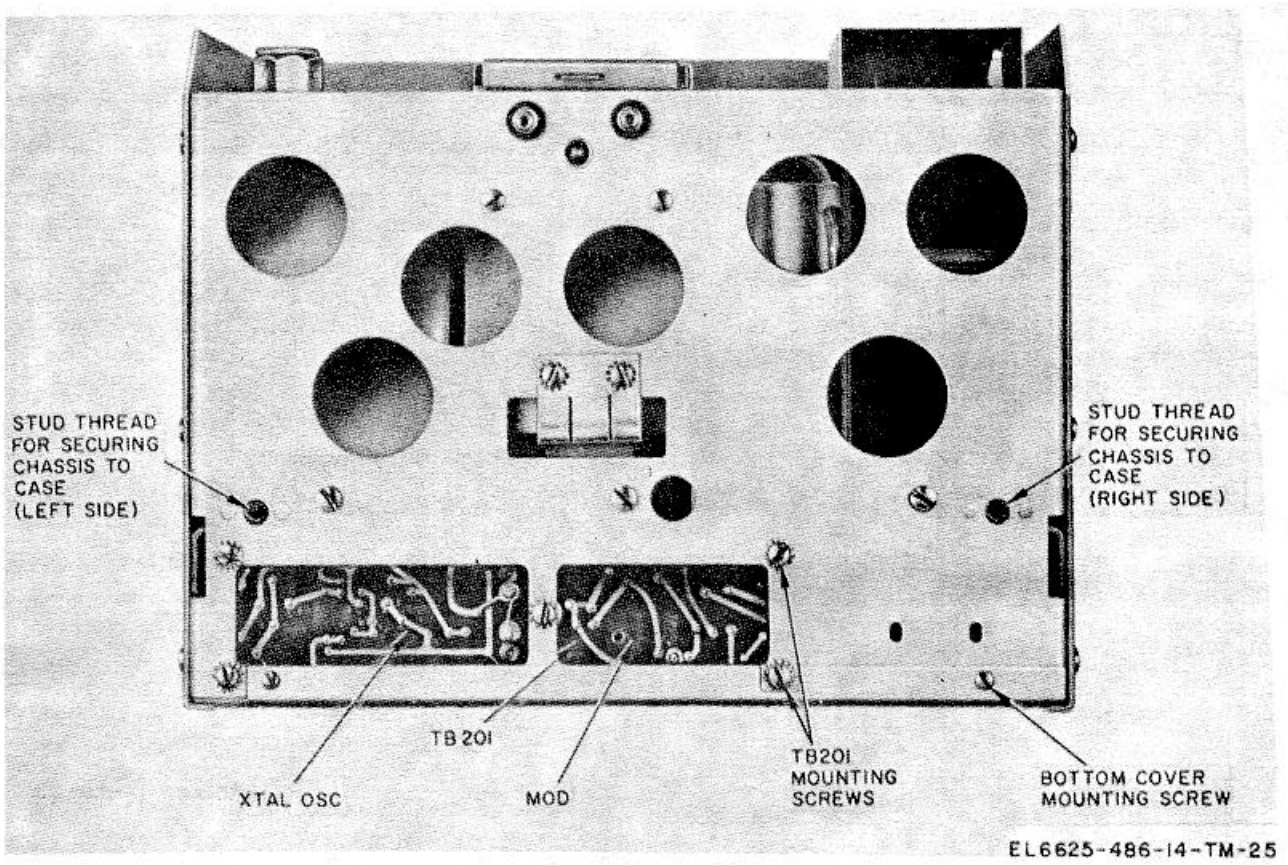


Figure 6-4. Frequency Meter FR-149(*)/USM-159, location of parts, rear view.

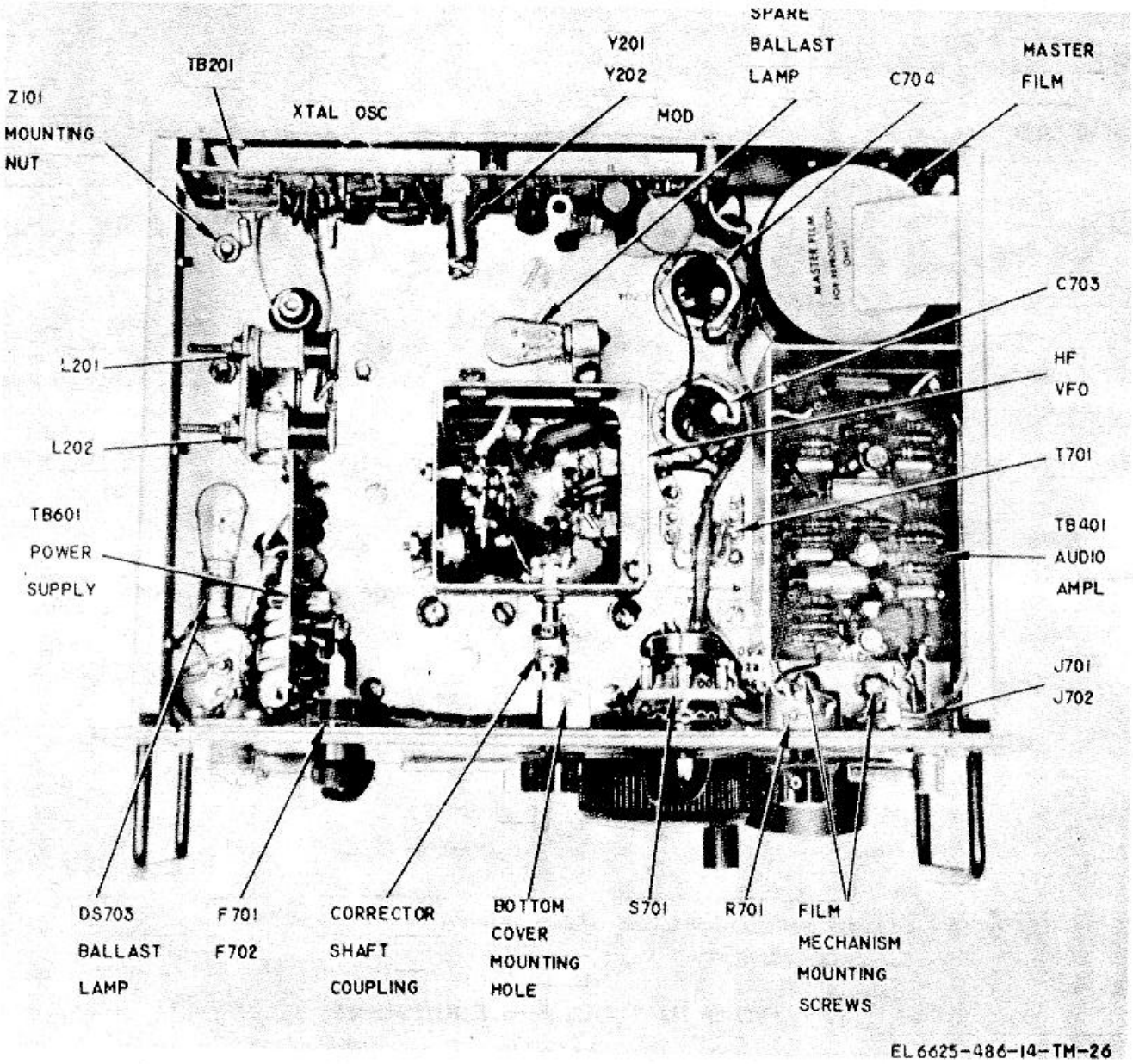


Figure 6-5. Frequency Meter FR-149/USM-159, location of parts, bottom view.

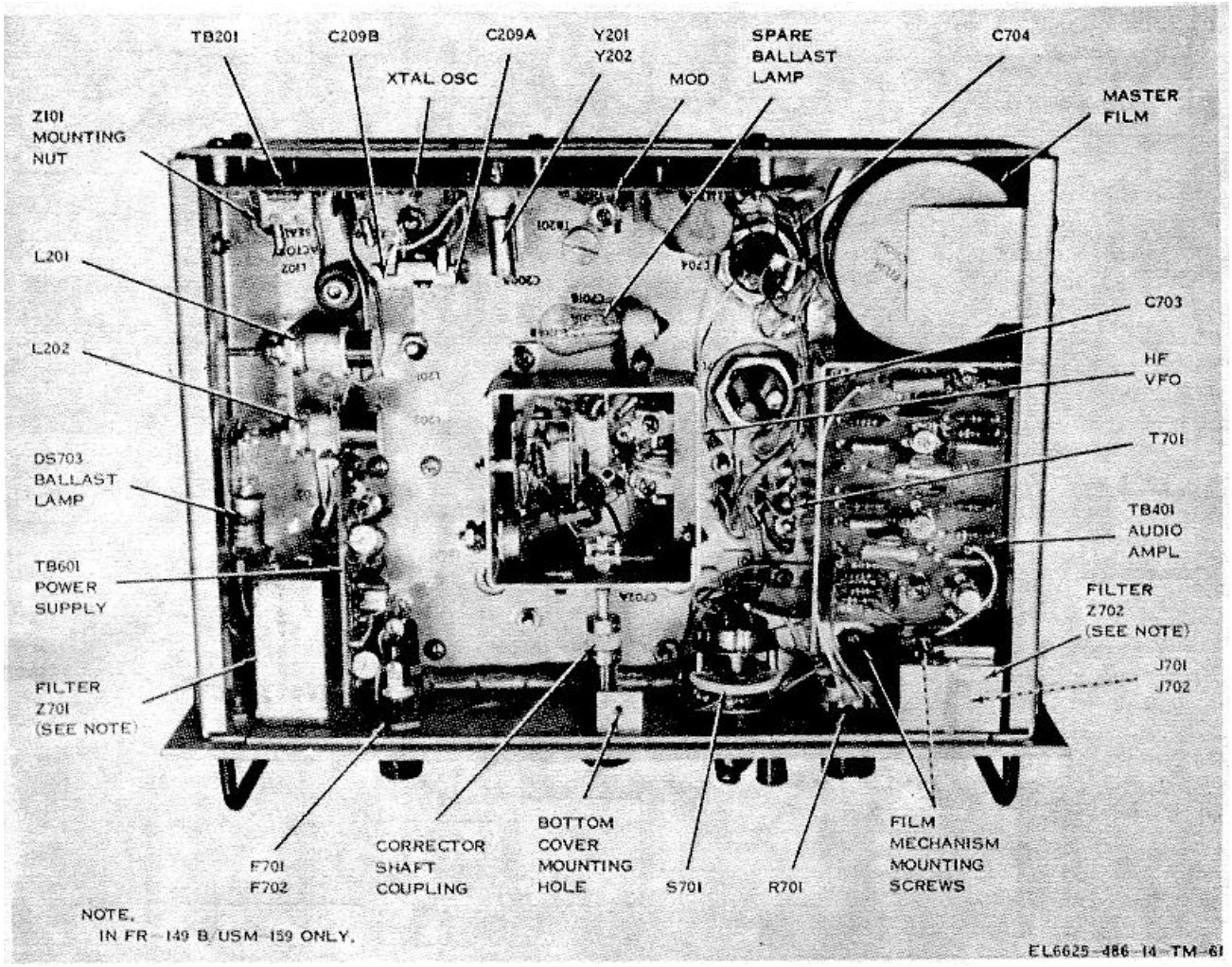


Figure 6-6. Frequency Meters FR-149A/USM-159 and FR-149B/USM-159, location of parts, bottom view.

Section II. TOOLS AND EQUIPMENT

6-4. General

Tools and test equipment authorized for general support maintenance are listed in appendix C.

Section III. TROUBLESHOOTING

6-5. General

Troubleshooting procedures at organizational maintenance include all the techniques outlined for operator maintenance and any special or additional techniques required to isolate a defective part. The systematic troubleshooting procedure, which begins with the checks that can be performed at operator maintenance, must be completed by sectionalizing, localizing, and isolating techniques.

6-6. Organization of Troubleshooting Procedures

a. General. The first step in servicing a defective frequency meter is to localize the fault. Localization means tracing the fault to the major circuit or stage responsible for abnormal operation. The second step is to isolate the fault. Isolation means tracing the fault to the part that is causing the trouble. Some faults, such as burned-out resistors, and arcing and shorted transformers, can

often be located by sight, smell, and hearing. The majority of faults, however, must be isolated by a check of voltages and resistance.

b. Localization. Frequency Meter FR149(*)/USM-159 consists of seven major circuits: crystal oscillator, modulator, low frequency vfo, high frequency vfo, mixer, audio amplifier, and power supply. The first step in tracing trouble is to locate the state or stages at fault by the following methods:

(1) *Visual inspection*. The purpose of visual inspection is to locate fualts without testing or measuring circuits. Observe the frequency meter panel voltmeter for indication of abnormally low power supply voltage. Midscale deflection of the frequency meter pointer indicates 6.5 volts. Normal operating voltage exists when the meter pointer swings to the right in three-fourths of the green scale. Pay particular attention to filmstrip lighting. If the filmstrip is not lighted, either the dial lamps are defective or the modulator is inoperative. Observe all other visual signs, and attempt to localize the fault to a particular stage.

(2) *Operational tests*. Operational tests often indicate the general location of trouble. In some instances, the tests will help in determining the exact nature of the fault. The procedures in table 4-4 provide a good overall check of operation.

c. Isolation. The tests and information listed below will help in isolating the trouble. First localize the trouble to a single stage or circuit; then, isolate the fault within that circuit by voltage, resistance, and continuity measurements.

(1) *Signal tracing.* Signal tracing (para 6-9) will help in localizing the trouble to the stage at fault.

(2) *Signal substitution.* Signal substitution procedures (para 6-12) enable the repairman to isolate trouble in the audio circuits. An audio oscillator and headset are typical units of equipment that may be used in signal substitution procedures.

(3) *Troubleshooting charts.* The trouble symptoms and procedures listed in table 6-3 will help in isolating trouble to a component part.

6-7. Checking B + Circuits for Shorts

a. If an operational failure occurs when the frequency meter is operated on battery only, check the amount of dc current required by the frequency meter. A convenient method of measuring this current is given below:

(1) Turn the frequency meter FUNCTION SW to OFF and unplug the power cable.

(2) Turn the multimeter FUNCTION switch to DC CURRENT and the RANGE switch to 100 MA.

(3) Plug a test lead (negative) into the OHMS -DC ± AC jack and another test lead (positive) into the +DC CURRENT jack.

(4) Remove the frequency meter from its case.

(5) Looking down on the top of the meter chassis, locate a white wire connected to the left switch terminal and a black wire connected to the right switch terminal of the panel interlock switch.

(6) Hold the negative test prod on the left switch terminal and the positive test prod on the right switch terminal.

(7) To read dc current, turn the frequency meter FUNCTION SW to OPER and push in on the battery interlock switch plunger. The multimeter should indicate 50 mA ± 2. If the current drain differs, turn the frequency meter FUNCTION SW to OFF and remove the battery drawer. Make resistance measurements in the battery wiring circuit. Be sure that the wiring is not grounded and the battery interlock switch operates properly. An ohmmeter measurement from B- in the battery circuit to ground should indicate at least 10,000 ohms.

b. If the frequency meter operates on batteries but not on ac power and the trouble is not an open fuse, check to see that the ballast lamp (fig. 6-5 or 6-6) glows. If the lamp does not glow, measure its internal resistance. Resistance should be approximately 200 ohms (cold). The combined resistance of the primary of power transformer T701 and ballast lamp DS703 can be measured from the plug end of the power cable. With the frequency meter FUNCTION SW set to OPER, measure the resistance between the two flat connectors of the plug. Resistance should be approximately 700 ohms. A measurement from either connector to ground should read infinity. If the trouble still persists, the most common form of trouble is a shorted capacitor in the distribution circuit. The quickest method of isolating a defective capacitor is to make a resistance measurement from either TP601 or TP603 (table 6-1) to ground. The voltage and resistance diagram of the power supply (fig. FO-2 (2) or FO-3 (2) shows the proper values for all major points as measured from the point indicated to ground.

6-8. Troubleshooting Table

The troubleshooting table (table 6-3) is designed to supplement operational checks. Begin with sequence number 1 and proceed until the malfunction is located.

CAUTION

Be sure that the power is on when making voltage measurements and off for resistance or continuity checks.

WARNING

Be extremely careful when working on the power supply circuit or the ac line connections. Serious injury or death may result from contact with these points.

Table 6-3. Troubleshooting

Malfunction	Probable Cause	Corrective Action
1. Frequency meter operates normally on batteries, but not on ac power.	Fuse F701 or F702 blown.	Replace fuse.
	Ballast lamp DS703 open.	Check resistance (200 ohms) and replace if necessary.
	Wiring in power cable	Check continuity and repair.
	Power switch S701B defective.	Replace switch.
	Primary of T701 open.	Check resistance of primary winding (table 6-2) and replace transformer if necessary.
	No power supply output voltage from secondary winding of T701.	On power supply circuit board (fig. FO-2 or FO-3) check dc voltage from TP601 to ground. If indicated voltage is not present, check ac voltage between terminals 1-5 and 5-6 of board. If no ac voltage exists, replace T701.
	Resistor R601 open.	Replace R601.
	Diode rectifier CR601 or CR602 defective.	Replace diode.
	Secondary winding of T701 open.	On power supply circuit board measure dc resistance between terminals 5 and 6 and then between 5 and 1. If resistance differs appreciably from 60 ohms, replace T701.
2. Frequency meter operates normally on ac power, but not on batteries.	Battery power interlock switch S702 not closing battery circuit.	Remove battery drawer. Check continuity through switch and replace S702 if necessary.
	Function switch S701 not completing circuit.	Check continuity from terminal (black wire) of battery interlock switch S702 to cathode side of CR603 (fig. FO-6). When checking continuity, remove battery drawer and turn FUNCTION SW to OPER. If circuit is open, replace switch DS701.
	Switching diode CR603 defective.	If battery voltage is present at junction of R604 and CR603 but not on TP601, replace CR603.
3. Frequency meter operates normally on batteries, but panel voltmeter does not indicate.	Voltmeter M701 multiplier resistor R604 open.	Replace R604.
	Voltmeter M701 defective.	Replace M701.
4. Frequency meter operates normally on ac power, but panel voltmeter does not indicate.	Voltage dropping resistor R605.	Replace R605.
	Multiplier resistor R604.	Replace R604.
	Meter M701 defective.	Replace M701.
5. Frequency meter inoperative on either batteries or ac power.	Capacitor C702 or C704 shorted.	Check voltages on TP601, TP602, and TP603 (collector, base, and emitter of Q601) (fig. FO-2 or FO-3). Check forward and reverse resistance at the above test points If no voltage exists at TP601 and a resistance measurement to ground indicates only a few ohms, replace capacitor C703 (fig. 6-1). If a low resistance exists from TP603 to ground, replace capacitor C704.
	Regulator Q601 base bias resistor R602.	Check voltage on TP602 (base of Q601) (fig. FO-2 or FO-3) and replace R602 if necessary.
	Zener diode Z601.	Check resistance from TP602 to ground. If resistance is low, replace Z601.
	Regulator Q601.	Replace Q601.

Table 6-3. Troubleshooting-Continued

Malfunction	Probable Cause	Corrective Action
6. Frequency meter inoperative in all ranges and functions, but noise can be heard when headset is plugged into PHONES jack.	No voltage on either vfo.	On power supply circuit board check voltage on TP604. If no voltage exists, check R603 and replace if necessary.
	Range switch wafer S703A not completing circuit.	With power off, check continuity through S703A contacts 9, 10, 11, and 12 and replace switch if necessary.
7. No frequency meter output signal at ANT. jack when FUNCTION SW set to OPER, and RANGE SW is in either A or B.	No voltage in low frequency vfo circuit.	On low frequency vfo circuit board, use vtvm and measure dc voltage on test points TP101 and TP102 (fig. FO-2 or FO-3). If voltages are not as indicated, make resistance measurements between test points and ground. Be sure that vfo supply voltage is present at test point TP604 on power supply circuit board (fig. FO-2 or FO-3).
	If no voltage exists at TP101, capacitor C104 may be shorted.	Replace C104 if shorted.
	If no voltage exists at TP102, capacitor C105 may be shorted.	Replace CR105 if shorted.
	No voltage on buffer amplifier Q102.	Check collector, base, and emitter voltages with vtvm. If voltages are not as indicated, remove power and make forward and reverse resistance measurements on Q102. Replace Q102 if necessary.
	No voltage on Q101.	With vtvm, check collector, base, and emitter voltages, if voltages are not as indicated in figure FO-2 or FO-3, make resistance measurements and replace Q101 if necessary. **NOTE** **If base bias voltage of Q101 changes appreciably, replace diode CR101.**
8. No frequency meter output signal at ANT. jack when FUNCTION SW set to OPER, and RANGE SW in A position. Operates normally in B or C position.	Voltage supply through coil-box Z101 not being applied to collector of Q101.	With vtvm, check voltage on TP101 (fig. FO-2 or FO-3). If voltage is normal, check collector voltage of Q101. If voltage is not present, Turn power off. With the multimeter, check resistance between TP101 and collector of Q101. If an open circuit exists and trouble is not due to switch S703, replace coilbox Z101 (para 6-20).
	Coil L102 open, or S703 not making contacts.	
9. No frequency meter output signal at ANT. jack when RANGE SW is in B position.	Coil L103 in Z101 open.	Check resistance between TP101 and collector of Q101. Replace Z101 if necessary.
	Q101 not oscillating.	Perform low frequency vfo signal tracing procedures given in paragraph 6-9b.
		Check emitter bias resistor R103 and replace if necessary.
	Aging of coil L103 in Z101.	Replace Q101 if necessary.
10. Insufficient rf output signal in A only.	Peaking coil L105 (on collector of Q102) in AN/USM-159 or resistor R102 in AN/USM-159A and AN/USM-159B defective.	Replace L105 (fig. FO-2 (2)) or (in AN/USM-159A and AN/USM-159B) R102 (fig. FO-3 (2)).
11. CORRECTOR control does not correct vfo to crystal checkpoint on A and B.	Capacitor C705 defective.	Replace C705 (fig. FO-2 or FO-3).

Table 6-3. Troubleshooting- Continued

Malfunction	Probable Cause	Corrective Action
12. Little or no harmonic output signals at ANT. jack.	Harmonic generating diode CR301 in mixer circuit.	Replace CR301.
13. No frequency meter output signal at ANT. jack when FUNCTION SW set to OPER, and RANGE SW is in C position.	No voltage on vfo circuit.	With vtvm, measure dc voltage at the junction of R5, C8 and L2.
	Capacitor C8 shorted.	Replace C8.
	Capacitor C10 shorted.	Replace C10.
	No voltage from power supply.	Check voltage from TP604.
	Incorrect voltage on buffer stage Q2.	With figure FO-2 or FO-3, check voltage on Q2. If voltages do not agree, turn power off and make forward and reverse resistance measurements. Replace Q2 if necessary .
	Incorrect voltages on oscillator stage Q1.	Make voltage and resistance Measurements and replace QI if necessary; then adjust R4.
	No rf signal on base of Q2.	Perform the signal tracing procedure (para 6-9).
	Transistor Q1 not oscillating.	Pay particular attention to the voltages on the emitter and base of Q1. If these voltages vary over 5 percent from figure FO-2 or FO-3, adjust R4. If correct voltages cannot be obtained, replace Q1.
	R3 or R6 defective.	Replace R3 or R6.
14. Little or no harmonic output signals at ANT. jack.	Harmonic generating diode CR303 or C304 in mixer circuit.	Replace CR303.
15. With FUNCTION SW set to CHK, and RANGE SW in any position, no beat notes can be heard in frequency meter headset.	Headset defective.	Check headset.
	Audio amplifier circuit defective.	Refer to steps 22 and 23 below.
	Mixer circuit.	Refer to steps 18 through 21 below.
	Function switch S701 not making contact.	Check continuity through S701 and replace switch if necessary.
	No voltage from power supply.	Check for presence of voltage at TP603 on power supply circuit board (fig. FO-2 or FO-3).
	Capacitor C206 shorted.	Replace C206.
	Incorrect or no voltages on buffer stage Q202.	Check voltages on base, collector, and emitter of Q202. With power off, make resistance measurements and replace Q202 if necessary.
	Incorrect or no voltages on oscillator stage Q201.	Check voltages on base, collector, and emitter of Q201. If there is no voltage on the collector of Q201, turn power off and check resistance of L201 and L202 (table 6-2). Replace coil if necessary.
16. With FUNCTION SW set to CHK, and RANGE SW in either A or B position, no beat notes can be obtained.	1-MHz crystl1-MHz crystal Y202 defective.	Replace crystal. Adjust 1-MHz frequency (para 6-26).
	Capacitor C202 or C203 defective.	Replace C203.
	Low frequency to vfo inoperative.	Refer to steps 7, 8, and 9 above.
17. With FUNCTION SW set to CHK, and RANGE SW in C position, no beat notes can be obtained.	2.5-MHz crystal Y201 defective.	Replace crystal. Adjust 2.5-MHz frequency (para 6-26).
	Capacitor C202 or C203 defective.	Replace C202.
	High frequency vfo inoperative.	Refer to step 13 above.
18. With FUNCTION SW set to CHK and RANGE SW in any range, no beat notes can be heard in meter headset.	Headset defective.	Check headset and wiring.
	Audio amplifier.	Refer to steps 22 and 23 below.
	Crystal oscillator.	Refer to steps 15 through 17 above.
	No voltage on mixer circuit.	With vtvm, check voltage on test point TP303 (table 6-1). Voltage should agree with diagram.
		Check voltage on TP603 on power supply circuit board (table 6-1).
	Capacitor C303.	If shorted, replace.
	Incorrect or no voltages on Q391.	Check voltages on base and collector of Q301. Replace Q301 if necessary.

Table 6-3. Troubleshooting-Continued

Malfunction	Probable Cause	Corrective Action
	Choke L303 open.	With power off, check resistance of L303 (para 6-9), and replace if open.
	Coupling capacitor C302 or C304.	Replace capacitor.
19. With FUNCTION SW set to CHK, and RANGE SW in A position, only weak beat notes can be obtained.	Diode CR302 defective.	Check forward and reverse resistance of diode, and replace diode if reverse resistance is not at least 10 times greater than forward resistance. Make forward resistance check with common test prod of multimeter on cathode side of diode and positive test prod on anode of diode. For the reverse resistance check, use positive test prod on cathode and common test prod on anode of diode.
	Insufficient diode biasing voltage (in AN/USM-159 only).	With vtvm, measure bias voltage on TP302 (mixer board). If 0.09 volt is not present, check resistor R308 connected from TP302 to contact 5 of S703 (fig. FO-6).
20. With FUNCTION SW set to OPER, and RANGE SW in range A or B, little or no harmonic output signals appear on ANT. jck.	Diode CR301 defective.	Unsolder one end of R302. Check forward and reverse resistance of diode and replace if defective.
21. With FUNCTION SW set to OPER, and RANGE SW in C position, harmonic output signals are weak.	Diode CR303 or CR304 defective.	The two diodes are connected back-to-back and the voltage measured on TP301 (junction of diodes) should be anything from 0 to 0.06 volt. The voltage may be either positive or negative with respect to the meter chassis depending on which diode is conducting the most. If the diodes are suspected, unsolder one diode from the board ground and check forward and reverse resistance. If the voltage exceeds 0.06 volt, one diode is not conducting properly.
22. No audio tone on noise heard in headset when AUDIO GAIN Control is turned fully clockwise.	Headset or wiring.	Check headset and wiring repair; repair if necessary.
	Coupling capacitor C410 open.	Replace C410.
	Incorrect voltages on Q403.	With AUDIO GAIN control fully ccw, measure the base and collector voltages of Q403. When AUDIO GAIN control is advanced, the B- voltage on the base and collector should increase.
		Measure the B- voltage at TP603 on the power supply circuit board. If present, trouble is in audio amplifier. (Refer to following steps).
	Resistor R402 defective.	Replace R402.
	Coupling capacitor C406 open.	Replace C406.
	Resistor R409 defective.	Replace R409
	Q403 defective.	Replace Q403
	No voltage on Q402.	Check voltage on Q402.
	Resistor R407 defective.	Replace R407.
	Resistor R405 or R406 defective.	Replace R405 or R406 if defective.
	Q402 defective.	Replace if necessary.

Table 6-3. Troubleshooting-Continued

	Malfunction	Probable Cause	Corrective Action
23.	Noise output signal louder than audio tone.	Capacitor C403 or resistor defective.	Replace capacitor or resistor if defective.
		Incorrect voltages on Q401.	Check voltages according to figure FO-2 or FO-3 and replace Q401 if necessary.
		Capacitor C409 open.	Replace C409.
		Audio output stage Q403 not performing the proper noise limiting action.	Check base and collector voltages and perform forward and reverse Resistance measurements. Replace Q403 if necessary.
24.	Noise present but no audio signal.	No output signal from mixer circuit.	Check mixer circuit and perform the signal tracing procedures in paragraph 6-9.
25.	When FUNCTION SW set to MOD, filmstrip is lighted but no audio tone can be heard in frequency meter headset.	Modulated signal not being applied to vfo supply voltage because switch S701A or Zener diode Z602 is defective.	Set up conditions for test according to figure 6-7. On vtvm, set FUNCTION to AC and RANGE to 3V. With ac probe, connect ground clip to chassis and touch the probe to TP604 on power supply circuit board. If the signal indicated in figure 6-7 cannot be obtained, make continuity checks through switch S701 to Zener diode Z602. Be sure that the cathode side of Z602 is not grounded when switch S701 is set to MOD. The modulated signal is applied through Z602 to test point TP604 which is the vfo supply voltage point. The forward resistance of Z602 should be approximately 800 ohms and the reverse resistance about 1,500 ohms. Replace Z602 if necessary.
26.	When FUNCTION SW is set to MOD, no aduio tone can be heard in frequency meter headset and filmstrip is not lighted.	Audio oscillator Q501 not oscillating.	Refer to the test setup in figure 6-8. On vtvm, set FUNCTION to AC and RANGE to 10V. With ac probe, connect ground clip to chassis and touch probe to TP501 on modulator circuit board.
		No B- voltage on collector of Q501.	With vtvm for measuring dc, measure the collector voltage at TP501.
		Primary winding of T501 open.	Replace T501.
		No voltage on base of Q501.	Check resistance of R501 and R502 and replace the defective resistor. Perform forward and reverse resistance measurements on Q501 and replace Q501 if necessary.
		Capacitor C501 defective or open.	Replace C501.
		Capacitor C504 shorted.	Replace C504 and Q501.
		Capacitor C505 defective.	Replace C505.
27.	When FUNCTION SW is set to MOD, audio tone heard in frequency meter headset, but filmstrip is not illuminated.	Neon lamp DS701 or DS702 defective.	Replace lamp (para 6-23).
		Current limiting resistor R702 or R703 defective.	Check and replace defective resistor (para 6-23).
		Transformer T501.	Measure resistance of T501 (table 6-2) and replace transformer if necessary.

6-9. Signal Tracing Procedures

Tracing the internally generated signals throughout the frequency meter will help in localizing trouble to a major circuit or stage. This method of troubleshooting is the process of checking for the presence or absence of a signal at both the input and output of circuits or stages. Proper use of the troubleshooting table, in conjuction with the signal tracing procedures, may isolate the trouble. To make full use of this information, a separate signal tracing procedure is given for each major circuit. Each procedure outlines the points of signal measurements and the relative value of the ac signal obtained with the vtvm. If the signal is absent, or differs appreciable from the ac value indicated, refer to the troubleshooting table.

NOTE

Since all ac signals in the meter are complex waveforms, a vtvm will not indicate the true rms values.

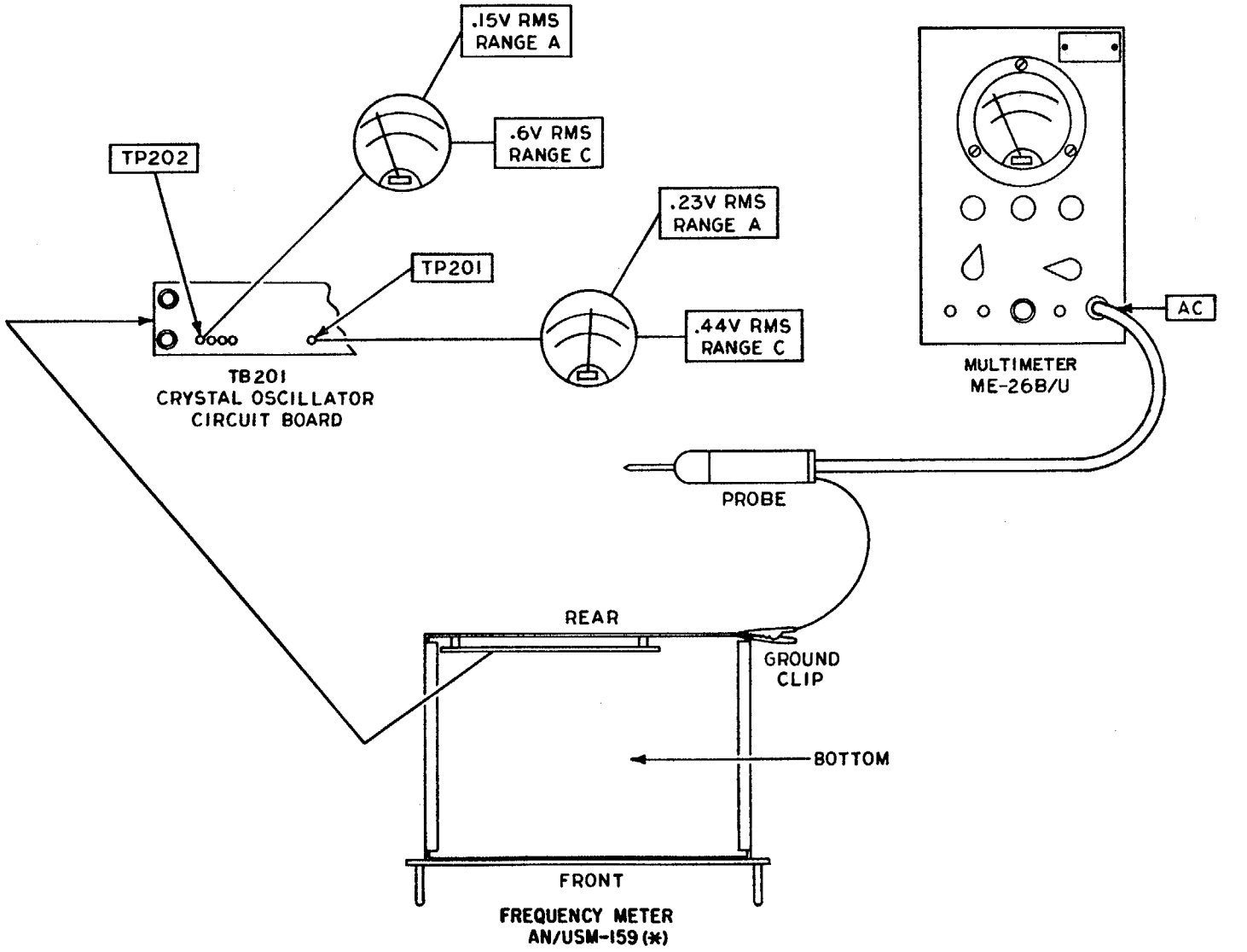


Figure 6-7. Crystal oscillator signal tracing.

a. Tracing Crystal Oscillator Signal. When performing this procedure, use the vtvm rf probe and the test setup shown in figure 6-7. Locate test points TP201 and TP202 on the crystal oscillator circuit board (table 6-1) and proceed as follows:

(1) Turn the vtvm FUNCTION to AC and RANGE to IV.

(2) Connect the vtvm ac probe ground clip to a convenient point on the frequency meter chassis. Hold the ac probe tip on test point TP202 (fig. 6-7).

CAUTION

Do not let the probe tip come in contact with any other circuit board connection.

(3) While holding the ac probe on test point TP202, turn the frequency meter FUNCTION SW to CHK and the RANGE SW to A. If the 1-MHz output signal measured at this point does not agree with that shown in figure 6-7, troubleshooting is required. The signal on TP202 is the buffer output of Q202.

(4) To measure the emitter-follower output signal of oscillator Q201, touch the probe tip to test point TP201. If signal voltage does not agree with figure 6-7, transistor Q201 is not oscillating properly.

(5) To measure the 2.5-MHz output signal, turn the frequency meter FUNCTION SW to CHK and the RANGE WS to C. Touch the ac probe tip to test points TP201 and TP202.

(6) The absence of a signal at TP201 for both the 1-MHz and the 2.5-MHz crystal frequencies indicates that Q201 is not oscillating because of a defective transistor or circuit component. No output signal at either the 1-MHz (ranges A or B) or the 2.5-MHz (range C) frequencies would indicate a defective crystal. The presence of a signal on TP201 and absence of a signal on TP202 indicates trouble in buffer stage Q202.

b. Signal Tracing Low Frequency Vfo Signal. This circuit has no test points for signal tracing but its activity can be checked as follows:

(1) On the low frequency vfo circuit board (fig. FO-2 (2) or FO-3 (2) and 6-24 or 6-25) locate the collector connections of Q101 and Q102. Transistor Q101 is the oscillator and Q102 the buffer.

(2) Turn the vtvm FUNCTION to AC and the RANGE to 10V. Connect the ac probe ground clip to the meter chassis and hold the probe tip on the collector of Q101.

(3) Turn the frequency meter FUNCTION SW to OPER. Take one voltage measurement with the RANGE SW on A and the other on B. The vtvm should indicate 4 volts for range A and 4.1 volts for rangel B. Rotate the frequency meter TUNING control and note that the output signal varies with the frequency.

(4) Turn the vtvm RANGE to 1V. Touch the probe tip to the collector of Q102. The vtvm should indicate 0.14 volt on range A of the frequency meter and 0.3 volt on range B.

(5) A relative signal tracing check of vfo output signal can also be made at the collector of mixer Q301. The collector soldered connection can be reached through the right sideplate cotout of the frequency meter chassis (fig. 6-2).

(6) The ac signal at, this point, for the same vfo frequencies given in (1) through (5) above, should be approximately 2.4 volts on range A and 0.88 volt on range B.

c. Signal Tracing High Frequency Vfo Signal. This circuit has no test points for signal tracing but its activity can be checked as follows:

(1) In the high frequency fvo circuit (fig. FO-2 (2) or FO-3 (2)), locate the collector connection of oscillator Q1.

(2) Turn the vtvm FUNCTION to AC and the RANGE to 1V. Connect the ac probe ground clip to the vfo side panel chassis ground. Touch the ac probe tip to the collector of Q1 or the junction connection of L1 and C702B.

(3) Turn the frequency meter FUNCTION SW to OPER and the RANGE SW to C. Set the frequency meter dial to 65 MHz. With this frequency, the vtvm should indicate 0.26 volt.

(4) The buffer output signal of Q2 must be measured at test point TP301 on the mixer circuit board (fig. FO-2 (1) or FO-3 (1)). At TP301, the signal should be 0.16 volt.

NOTE

The above signal values will gradually decrease with increasing frequency.

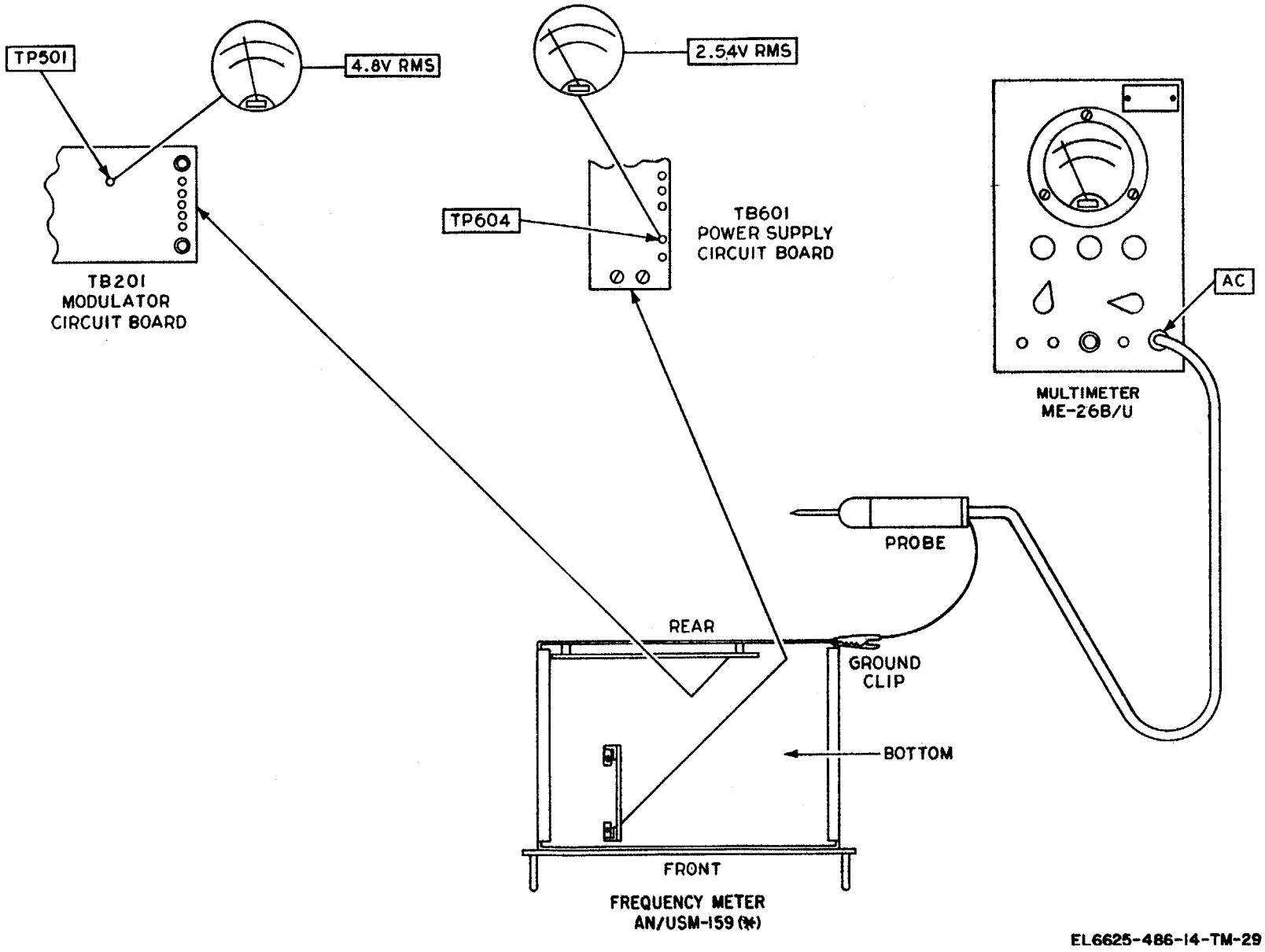


Figure 6-8. Modulator signal tracing.

d. Tracing Modulator Signal. When performing the signal tracing check below, refer to the test setup in figure 6-8. Locate test point TP501 on the modulator circuit board and TP604 on the power supply circuit board; then proceed as follows:

(1) Turn the vtvm FUNCTION to AC and the RANGE switch to 10V. Turn the frequency meter FUNCTION SW to MOD and the RANGE SW to any range.

(2) To measure the modulator 900-hertz ac output signal of oscillator Q501, connect the vtvm probe ground clip to the meter chassis and touch the ac probe tip to TP501. The vtvm should indicate 4.8 volts.

(3) To trace the 900-hertz ac signal where it modulates the vfo B- voltage, touch the ac probe tip to TP604 (power supply). The vtvm should indicate 2.54 volts.

6-10. Fabrication of Dummy Load

Some of the tests require a 600-ohm dummy load. The materials required to construct the dummy load are listed below. Construct the dummy load as shown in figure 6-9 and outlined below:

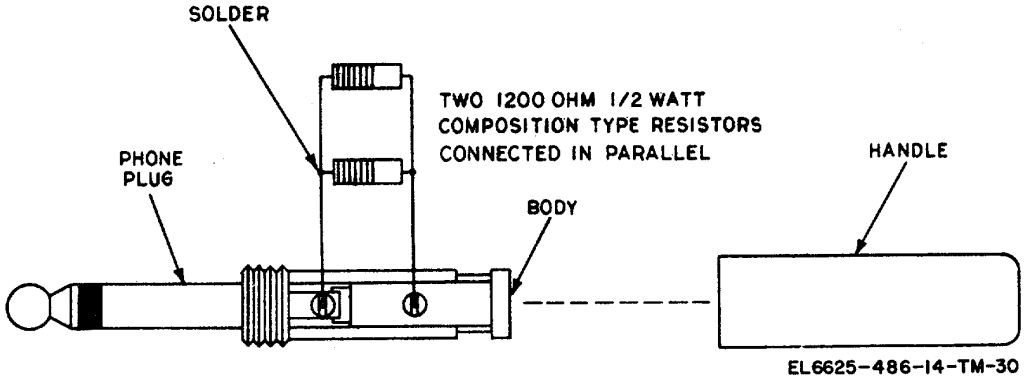


Figure 6-9. Dummy load fabrication diagram.

a. The following materials are required to fabricate the dummy load:

(1) Resistor, 1/2 watt, 1,200 ohms (2 each).
(2) Phone plug.
(3) Screw, 2-56 x 1/4 (2 each).

b. Remove the handle from the phone plug.

c. Connect the two 1,200-ohm resistors in parallel and solder the leads; then connect the two leads to the phone plug terminals.

d. When a 600-ohm dummy load is specified for any of the following tests, insert the dummy load phone plug into one of the frequency meter PHONES jacks. If any difficulty is experienced in connecting test equipment to this phone plug, use a spare plug and insert the plug into the other frequency meter PHONES jack; then connect the test equipment to this plug.

NOTE
If a 600-ohm resistor is available, use it as a dummy load instead of the two 1,200 ohm resistors.

6-11. Signal Tracing of Internally Generated Signals Through Audio Amplifier

Signal tracing of generated signals through the audio amplifier may be accomplished by use of either the internal modulator or the crystal oscillator, provided the vfo signal is present. Use the 600 ohm dummy load constructed according to paragraph 6-12. Plug the dummy load into a PHONES jack and proceed as follows:

NOTE
Do not plug in the headset.

a. Using Internal Modulator. For these tests, use the vtvm ac probe. Turn the vtvm FUNCTION to AC and the RANGE to 3V.

(1) Turn the frequency meter FUNCTION SW to MOD and the RANGE SW to A. Rotate the AUDIO GAIN control fully clockwise.

(2) First measure the modulated vfo signal at the collector of mixer Q301. This point can be reached through the right side-panel output of the meter (fig. 6-2). Connect the ac probe ground clip to the chassis and the probe tip to the collector of Q301. The vtvm should indicate 2.7 volts.

(3) The next step is to trace the signal at the output of the first audio amplifier stage. Refer to figures FO-2 (1) and 6-5 or 6-6 to locate transistor Q401. Touch the ac probe tip to the collector of Q401. The vtvm should indicate 1.5 volts.

(4) Locate transistors Q402 and Q403. The vtvm should indicate 0.8 volt at the collector of Q402 and 1.6 volt at the collector of Q403.

(5) From the above tests, it should be evident that if a signal does not exist at any particular signal tracing point, the trouble may be assumed to be in that stage.

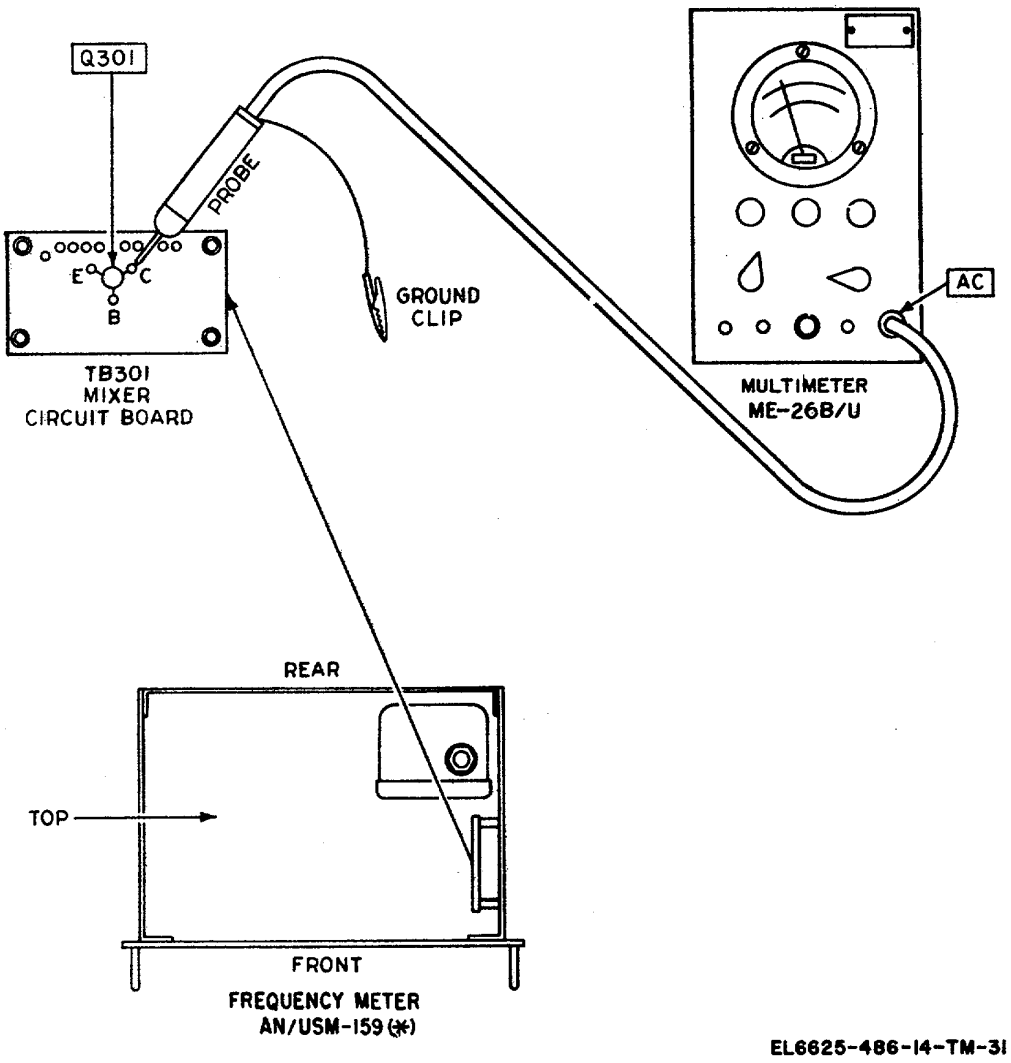


Figure 6-10. Mixer signal tracing.

b. Using Crystal Oscillator. For these tests, use the vtvm ac probe. Turn the vtvm FUNCTION switch to AC and the RANGE SW to 3V.

(1) Turn the frequency meter FUNCTION SW to CHK and the RANGE SW to A. With the TUNING control, turn the frequency meter to the 250-kHz checkpoint (horizontal arrow pointing to right). Turn the CORRECTOR control to the midrange.

(2) Refer to figure 6-10 and measure the ac signal on the collector of Q301. The vtvm should indicate 2.3 volts.

(3) With the vtvm ac probe, measure the ac signal at the collectors of Q401, Q402, and Q403. The vtvm should indicate ac signals of 1.5 volts on Q401, 1.4 volts on Q402, and 1.6 volts on Q403.

6-12. Audiofrequency Signal Substitution

Audiofrequency (af) signal substitution procedures help to localize troubles to a section or stage in the audio amplifier. An externally generated af signal is substituted for the signal normally present.

Ground one side of the AN/URM-127 at a convenient point on the frequency meter chassis and connect the other side to the test point indicated.

CAUTION

In this equipment, the transistors can be damaged by excessive input signals. Do not apply input signals greater than the levels specified in the tests below.

a. Plug the headset into the frequency meter PHONES jack.

b. Turn the frequency meter FUNCTION SW to OPER and the RANGE SW to any range. Turn the AUDIO GAIN control fully clockwise.

c. Adjust the AN/URM-127 for 1,000 hertz and the ATTENUATOR control for an output signal of

1 volt. Use a 33-microfarad capacitor in series with the oscillator output jack and connect the output signal to the base of audio output transistor Q403.

NOTE

With no input signal, transistor Q403 is in saturation (conducting maximum current). It requires approximately 1 volt ac of signal to bring the transistor out of saturation and produce an output signal.

d. Through the headset, note the volume obtained. If no signal can be heard in the headset, make voltage and resistance measurements to isolate the trouble in this stage. If a signal can be heard, proceed to e below.

e. With the ATTENUATOR, set the AN/URM127 output signal to 15 millivolts. Inject a 1,000-hertz ac signal (in series with the 33-microfarad capacitor) at the base of transistor Q402. Note that the audio volume increases.

f. Adjust the AN/URM-127 for a 5-millivolt output signal and inject the test signal at the base of transistor Q401. If this stage of the audio amplifier is operating properly, the headset volume will be excessive.

6-13. Audio Power Output Test

The audio power output test will indicate the power output of the meter with various external rf input signals. For the test equipment required and associated technical manuals, refer to appenidx C of this manual. Set up the equipment according to figure 6-23 and proceed as follows:

a. Construct a 600-ohm dummy load in accordance with paragraph 6-10 and insert the phone plug into one of the frequency meter phone jacks.

b. Connect the vertical input of the oscilloscope to the phone plug terminals of the 600-ohm dummy load. Calibrate the oscilloscope for an input signal of 3 volts peak-to-peak.

c. Turn the frequency meter front panel FUNCTION SW to MOD and the AUDIO GAIN control fully clockwise.

d. Use Signal Generator Set AN/URM-25 for test frequencies up to 10 MHz, RF Signal Generator AN/USM-44 for test frequencies of 10 through 400 MHz, and Signal Generator AN/URM-49 to generate frequencies of 400 to 1,000 MHz.

e. Connect the output of the appropriate signal generator (depending on the test frequency specified below) to the frequency meter ANT. jack. For each test frequency, adjust the signal generator rf output attenuator for a signal of 0.1 volt. Tune the signal generator and frequency meter to the frequencies listed below and record the peak-to-peak audio output signals as shown on the oscilloscope.

(1) RANGE SW in range A.

Signal generator frequency (MHz)	*Harmonic*	*Frequency meter dial (kHz)*
1	8th	125
1.52	8th	190
2.5	10th	250

(2) RANGE SW in range B.

Signal generator frequency (MHz)	*Harmonic*	*Frequency meter dial (kHz)*
20	8th	2,500
30	8th	3,750
65	13th	6,000

(3) RANGE SW in range C.

Signal generator frequency (MHz)	*Harmonic*	*Frequency meter dial (kHz)*
260	4th	65
520	8th	65
520	4th	120
1,000	8th	125

f. As indicated on the oscilloscope, the minimum output signal on all harmonic frequencies should be not less than 0.48 volt peak-to-peak (0.05 milliwatt). If audio output power is not specified, troubleshooting is required.

Section IV. MAINTENANCE OF FREQUENCY METER

6-14. General Parts Replacement Techniques

Except for two factory-calibrated subassemblies (the high frequency vfo and the low frequency vfo coilbox), the majority of component parts in the frequency meter can be easily reached and, if found to be defective, can be replaced with new parts; however, the parts mounted on printed circuit boards cannot be replaced without removal of the circuit board. In certain cases, removal of the circuit board involves the unsoldering of one or m ore wires. In other cases, the length of wiring is enough to permit removal of the circuit board to the extent required for repairs without unsoldering any wires. The following repair techniques and precautions apply specifically to the frequency meter.

a. The frequency meter is a precision instrument, completely tested and accurately calibrated during manufacture. In the high frequency vfo, the position and lead length of all component parts were taken into consideration during the calibration procedure when the vfo was manufactured; therefore, if the trouble has been traced to this unit and it is absolutely necessary to replace a defective part, use exactly the same length and dress of part leads as used originally.

If transistor Q1 (fig. FO-2 (2) or FO-3 (2) must be replaced, potentiometer R4 must be readjusted (para 6-25).

b. Low frequency vfo coilbox Z101 (fig. 6-1) is a factory-sealed unit and, if trouble has been traced to this unit or if the humidity indicator turns pink, the coilbox must be replaced with a new unit.

c. To remove any of the front panel control knobs, use an Allen wrench.

d. If either the FUNCTION or the RANGE SW needs to be replaced, use the wiring diagrams (fig. FO-6 and FO-7) and carefully mark or tag each wire as it is removed to avoid misconnection when the new switch is installed. Note the wire colors. For wiring on the boards, refer to figures 6-25 through 6-33.

CAUTION

Do not use a soldering gun; it may include damaging ac signals in the transistors.

e. When soldering, use a pencil-type soldering iron with a 25-watt maximum capacity. When soldering the transistor, semiconductor diode, or other part leads to the circuit board, solder quickly. To avoid transistor or semiconductor diode damage, use a heat sink (such as a longnosed pliers) between the soldered joint and the transistor of the diode.

f. To view the printed wiring from the parts side of the circuit board, hold the board in front of a light source.

g. Repair damaged circuit board printed wiring by bridging the gap with a piece of single conductor hookup wire.

h. In an emergency, or during battle conditions, a defective circuit board resistor or capacitor can be replaced without removing the circuit board. With a pair of cutter pliers, cut the part in the center and use the old leads for mounting the new part.

i. When repair work has been completed, the frequency meter should then be given a final test to be sure that it operates with its original accuracy.

6-15. Removal and Replacement of Crystal Oscillator and Modulator Circuit Board

(fig. 6-4, 6-5 or 6-6, and FO-2(1)or FO-3(1)).

CAUTION

When removing the crystal oscillator and modulator board, do not let the terminals come in contact with the hot terminal (purple wires) on filter capacitor C704.

The wires connected to the crystal oscillator and modulator circuit board are long enough to permit repairs to be made without unsoldering any wires. The circuit board is under the frequency meter chassis and is secured to the chassis rear plate by five screws that extend into threaded bushings mounted on the board. Remove these screws and tip the board upward. When repairs are made, remount the board and replace the five screws.

6-16. Removal and Replacement of Audio Amplifier Circuit Board

(fig. 6-5 or 6-6, and FO-2 (1) or FO-3 (1)).

The wires connected to the audio amplifier circuit board are long enough to permit repairs to be made without unsoldering any wires. The circuit board is in a shielded compartment under the chassis. The board is held in position by a screw at each corner of the board. Remove the four screws and lift the board from the shielded compartment. When repairs are made, remount the board and replace the four screws.

6-17. Removal and Replacement of Power Supply Circuit Board

(fig. 6-5 or 6-6, and FO-2 (2) or FO-3 (2)).

The wires connected to the power supply circuit board are long enough to permit repairs to be made without unsoldering the leads. The board is held in a vertical position by four screws that extend into two brackets mounted on the chassis. Remove the four screws and gently pull the board and cabling away from the fuse posts. After making repairs, remount the board and replace the four screws.

6-18. Removal and Replacement of Mixer Circuit Board

The wires on this circuit board are too short to permit repairs to be made without removal of the board entirely.

a. Refer to figures 6-1 and FO-2 (1) or FO-3 (1) and carefully unsolder the bare wire connected from terminal 9 of the mixer circuit board to the ANT. jack; then (in AN/USM-159 only), unsolder the 10K resistor (R308, FO-6 or FO-7) connected from terminal 7 to RANGE SW S703. Unsolder the resistor at the switch terminal only.

b. The right side panel (fig. 6-2) is secured to the main unit with two screws that extend through the front panel (right side) and six screws through the side panel. Three of the screws are on a horizontal line across the side panel and the other three are in a vertical line from top to bottom. Remove the eight screws.

c. Carefully pull the top of the side panel away from the chassis; be careful not to damage the wiring that remains soldered to the mixer circuit board.

d. Remove the mixer board by removing the four screws and nuts that hold the board to the side panel. Any part on the mixer board can now be replaced without unsoldering the main terminal wiring. If the wiring is handled carefully, voltage and resistance measurements can also be made.

e. After the defective part is replaced, mount the mixer board on the side panel with the four screws and nuts; then attach the side panel to the chassis and front with the eight screws. Solder the 10K resistor to switch S703, and the antenna lead (bare wire) to the ANT. jack.

6-19. Removal and Replacement of Low Frequency Vfo Circuit Board

The wiring connected to the low frequency vfo circuit board is too short to permit repairs to be made without unsoldering the wires.

a. Refer to figures 6-1, FO-2 (2) or FO3 (2) , and FO-6 or FO-7 and carefully unsolder the wires connected to circuit board terminals 1 through 7. Note the wire color and mark or tag the wire for identification.

b. The vfo circuit board is mounted on coilbox Z101 with four nuts (one at each corner of the board). Remove the four nuts and the board.

c. After repairs are made, remount the circuit board on Z101 with the four nuts. Resolder the wires on board terminals 1 through 7. Arrange the wiring in approximately the same position as before.

d. The low frequency vfo should then be given a final test to be sure it functions with its original accuracy (para 6-27).

6-20. Removal and Replacement of Low Frequency Vfo Coilbox Z101

Low frequency vfo coilbox Z101 was sealed during manufacture; no attempt should be made to unseal it. If the humidity indicator (fig. 6-1) turns pink, or some internal component is defective, the coilbox must be replaced.

a. Remove the low frequency vfo circuit board by following the procedure given in paragraph 6-19, but do not unsolder the wire on terminal 7.

b. On coilbox Z101, note the wire colors and carefully unsolder the wires connected from S703 to Z101 terminals 1 through 5 (fig. FO-6 or FO-7); then, unsolder the wires on terminal 3 and the ground lug of Z101. Mark or tag the wires.

NOTE

Do not unsolder the wires connected from terminals 1 and 2 to C112 and C114 at this time.

c. The coilbox is chassis mounted with four nuts (fig. 6-5 or 6-6). Remove the hardware and carefully pull upward on Z101 and remove the unit.

d. On the coilbox terminals, unsolder the leads going from terminals 1 and 2 to C112 and C114; then, loosen the two nuts and screws that hold the trimmer capacitor mounting bracket to the coilbox and remove the bracket.

e. Obtain a new coilbox and remount the trimmer capacitor bracket with the two screws and nuts. Solder the trimmer capacitor leads on terminals 1 and 2.

f. Mount the coilbox by replacing the four nuts under the frequency meter chassis; then, connect and solder the wires on terminals 1 through 5 and the ground lug.

g. Refer to the procedures given in paragraph 6-19 and replace the low frequency vfo circuit board.

h. The low frequency vfo should then be aligned and given a final test.

6-21. Removal and Replacement of Switch S703 (RANGE SW)

a. Looking down on the top of the frequency meter (fig. 6-1), locate the wires connected to battery interlock switch S702 and voltmeter M701. Remove these wires and tag them for identification; then, unsolder the bare wire connected to the ANT. jack on the front panel.

b. With a set of Allen wrenches, remove the front panel knobs. Slide the battery drawer out of the panel.

c. Remove the two screws and nuts that hold the battery drawer support bracket to the front panel. The front panel is held to the left and right side panels by two screws that extend through each side panel. Remove the four screws and the front panel.

d. The mask in the filmstrip mechanism is mechanically linked with a lever to the shaft of switch S703. Remove the nut and screw that hold this lever to the film mask (fig. 6-1 and 6-12). The other end of the lever is mounted on the shaft of S703 with a screw and nut attached to a rectangular block. Remove this hardware and pull the block and mask operating lever from S703.

e. In the AN/USM-159 only, in figures 6-1 and FO-6, locate the 10K resistor (R308) connected

from the front section of S703 to the mixer circuit board. Unsolder this resistor from S703.

f. Refer to paragraph 6-18 and remove the right side panel and mixer circuit board. Leave the mixer board hanging on its leads and remove the side panel entirely.

g. The two switch-mounting brackets are secured to the chassis with four screws and nuts. Loosen the front bracket by taking out the two screws and nuts. Remove the screws and nuts from the rear bracket. To facilitate removal, loosen the screws from under the chassis until the nuts can be removed. Switch S703 can then be moved forward a small amount for access to the wiring.

h. Unsolder the five wires connected to the front section of S703. Refer to the wiring diagram (fig. FO-6 or FO-7) and tag or mark each wire as soon as it is removed.

i. Carefully unsolder the wiring on the rear section of S703. Tag or mark the wires. Be extremely careful not to damage trimmer capacitors C112 and C114. Remove switch S703.

j. Remove the mounting brackets from the defective switch and remount them on the new switch.

k. Reconnect and solder the wires on the rear section of the new switch. Install the screws and nuts on the front and rear switch mounting brackets. Reconnect and solder the wires on the front section of S703.

l. On the shaft of S703, remount the filmstrip mask operating lever and block with the screw and nut. Attach the lever to the filmstrip mask (fig. 6-12).

m. With the four screws and nuts, remount the mixer circuit board on the right side panel. Replace the side panel with the six screws. In the AN/USM-169 only, resolder the 10K resistor (R108) onto switch S703.

n. Replace the front panel and remount the battery drawer support bracket. Slide the battery drawer in place.

o. Reconnect and solder the wires on battery interlock switch S702, voltmeter M701, and the ANT. jack. Replace the panel control knobs.

6-22. Removal and Replacement of Other Components

a. The PHONES jacks, AUDIO GAIN control, function switch, fuse posts, and ac receptacle can easily be reached from underneath the chassis (fig. 6-5 and 6-6) and replaced in accordance with general repair practice. The only precaution that need be observed is to tag each wire as soon as it is removed to avoid misconnection when installing the new part. The 1-MHz and 2.5-MHz crystals are secured to their sockets with spring clips on the crystal oscillator and modulator circuit board (fig. FO-2 (1) and FO-3 (1)). Crystal Y202 is the 1-MHz crystal, and Y201 is the 2.5-MHz crystal.

b. In the high frequency vfo (fig. FO-2 (2) or FO-3 (2), all replaceable parts can be replaced without removal of the unit. All parts have voltage and current ratings 'far in excess or normal operating conditions and should last beyond the life of this instrument. The vfo, tuning capacitor, and mechanical drive system are integrated into one unit and, if disassembled, will void the entire calibration of the unit. If new parts are installed in the same physical location and with the same lead lengths as the original part, calibration should not be affected.

6-23. Removal and Replacement of Dial Lamps

The two dial lamps (fig. 6-1, 6-12, and 6-13) are mounted on an L-shaped bracket that is attached to the film mask with two screws and associated nuts. The lamps receive power through a shielded cable connected to the modulator circuit board. Install a new lamp as described below.

a. Pull the battery drawer out of the front panel.

b. Remove the filmstrip mechanism top cover (fig. 6-1). Remove the dial lamp cable clamp which is attached to the mechanism frame with a screw and nut (fig. 6-12).

c. Note that the dial lamp mounting bracket is attached to the mask with two screws and nuts (fig. 6-13). Remove this hardware. Tip the dial lamp mounting bracket upward and pull it out through the side of the film mechanism frame.

d. The wire leads of the lamps are soldered to terminals on an insulated board. If not sure which lamp is defective, plug the power cable into the front panel ac receptacle and source of ac power. Turn the FUNCTION SW to OPER and note which lamp does not glow. Unsolder the defective lamp and replace it with a new type NE-2 lamp. If the lamp still does not glow, turn off the power and check the associated current limiting resistor.

e. Remount the dial lamp mounting bracket and secure it to the mask with the two screws and nuts. Replace the lamp cable clamp and film mechanism top cover. Replace the battery drawer.

6-24. Removal and Replacement of Filmstrip Mechanism and Filmstrip

a. Removing Filmstrip Mechanism.

(1) On the modulator circuit board, unsolder

the wires connected to terminals 2, 3, and 4; then, pull the dial lamp Fielded cable up through the hole in the chassis (fig. 6-1).

(2) Disconnect the filmstrip dial mask operating level (fig. 6-1). Move the dial mask operating lever away from the filmstrip mechanism by turning the RANGE SW to C.

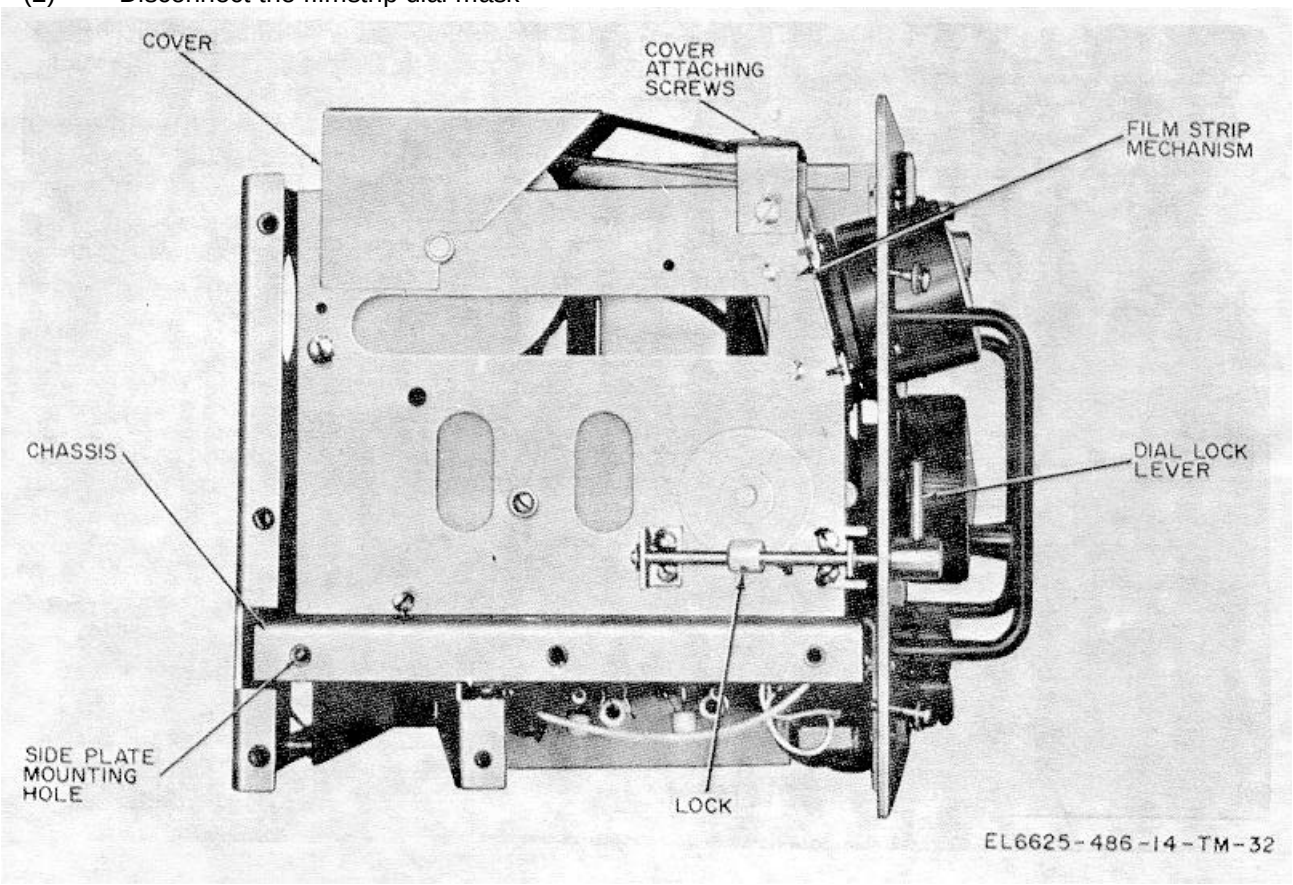


Figure 6-11. Filmstrip mechanism, left side view.

(3) With a screwdriver, loosen the DIAL LOCK lever (fig. 6-3) and remove the knob.

(4) Remove all of the screws that hold the left sideplate. Remove the panel that exposes the filmstrip mechanism (fig. 6-11).

(5) On the meter front panel, rotate the TUNING control knob counterclockwise until the control reaches its stop position.

(6) Under the frequency meter chassis (fig. 6-5 or 6-6), locate the four screws (two under the master film container and two under the AUDIO GAIN control) that hold the film mechanism to the chassis. Remove these screws while holding the mechanism to prevent it from falling out.

(7) Carefully slide the film mechanism toward the rear to clear the dial lock shaft; then, slide the unit out of the left side.

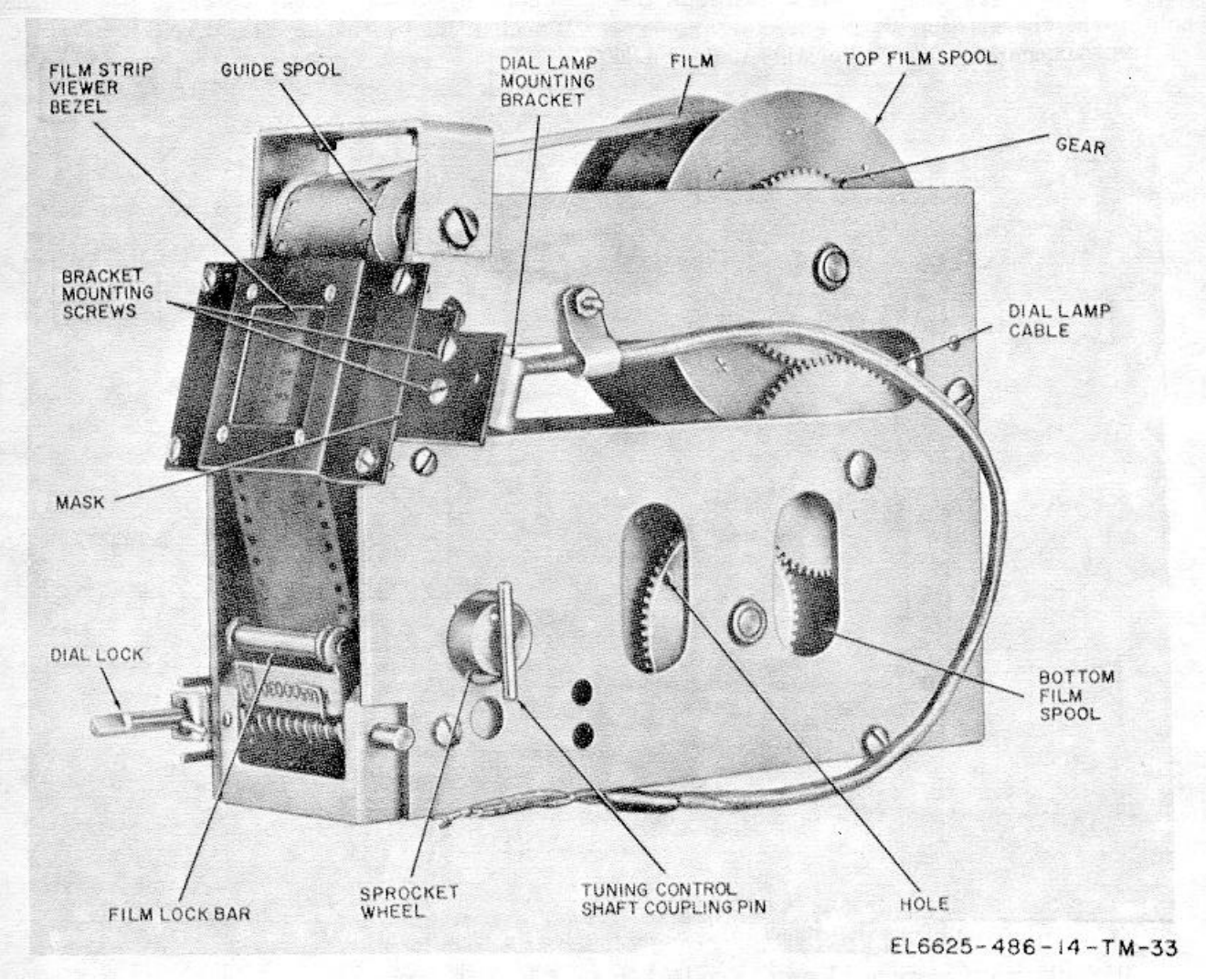


Figure 6-12. Filmstrip mechanism, right-side view.

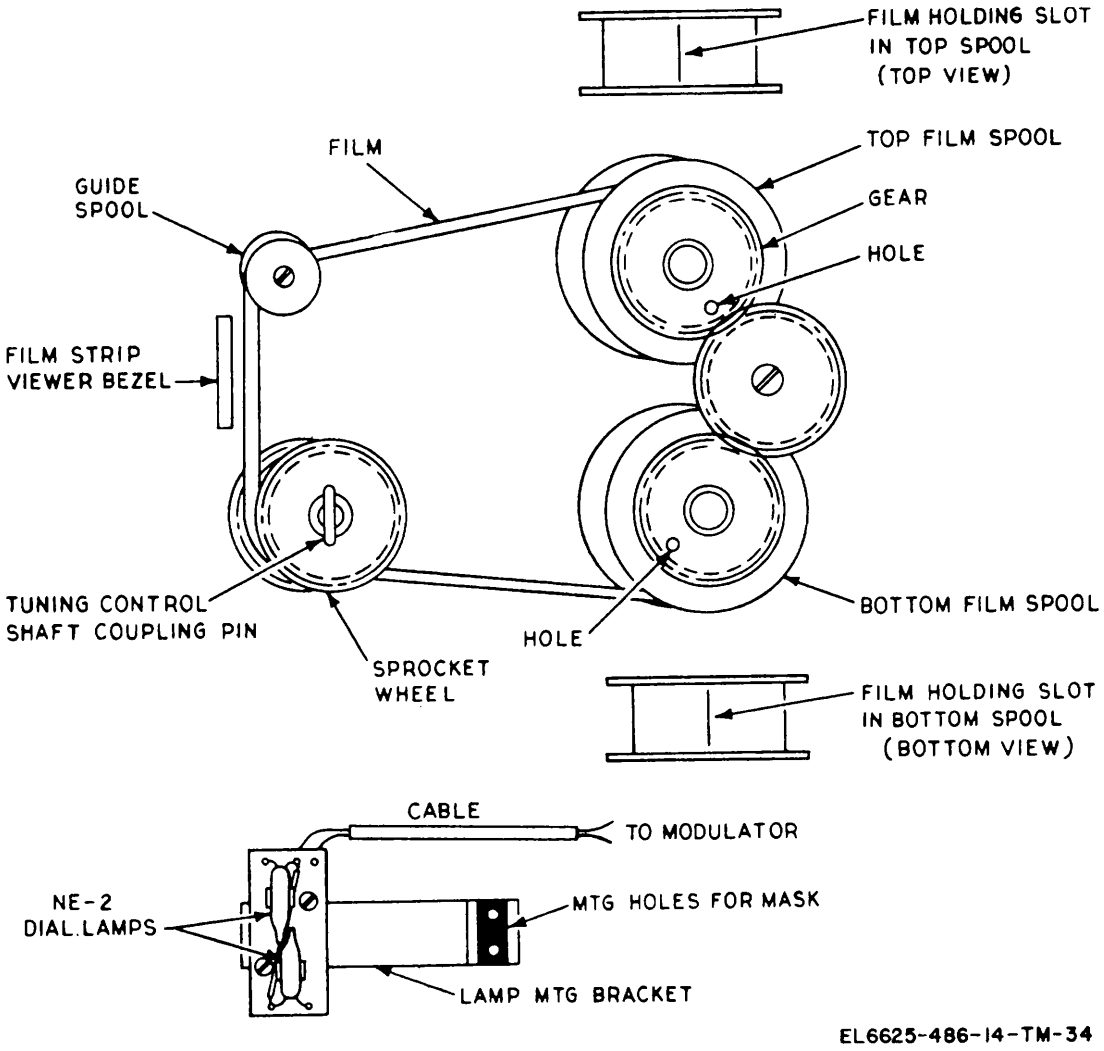


Figure 6-13. Dial lamp and filmstrip, installation diagram.

b. Replacing Filmstrip. To install a new filmstrip, refer to figures 6-12 and 6-13 and proceed as follows:

(1) Manually rotate the top film spool until all the film is wound on this spool. Observe that the extreme end of the film is secured to the bottom spool with tape. Remove this tape; then, remove the film from the top spool and a similar piece of tape. The new filmstrip will be secured in the same way.

(2) The top and bottom film spools are driven by their associated gears through friction only. The spools are spring-loated (internally) independently of the gears and exert sufficient pulling force to take up any slack in the film for any position of the gears. Before installing a new film, each spool must be secured to its associated gear to be sure that the two items will rotate as one unit. This condition is accomplished by insertion of a screw through a hole in the gear so that it engages threads in the spool Refer to figures 6-12 and 6-13 to locate these holes.

(3) Use the two No. 2-56 by 1/4-inch machine screws in the following operation. Insert one screw in the top film spool and the other in the bottom spool. To locate the spool threads, it may be necessary to hold the gear and turn the spool slightly. Tighten the screws with a screwdriver.

(4) Obtain a new filmstrip and trim the extreme end in the same way as the old film was removed (b (1) above) so that it can be inserted into a spool-holding slot. Be sure that this end of the filmstrip has the highest frequency numbers. Insert this end of the filmstrip into the top spool holding slot so that the extreme end of film will face the rear; then, secure the film with paper tape.

(5) Rotate the top spool until the entire filmstrip is wound on this spool.

(6) Trim the other end of the filmstrip for

insertion in the bottom spool holding slot. Thread this end of the film over the guide spool, under the filmstrip viewer bezel, and round the sprocket wheel to the bottom spool.

(7) Pull up all slack in the filmstrip and insert the end of the film in the spool holding slot. Secure the film to the spool with paper tape.

(8) Rotate the bottom film spool and wind approximately 8 turns of film; then, remove the two machine screws that were inserted ((3) above).

c. Replacing Filmstrip Mechanism.

(1) Place the filmstrip mechanism on the frequency meter chassis and mate the shaft coupling pin with the associated TUNING control shaft coupling unit.

NOTE

To accomplish the above, rotate the film mechanism shaft slightly, if necessary. Do not turn the shaft any more than necessary. Also, be sure that the TUNING control is still at its upper stop position.

(2) Secure the filmstrip mechanism to the chassis with the four screws that were removed (a (6) above). Do not replace the left-side panel at this time.

(3) Insert the dial lamp cable through the hole in the chassis and solder the wires to terminals 2, 3, and 4 on the modulator circuit board.

(4) Turn the RANGE SW to B and the FUNCTION SW to CHK. Manually push the film mask to range B. Plug the headset into one of the PHONES jack.

NOTE

Do not connect the mask operating level.

(5) Rotate the TUNING control until the 2,500-kHz checkpoint is under the hairline indicator If the beat note is heard, adjust the CORRECTOR control for zero beat. If the beat note cannot be heard, refer to the procedure given in (6) below.

(6) Slowly tune the frequency meter in the immediate vicinity of the checkpoint until the beat note is heard. If the beat note occurs on a calibration mark displaced from the 2,500-kHz checkpoint, adjust the CORRECTOR control for a zero beat and leave the TUNING control set at this point.

(7) Look down on the film mechanism shaft and locate the insulated coupling unit between the film mechanism shaft and the TUNING control shaft (fig. 6-1). With an Allen wrench, loosen the two screws on the left side of the insulated coupling unit (nearest to the film mechanism). The film mechanism shaft can now be turned while the TUNING control shaft remains stationary. Turn the film mechanism shaft until the 2,500-kHz checkpoint is centered under the hairline; then, tighten the two Allen screws.

(8) Tune the meter to several other checkpoints on range B and note if the zero beat can be obtained on the checkpoint. If the filmstrip is properly centered for the 2,500-kHz checkpoint, all other checkpoints should be correct.

(9) Secure the filmstrip mask operating lever to mask with the associated hardware.

(10) Install left side panel and replace the attaching screws. Replace front panel DIAL LOCK knob.

6-25. Equipment Adjustments

If transistor Q1, in the high frequency vfo, has been replaced, readjust potentiometer R4 (fig. FO-2 (2) or FO-3 (2)) as follows:

a. On the meter front panel, turn the FUNCTION SW to OPER and the RANGE SW to range C.

b. Set the vtvm FUNCTION to AC and the RANGE to IV. Refer to figure FO-2 (2) or FO-3 (2).

c. Connect the rf probe ground clip to the vfo compartment side panel and touch the probe tip to the collector of Q2. Note the rf signal level at this point.

d. While holding the ac probe on Q2, rotate the TUNING control in any direction until the ac signal level reaches the greatest amplitude indicated on the vtvm. This frequency setting is the point of maximum oscillator activity. Remove the ac probe connection but do not touch the TUNING control knob.

e. Set the vtvm FUNCTION to DC- and the RANGE to 10V. Connect the common clip to the chassis and the dc test prod to the collector of Q1.

f. Turn potentiometer R4 (fig. FO-2 (2) or FO-3 (2) until the vtvm indicates 3.15 volts. The potentiometer is then set correctly and should not be touched unless Q1 is replaced again.

6-26. Adjustment of Crystal Oscillator

The crystal oscillator in the frequency meter is quite stable and normally requires adjustment only at very infrequent intervals, or unless a part has been replaced that may effect the frequency. If adjustment is necessary, use the alignment setup given in figure 6-14 and the procedure outlined below:

a. Plug Frequency Meter Subassembly MX1637/U (100-MHz converter) into the counter front panel. In the converter, only the video

amplifier will be used. Turn the MIXING FREQUENCY MCS switch to 0. Set the counter controls for a frequency readout of 10 Hz to 10 MHz. Turn on the power and allow the counter to warm up for 15 minutes. Set the STD GATE TIME SEC switch to 10.

b. On the crystal oscillator circuit board, locate test point TP202. Connect the SIGNAL INPUT jack of the counter to TP202 and the ground clip to the frequency meter chassis.

c. Turn the frequency meter FUNCTION SW to CHK and the RANGE SW to A. Allow a 5-minute warmup period.

d. On the counter display, read the frequency of the 1-megahertz crystal oscillator. The frequency should be 1 MHz ± 5 hertz (limits 0.999,995 to 1.000,005 MHz). If incorrect in the AN/USM-159, adjust L202 (fig. 6-2) for correction; if incorrect in the AN/USM-159A or AN/USM-159B, adjust C209A (fig. 6-6).

e. To adjust the 2.5-MHz frequency, turn the frequency meter RANGES SW to C.

f. On the counter display, read the frequency of the 2.5-megahertz oscillator. The frequency should be 2.5 MHz ± 12.5 hertz (limits 2.4999875 to 2.5000125 MHz). If incorrect in the AN/USM159A or AN/USM-159B, adjust C209B.

NOTE

If any difficulty is experienced in obtaining a satisfactory readout on the counter display, be sure that the converter GAIN control is not set to overdrive the counter and cause an erratic counter readout.

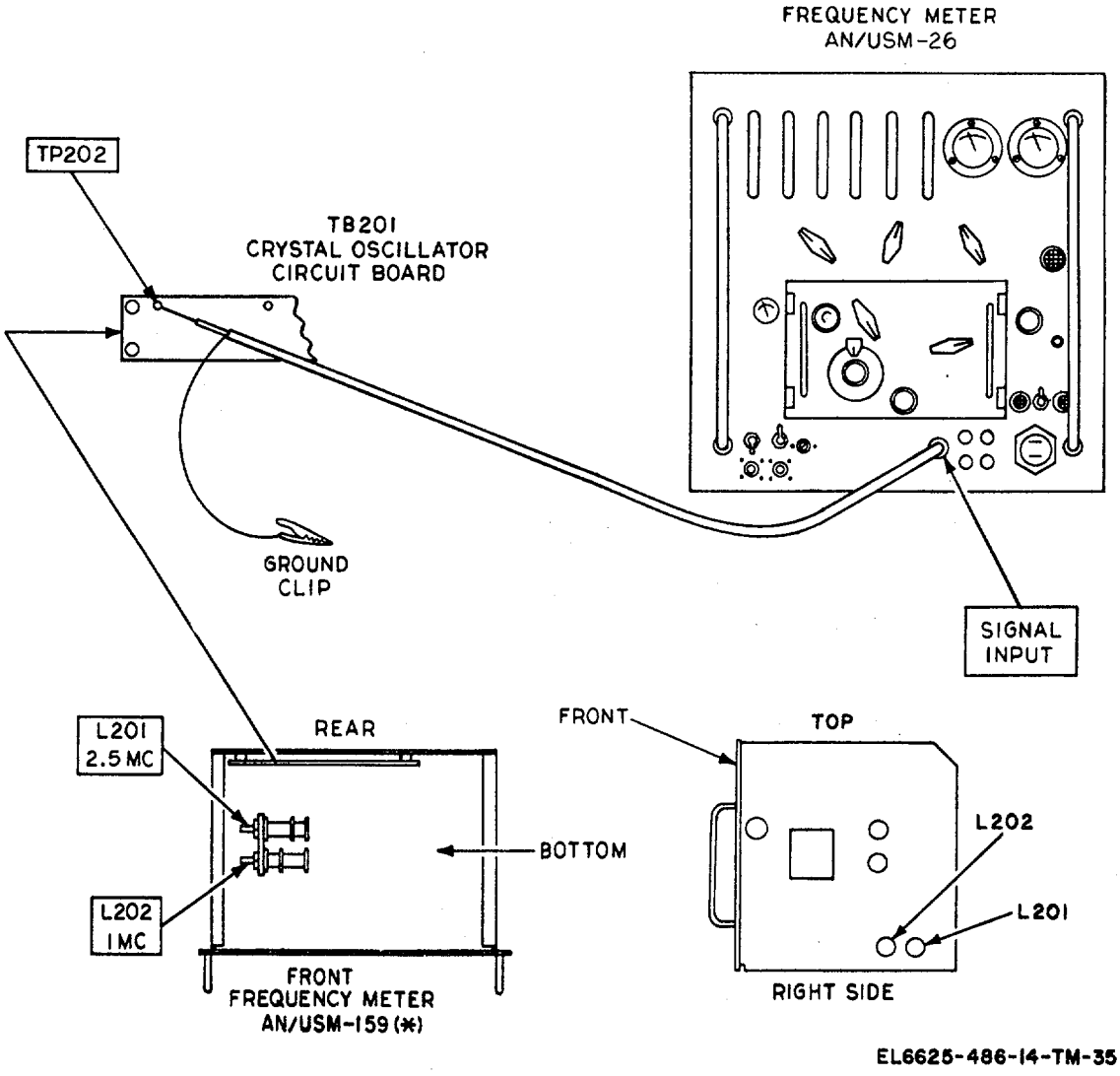


Figure 6-14. Crystal oscillator alignment setup.

6-27. Adjustment of Low Frequency Vfo

The low frequency vfo is a precision oscillator with tunable frequency ranges of 125 kHz to 250 kHz and 2,500 kHz (2.5 MHz) to 5,000. kHz (5 MHz). The design of the coils, and other frequency determining elements in coilbox Z101, sets the low frequency end of the two vfo frequency ranges and, therefore, no external adjustments are provided. The high frequency limit of the two ranges (250 kHz and 5 MHz) is adjusted with trimmer capacitors. In figure 6-2 trimmer capacitor C114 is used to adjust the high end of range A, and trimmer capacitor C112 the high end of range B. These trimmers should never be touched unless coilbox Z101 is replaced. It adjustment is necessary, refer to the test equipment setup in figure 6-15 and adjust range, A and B as follows:

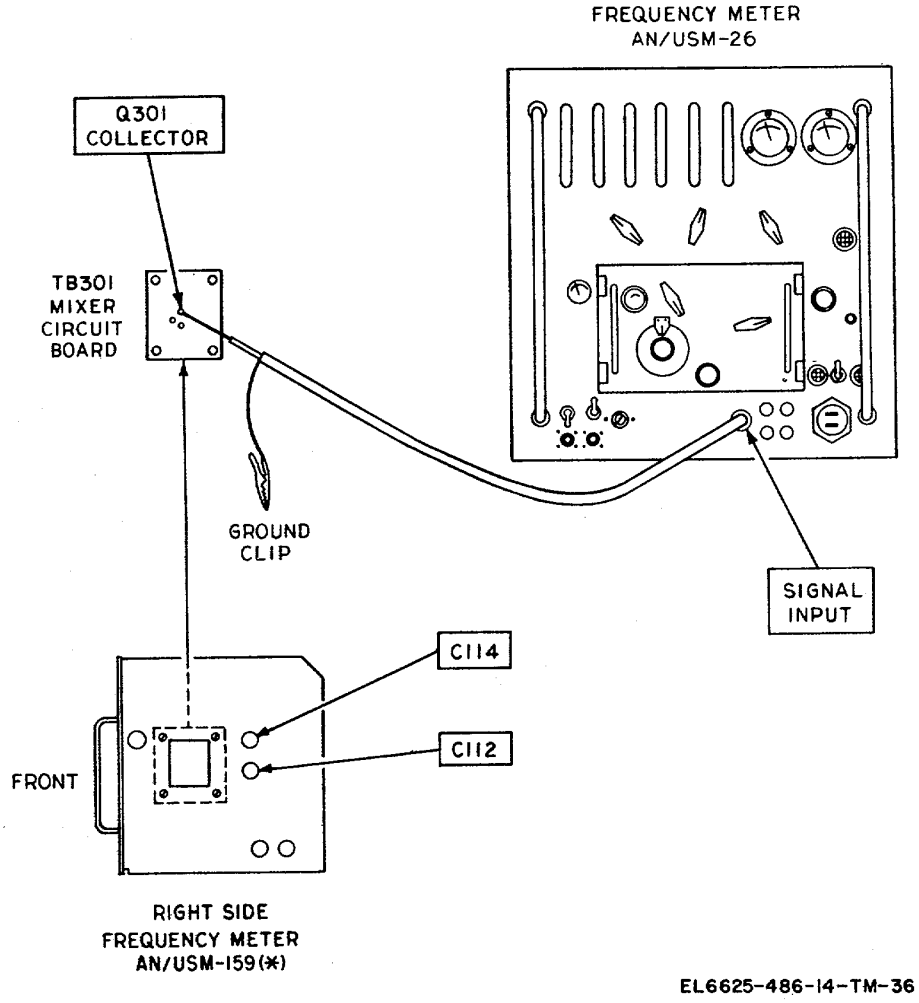


Figure 6-15. Low frequency vfo alignment setup.

a. Range A.

(1) Set the counter FUNCTION SELECTOR switch to FREQUENCY and the STD GATE TIME SEC to 1. Turn the counter power on and allow for a 15-minute warmup period. Set the counter for a readout of 10 Hz to 10 MHz.

(2) Turn the frequency meter FUNCTION SW to OPER and the RANGE SW to A. Turn the CORRECTOR knob until the pointer or index is at the midpoint position. Rotate the TUNING control to center the 250-kHz checkpoint under the hairline indicator.

(3) On the the mixer circuit board (fig. 6-15), locate the collector soldered connection of transistor Q301. Since there is no testpoint at this connection, be extremely careful not to short the wiring. On the right side panel of 'he frequency meter, locate trimmer capacitor C114.

(4) Connect the counter SIGNAL INPUT jack to the collector of Q301 and the ground clip

to the frequency meter side panel. Adjust the 100-MHz converter GAIN control for a satisfactory counter readout. I f the readout is erratic, decrease the gain.

(5) Note the readout display of the counter. The counter should indicate either the 250-kHz fundamental frequency ± 25 hertz or the 500-kHz second harmonic frequency ± 50 hertz. If incorrect, adjust C114 for correction.

(6) As a final readout accuracy check, tune the frequency meter to the 125-kHz checkpoint and note the counter readout. The frequency should be either 125 kHz ± 12.5 Hz or 250 kHz ±25 Hz.

b. Range B.

(1) The counter can be used to read out the frequency of this range is fundamentals without using harmonics. Set up the counter as instructed in a (1) above.

(2) Turn the frequency meter RANGE SW to B and set the CORRECTOR control to the midpoint. Tune the frequency meter to the 5,000-kHz checkpoint.

(3) Connect the counter SIGNAL INPUT to the collector of Q301. On the counter, adjust the converter GAIN control for a satisfactory readout. If the counter readout is erratic, decrease the converter gain.

(4) Note the readout frequency of the counter. The counter should indicate 5,000 kHz ± 500 Hz. I f incorrect, adjust C112 for correction.

(5) Tune the frequency meter to the 2,500 kHz checkpoint and note the counter readout frequency. The frequency should be 2,500 kHz ± 250 Hz.

c. Checking Low Frequency Vfo Against Crystal Check points.

(1) Remove the electrical connection between the counter and the meter. Turn off the counter.

(2) Turn the frequency meter FUNCTION SW to CHK and the RANGE SW to A. Plug the headset into a PHONES jack.

(3) Tune the frequency meter to the lowest checkpoint (125 kHz) on the filmstrip. A zero beat should be obtained as the CORRECTOR control is turned. Tune the frequency meter to the last checkpoint (250 kHz). A zero beat should be obtained as the CORRECTOR control is tuned.

NOTE

The frequency range of the CORRECTOR at 250 kHz is slightly greater than ± 25 Hz, and at 125 kHz slightly greater than ± 12.5 Hz which is sufficient to obtain the original 0.01-percent accuracy of the vfo. If a zero beat cannot be obtained with the CORRECTOR control on a crystal checkpoint, the filmstrip alignment (para 6-24) may need to be recalibrated.

(4) Turn the RANGE SW to B and tune the frequency meter to the lowest checkpoint (2,500 kHz, 2.5 MHz) on the filmstrip. Leave the FUNCTION SW set to CHK.

(5) Adjust the CORRECTOR control for a zero beat as heard in the headset. Tune the frequency meter to the last checkpoint (5,000 kHz). A zero beat should be obtained as the CORRECTOR control is turned.

6-28. Adjustment of High Frequency Vfo

This vfo covers a fundamental frequency range of 65 to 130 MHz. A minimum of 27 crystal checkpoints, spaced at 2.5-MHz intervals from 65 to 130 MHz on the filmstrip, enables this range to be checked to a high degree of accuracy. Provided the frequency range of the CORRECTOR is .sufficient to correct this vfo on any of the above checkpoints, the vfo accuracy between checkpoints should equal the original 0.01-percent accuracy. If a zero beat cannot be obtained on some of the crystal checkpoints, and it has been definitely established that the crystal oscillator is not at fault, the high frequency vfo will need recalibration. To recalibrate the high frequency vfo, switch the RANGE SW to C. Tune the frequency meter to the highest crystal checkpoint. If unable to obtain a zero beat, adjust C5. Check the tracking of the oscillator at every checkpoint from the highest to the lowest on range C. Vary C5 and spread or compress L1 to obtain proper tracking. Do not adjust L1 unless it is absolutely necessary.

Section V. GENERAL SUPPORT TESTING PROCEDURES

6-29. General

a. These testing procedures have been prepared for use by general support maintenance shops to determine the acceptability of repaired equipment. These procedures set forth specific requirements that repaired equipment must meet before it is returned to the using organization.

b. Comply with the instructions preceding each table before proceeding to the table itself. Perform each step in sequence. For each step

perform all the actions in the Control settings columns; then, perform each specific procedure and verify it against its performance standard.

c. Tools and test equipment required for maintenance at general support maintenance are listed in appendix C.

6-30. Modification Work Orders

The performance standards in tables 6-4 through 6-14 are based on the assumption that all MWOs applicable to the equipment have been applied. A listing of current MWOs will be found in DA Pam 310-7.

6-31. Physical Tests and Inspections

a. Test Equipment and Materials. None required.

b. Test Connections and Conditions.

(1) No connections are necessary.

(2) Remove the frequency meter from its case.

c. Procedure. Follow the procedures given in table 6-4.

Table 6-4. Physical Tests and Inspections

Step No.	Control Settings: Test Equipment	Control Settings: Equipment under test	Test Procedure	Performance Standard
1	N/A	Controls may be in any position.	*a*. Inspect case, chassis, and panel for damage, missing parts, and condition of paint. **NOTE** **Touchup painting is recommended in. stead of refinishing whenever practical; screw heads, jacks, receptacles, and other plated parts will not be plated or polished with abrasives.**	*a*. No damage evident or parts missing. External surfaces to be painted will not show bare metal. Panel lettering will be legible.
			b. Inspect all controls and mechanical assemblies for loose or missing screws, bolts, and nuts.	*b*. Screws, bolts, and nuts will be tight. None missing.
			c. Inspect all connectors, receptacles, fuseholders, dial glass, and panel meter for looseness, damage, or missing parts.	*c*. No loose parts or damage. No missing parts.
2	N/A	controls may be in an y position.	a. Rotate all panel controls throughout their limits of travel.	*a*. Controls will roate without bind- ing or excessive looseness.
			b. Inspect filmstrip mechanism and dial drive system for damage, binding, and for proper operation.	*b*. Filmstrip mechanism and dial drive system will operate properly without evidence of damage.
			c. Operate all panel switches, including the battery power interlock switch above the panel meter.	*c*. Switches will operate properly. **NOTE** **The battery power in- terlock switch is spring- loaded and should spring outward when released.**

6-32. Frequency Drift with Change in Line Voltage

a. Test Equipment and Material.

(1) Variable Power Transformer CN-16/U.

(2) Multimeter TS-352B/U.

(3) Frequency Meter AN/USM-26(*) with Frequency Meter Subassembly MX-1637A/U

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b. Test Connections and Conditions. Connect the equipment as shown in figure 6-16.

c. Procedure. Follow the procedures given in table 6-5.

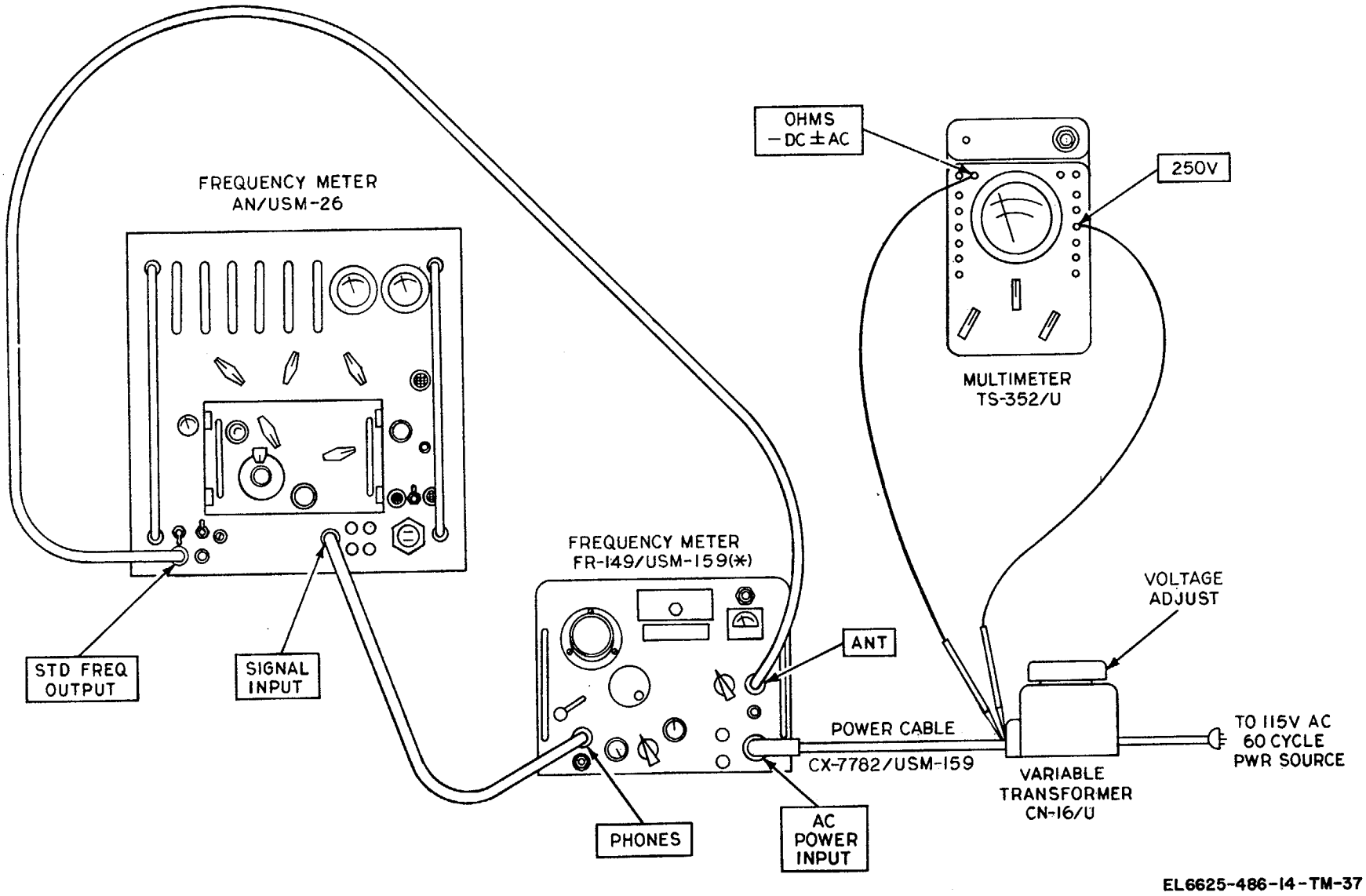


Figure 6-16. Frequency drift with change in line voltage test setup.

Table 6-5. Frequency Drift with Change in Line Voltage Test

Step No.	Control Settings: Test Equipment	Control Settings: Equipment under test	Test Procedure	Performance Standard
1	CN-16/U: Voltage control: 103. TS-352B/U: FUNCTION: AC VOLTS. Range sacle: 250V AC. AN/USM-26(*): POWER: ON. FUNCTION: FREQUENCY. STD FREQ: 10 MC. STD GATE TIME: 1. MIXING FREQ. MCS: 0.	FUNCTION SW: OPER. RANGE SW: B. DIAL LOCK: 5000 kHz (5 MHz). AUDIO GAIN: As required.	CN-16/U: *a.* Adjust voltage control until output measured on TS-352B/U is 103 volts. *b.* Allow AN/USM-26(*) to warm up for 15 minutes before proceeding. AN/USM-159(*) *c.* Adjust control to obtain a heterodyne beat difference frequency between 2,000 and 4,000 Hz as indicated on AN/USM-26(*). *d.* Record frequency readout on AN/USM-26(*) and proceed to step No. 2.	*a.* None. *b.* None. *c.* None. *d.* None.
2	CN-16/U: Voltage control to 230V. Same as step No. 1.	Same as step No. 1.	CN- 16/U: *a.* Adjust voltage control until output measured on TS-352B/U is 230 volts. *b.* Observe readout frequency on AN/USM-26(*) and compare with indication in step No. 1.	*a.* None. *b.* Frequency indication should be same as in step a above within '+ 0.005%.
3	Same as step No. 1.	Same as step No. 1.	*a.* Unplug power cable from power outlet. *b.* Observe readout frequency on AN/USM-26(*) and compare with indication in step 1.	a. None. *b.* Frequency indication should be same as in step No. 1 above within±0.005%.
4	Same as step No.1	Same as step No. 1. except: RANGE SW: C. DIAL: 80 MHz.	Same as step No. 1.	None.
5	Same as step No. 1	Same as step No. 4.	Same as step No. 2.	Frequency indication should be the same as in step No. 1 above within ± 0.005 %.
6	Same as step No. 1.	Same as step No. 4	Same as step No. 3.	Frequency indication should be the same as in step No. 1 above within ± 0.005%.

6-33. Crystal Oscillator Frequency Test

a. Test Equipment and Material. Frequency Meter AN/USM-26(*) with Frequency Meter Subassembly MX-1637A/U.

b. Test Connections and Conditions. Remove Frequency Meter FR-149(*)/USM-159 from its case and connect the equipment as shown in figure 6-17.

c. Procedure. Follow the procedures given in table 6-6.

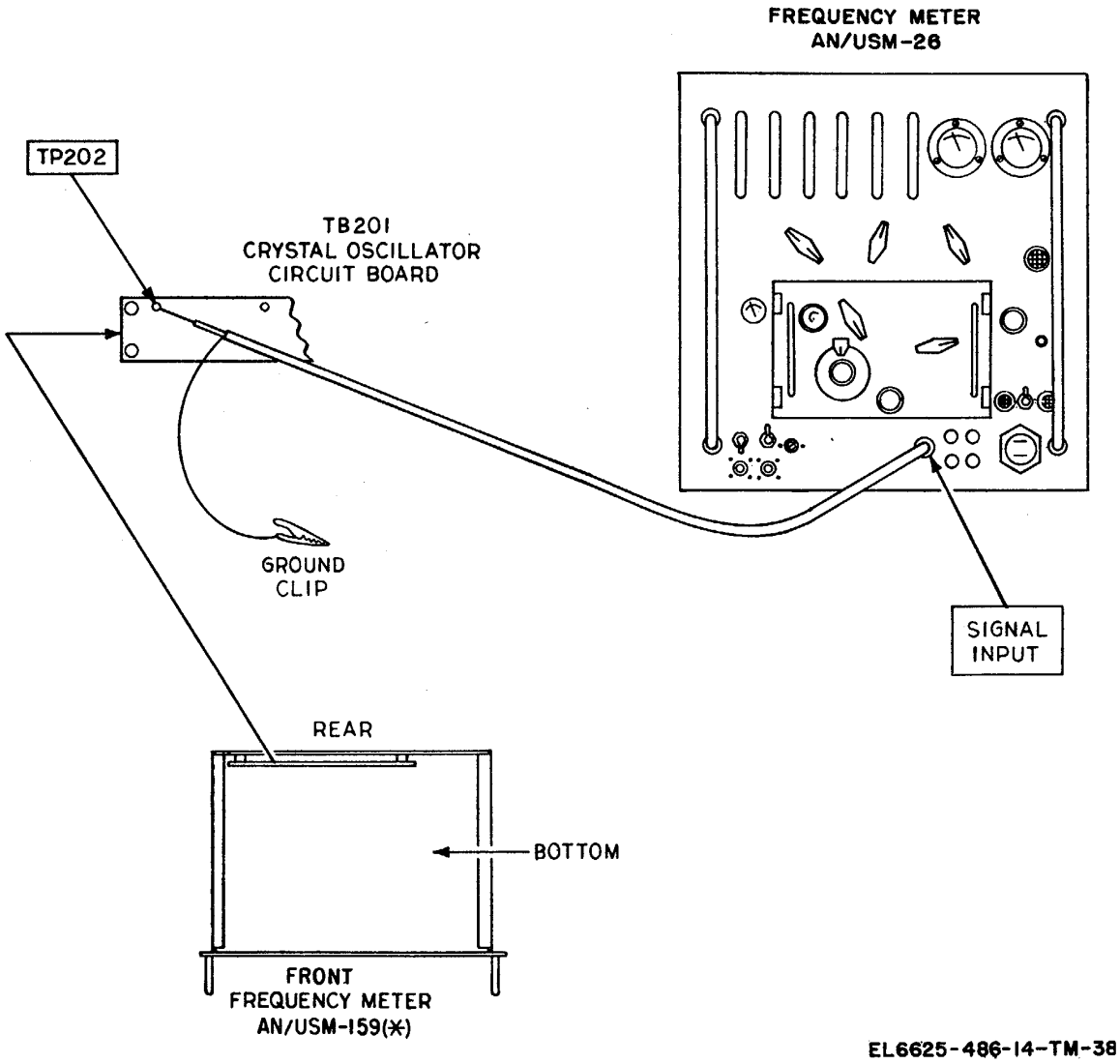


Figure 6-17. Crystal oscillator frequency test setup

Table 6-6. Crystal Oscillator Frequency Test

Step No.	Control Settings: Test Equipment	Control Settings: Equipment under test	Test Procedure	Performance Standard
1	AN/USM-26(*) POWER: ON. FUNC T I O N: FREQUENCY. STD FREQ: 10 MC. STD GATE TIME: 1. MIXING FREQ. MCS: 0.	FUNCTION SW: CHK RANGE SW: A.	Observe readout frequency on AN/USM-26(*).	Frequency should be between 999,995 and 1,000,005 Hz.
2	Same as step No. 1.	FUNCTION SW: CHK RANGE SW: C.	Observe readout frequency on AN/USM-26(*).	Frequency should be between 2,499,988 and 2,500, 012 Hz.

6-34. Crystal Checkpoint and Vfo Calibration

a. Test Equipment and Materials. Headset H-216/U.

b. *Test Connections and Conditions*. Plug in headset.

c. Procedure. Follow the procedures given in table 6-7.

Table 6-7. Crystal Checkpoint and Vfo Calibration Test

Step No.	Equipment under test Control settings	Test Procedure	Performance Standard
1	FUNCTION SW: CHK. RANGE SW: A.	a. Allow equipment to warm up for 5 minutes before proceeding. Plug in Headset HS-216/U. b. Starting from 125-kHz checkpoint, adjust TUNING knob and CORRECTOR control for a zero beat on all checkpoints within range A of filmstrip.	a. None. b. Zero beat should be obtained at each checkpoint.
2	FUNCTION SW: CHK. RANGE SW: B.	Starting from 5,000-kHz checkpoint, Adjust TUNING and CORRECTOR controls for zero beat on all checkpoints within RANGE B of the filmstrip.	Zero beat should be obtained directly at each checkpoint.
3	FUNCTION SW: CHK.	Starting from 130-MHz checkpoint, adjust TUNING and CORRECTOR controls for zero beat on all checkpoints within range C of filmstrip.	Zero beat should be obtained directly at each checkpoint.

6-35. Frequency Range of Corrector

a. Test Equipment and Materials. Frequency Meter AN/USM-26(*) with Frequency Meter Subassembly MX-1637A/U.

b. Test Connections and Conditions. Remove Frequency Meter FR-149(*)/USM-159 from its case and connect the equipment as shown in figure 6-18.

c. Procedure. Follow the procedures given in table 6-8.

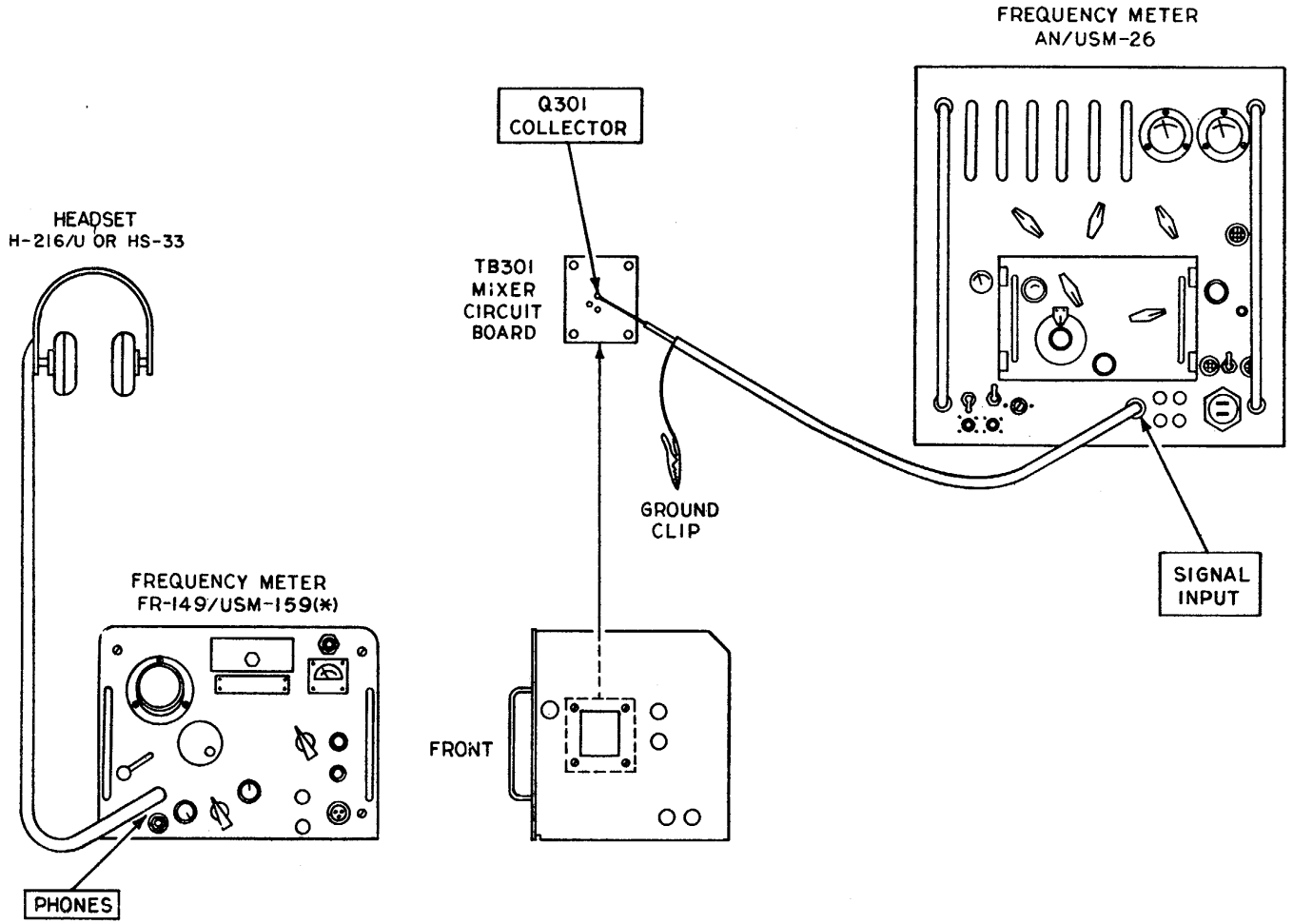


Figure 6-18. Frequency range of corrector test setup.

Table 6-8. Frequency Range of Corrector Test Control settings

Control Settings		Test Procedure	Performance Standard
Test Equipment	**Equipment under test**		
AN/USM-26(*): POWER: ON. FUNCTION: FREQUENCY. STD FREQ: 10 MC. STD GATE TIME: 1. MIXING FREQ, MCS: 0. CONVERTER GAIN: Advance control for a satisfactory counter readout.	FUNCTION SW: OPER. RANGE SW: B. DIAL: 5,000 kHz (5 MHz). CORRECTOR: midrange.	*a.* Allow AN/USM-26(*) to Warm up for 15 minutes before proceeding. *b.* Adjust CORRECTOR Control to indicate 5,000 kHz on AN/USM-26(*). *c.* Rotate CORRECTOR control over its full range and observe frequency on AN/USM-26(*).	*a.* None. *b.* None. *c.* CORRECTOR control should cause a frequency change of ± 500 Hz from 5,000 kHz.

6-36. Frequency Resetability

a. Test Equipment and Material.

(1) Frequency Meter AN/USM-26(*) with Frequency Meter Subassembly MX-1637A/U.

(2) Headset H-216/U.

b. Test Connections and Conditions. Remove the FR-149(*)/USM-159 from its case and place the equipment as shown in figure 6-19. Do not connect the AN/USM-26(*) until instructed to do so.

c. Procedure. Follow the procedures given in table 6-9.

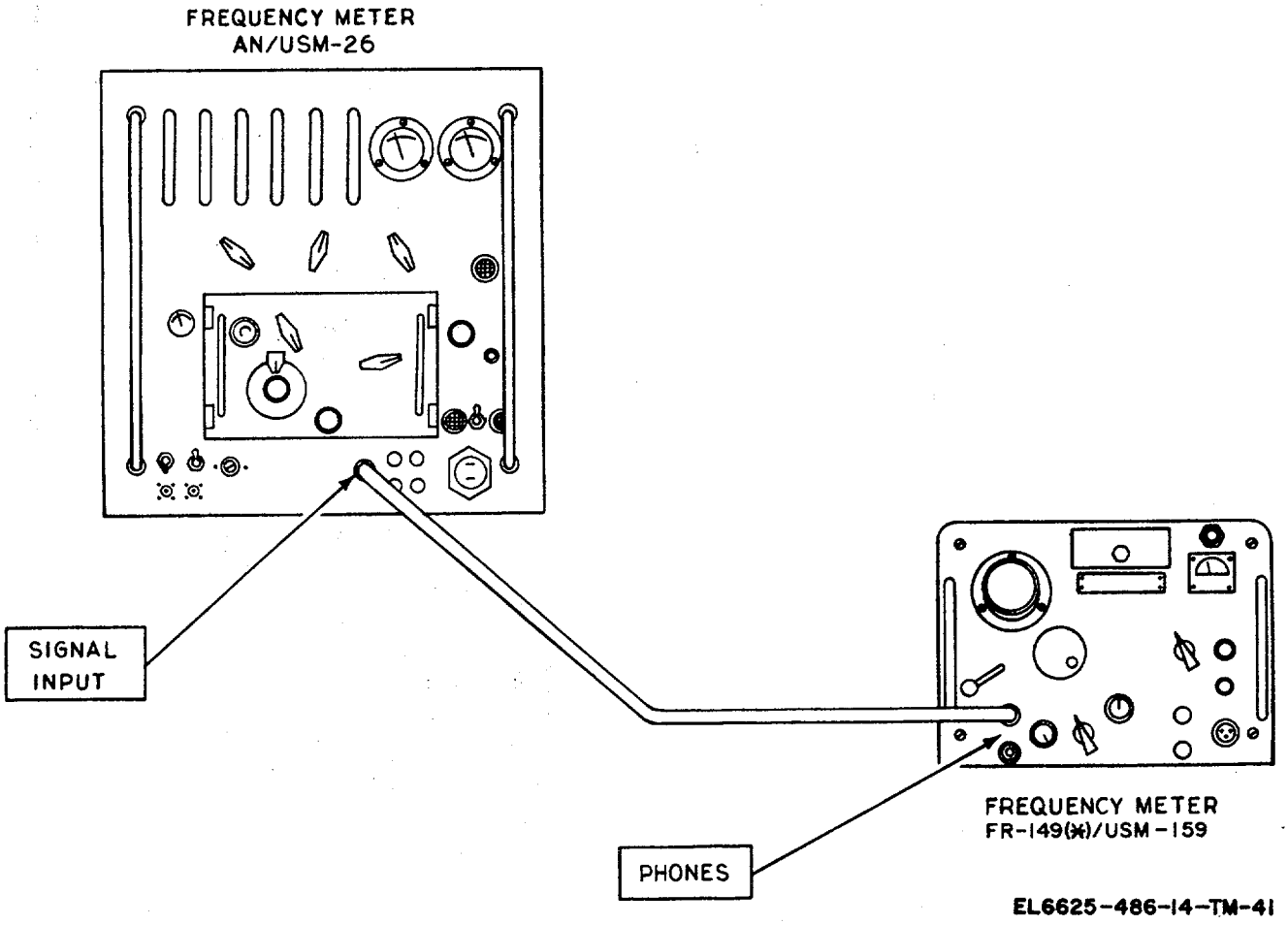


Figure 6-19. Frequency resetability test setup.

Table 6-9. Frequency Resetability Test

Step No.	Control Settings		Test Procedure	Performance Standard
	Test Equipment	Equipment under test		
1	*AN/USM-26*(*): POWER: ON. FUNCTION: FREQUENCY. STD FREQ: 10 MC. STD GATE TIME: 1. MIXING FREQ MCS: 0.	FUNCTION SW: CHK. RANGE SW: B.	Tune AN/USM-159(*) to 4,750-kHz checkpoint. Adjust CORRECTOR for zero beat in H-216/U. **NOTE** **Unless instructed to do so, do not disturb CORRECTOR setting.**	None.
2	Same as step No. 1.	Same as step No. 1.	*a.* Connect AN/USM-26(*) as shown in figure 6-19. *b.* Tune AN/USM-159(*) to 4,765 kHz and record frequency readout on AN/USM-26.	*a.* None. *b.* None.
3	Same as step No. 1.	Same as step No. 1.	Disconnect AN/USM-26(*) and proceed as in step No. 1 above.	None.
4	Same as step No. 1	Same as step No. 1.	Same as step No. 2 above.	Frequency read on AN/USM-26(*) in step 2 should agree with reading obtained in step No. 4 within ±0.005%.

6-37. Dial Lock Frequency Shift

a. Test Equipment and Materials. Frequency Meter AN/USM-26(*).

b. Test Connections and Conditions. Connect the equipment as shown in figure 6-20.

c. Procedure. Follow the procedures given in table 6-10.

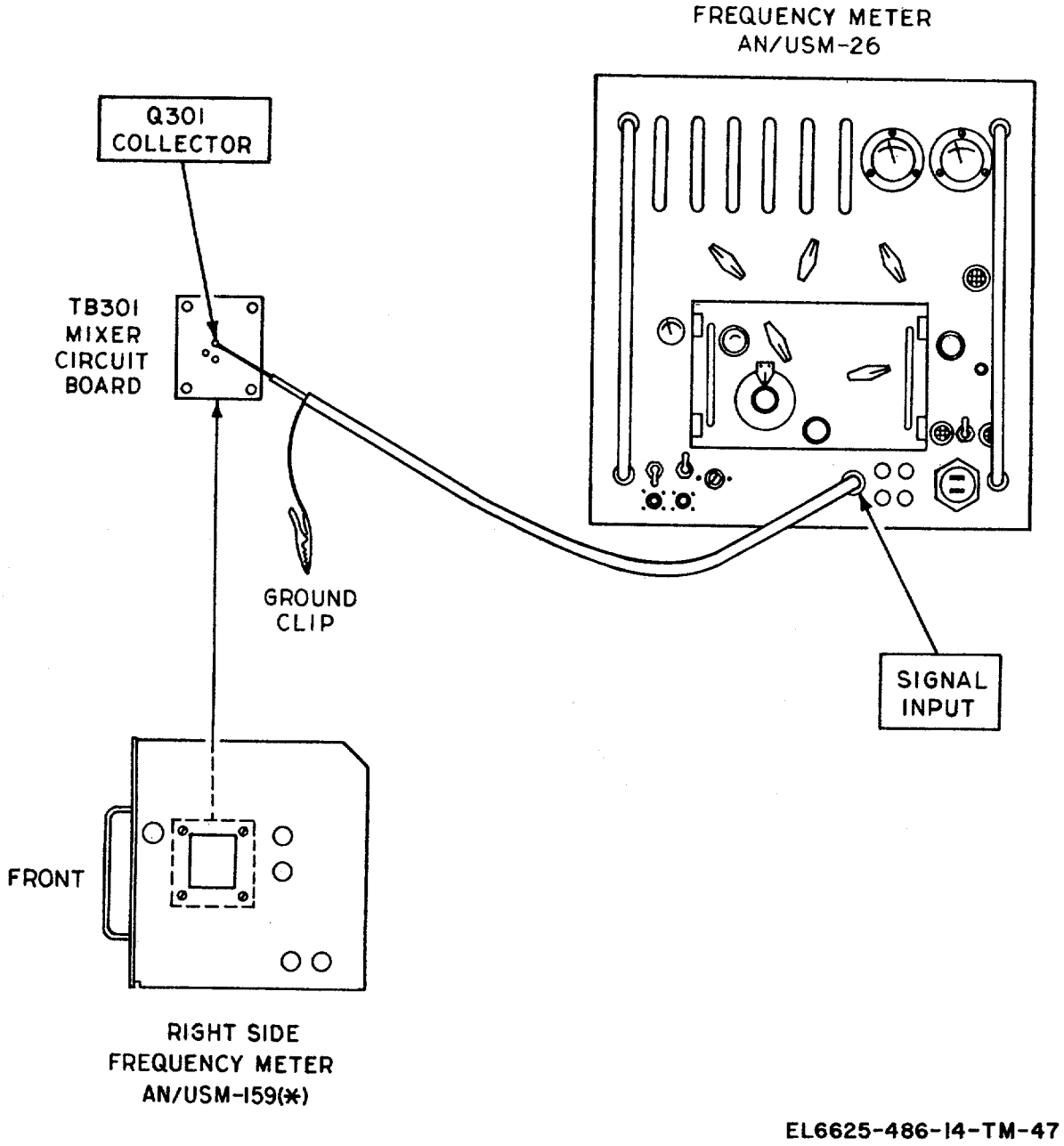


Figure 6-20. Dial lock frequency shift and modulator repetition rate test setup.

Table 6-10. Dial Lock Frequency Shift Test

Control Settings		Test Procedure	Performance Standard
Test Equipment	**Equipment under test**		
POWER: ON. FUNCTION: FREQUENCY. STD FREQ: 10 MC. STD GATE TIME: 1. MIXING FREQ MCS: 0.	FUNCTION SW: CHK. RANGE SW: B.	*a.* Apply power to AN/USM-26(*) and allow it to warm up for 15 minutes. *b.* Tune AN/USM-159(*) to point and adjust TUNING knob and CORRECTOR control to obtain a readout frequency of 3,000 Hz on AN/USM-26(*). *c.* Frequency shift should be within ±0.0025% (limits ± 125 Hz, computed at 5,000 kHz).	*a.* None *b.* None. 5,000-kHz (5 MHz) check-
	c. Lock TUNING knob and dial with DIAL LOCK lever. Observe readout frequency on AN/USM-26(*).		

6-38. Modulator Repetition Rate

a. Test Equipment and Materials. Frequency Meter AN/USM-26(*) (with plug-in converter).

b. Test Connections and Conditions. Connect the equipment as shown in figure 6-20.

c. Procedure. Follow the procedures outlined in table 6-11.

Table 6-11. Modulator Repetition Rate Test

Control Settings		Test Procedure	Performance Standard
Test Equipment	**Equipment under test**		
POWER: ON. FUNCTION: FREQUENCY. STD FREQ: 100 kHz. STD GATE TIME: 1. MIXING FREQ. MCS: 0. 900 Hz 300 Hz.	FUNCTION SW: MOD. RANGE SW: Any range. AUDIO GAIN: Fully -clock-wise.	a. Apply power to AN/USM-26(*) and allow it to warm up for 15 minutes. b. Observe frequency indicated	a. None. b. Readout frequency should be on AN/USM-26(*).

6-39. Spurious Crystal Checkpoint Rejection

a. Test Equipment and Materials.

(1) Oscilloscope AN/USM-151(*).

(2) Headset H-216/U.

(3) 600-ohm dummy load (fabricated in accordance with instructions given in paragraph 6-10).

b. Test Connections and Conditions.

(1) Connect the equipment as shown in figure 6-21.

(2) Allow the oscilloscope to warm up for 15 minutes and the frequency meter (battery operations) for 5 minutes.

c. Procedure. Follow the procedures outlined in table 6-12.

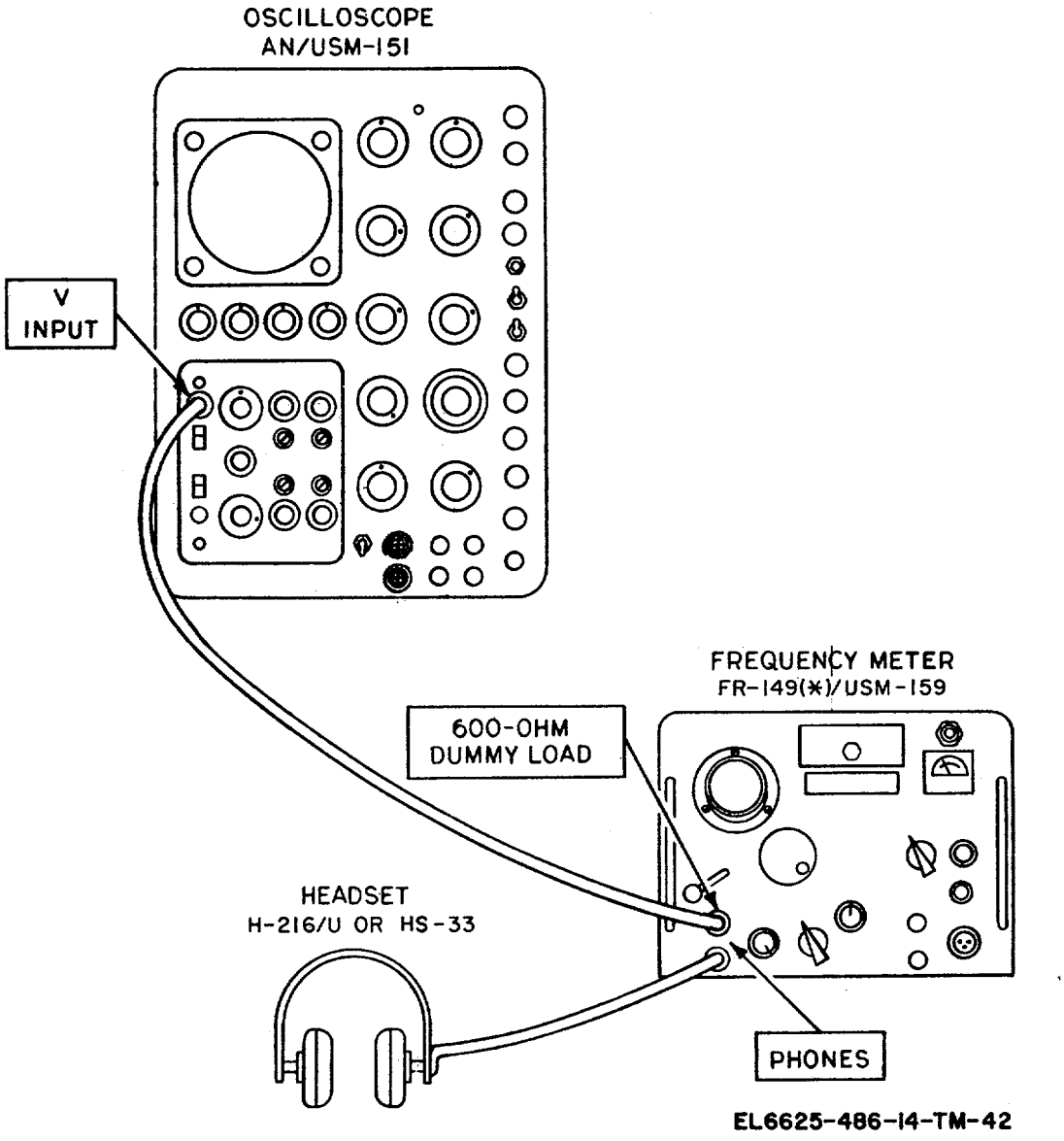


Figure 6-21. Spurious crystal checkpoint rejection test set up.

Table 6-12. Spurious Crystal Checkpoint Rejection Test

Control Settings		Test Procedure	Performance Standard
Test Equipment	**Equipment under test**		
POWER: ON. AMPLITUDE CALIBRATOR VOLTS/CM: 0.5.	FUNCTION SW: CHK. RANGE SW: Any range.	*a.* Allow oscilloscope to warm up for 15 minutes before use. *b.* Adjust oscilloscope AMPLITUDE CALIBRATOR to calibrate CRT screen for 2V PP; then, turn AMPLITUDE CALIBRATOR to OFF.	*a.* None. *b.* None.
	c. Tune Frequency Meter FR-149(*)/USM-159 to any crystal checkpoint. Plug in Headset HS-216/U and adjust CORRECTOR control for zero beat (use loudest beat note) in headset.		*c.* None.
	d. Adjust CORRECTOR and AUDIO GAIN controls to obtain 1.54 volts peak-to-peak of true zero-beat note as indicated on oscilloscope and heard in headset; then, unplug HS-216/U.		*d.* Note.
	e. Rotate CORRECTOR control throughout its range and observe peak-to-peak voltage level of any spurious beat notes other than true zero-beat note level of 1.54 volts.		*e.* Peak-to-peak voltage level of any spurious beat notes should be not greater than 0.154 volts peak-to-peak (down at least 20 db below true beat level).

6-40. Audio Power Output With Internal Crystal Oscillator Test

a. Test Equipment and Materials.

(1) Oscilloscope AN/USM-151(*).

(2) 600-ohm dummy load (fabricated in accordance with instructions given in paragraph 6-10).

(3) Multimeter TS-352B/U.

(4) Variable Power Transformer CN-16/U.

(5) Headset H-216/U.

b. Test Connections and Conditions. Connect the equipment as shown in figure 6-22.

c. Procedure. Follow the procedures given in table 6-13.

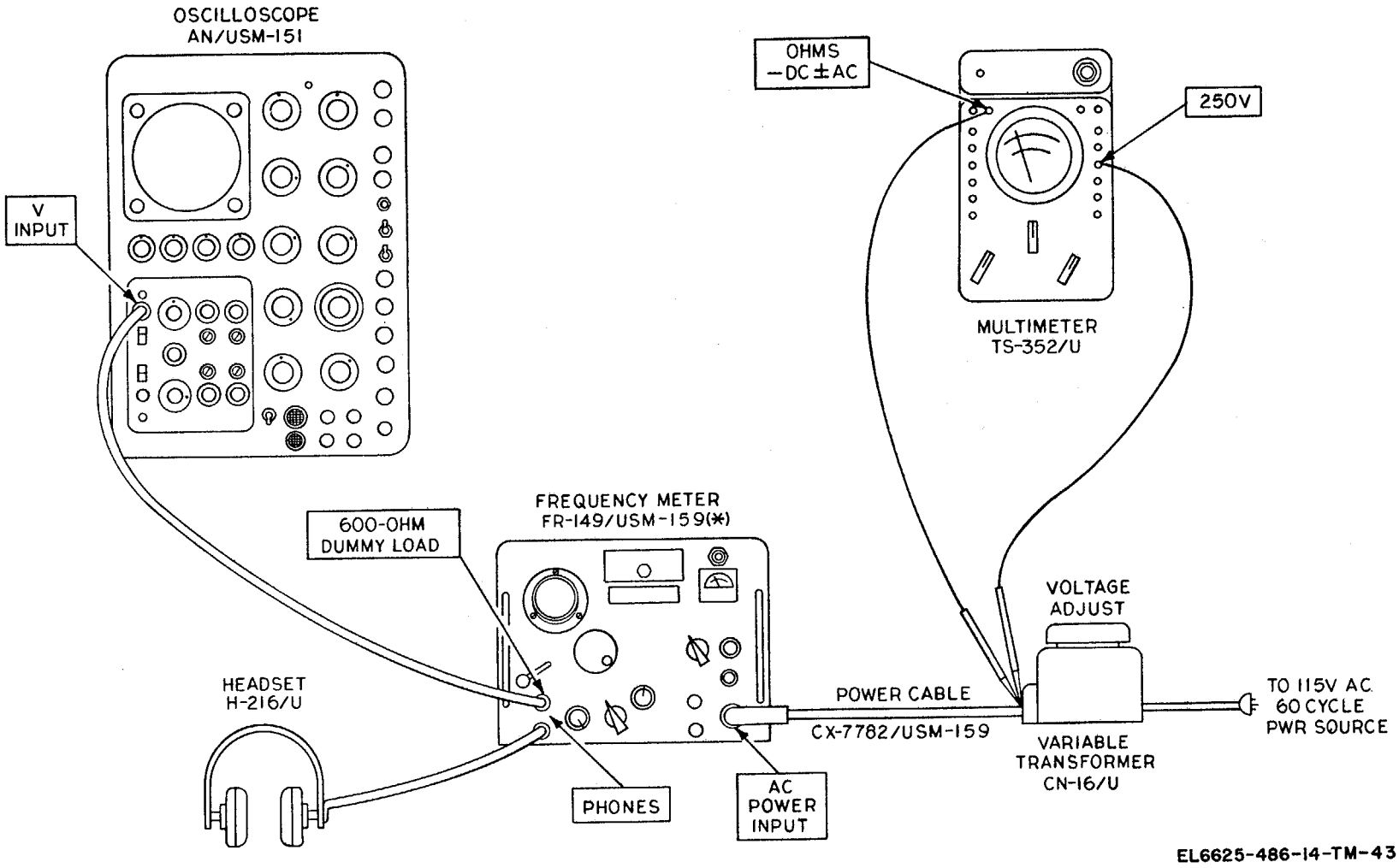


Figure 6-22. Audio power output with internal crystal oscillator test setup.

Table 6-13. Audio Power Output With Internal Crystal Oscillator Test

Step No.	Control Settings: Test Equipment	Control Settings: Equipment under test	Test Procedure	Performance Standard
1	*CN-16/U*: Voltage control: 103 *TS-352B/U:* FUNCTION: AC VOLTS. Range: 250V AC. *AN/USM-151(*):* STABILITY: Fully right. TRIGGERING LEVEL: Fully right. TRIGGERING SLOPE: +INT. TRIGGERING MODE: AC LF REJECT. TIME/CM: 10 USEC. MULTIPLIER: 1. 5X MAGNIFIER: OFF. HORIZONTAL DISPLAY: MAIN SWEEP NORMAL. ATTN: X1. SLOPE: +. AMPLITUDE CALIBRATOR: 20. POWER: ON.	FUNCTION SW: CHK. AUDIO GAIN: Fully	*CN-16/U* *a.* Adjust voltage control until ccw. TS-352B/U indicates 103V. *b.* Apply power to AN/USM-159(*) and AN/USM-151(*). Allow a 15-minute warmup period.	*a.* None. *b.* None.
2		RANGE SW: A. TUNING: 125 kHz.	*AN/USM-159(*)* *a.* Adjust AUDIO GAIN control for comfortable sound level. *b.* Adjust CORRECTOR control unit sound heard in headset is loudest beat note obtainable. Unplug headset. *c.* Turn AUDIO GAIN control fully clockwise and observe peak-to-peak voltage indicated on oscilloscope.	*a.* None. *b.* None. *c.* Minimum amplitude indicated on oscilloscope should be 1.54 volts, peak-to-peak.
3	Same as step No. 1.	Same as step No. 1.	Disconnect TS-352B/U and CN-16/U and proceed as in step 2.	Same as step No. 2.
4	Same as step No. 1.	Same as step No. 1, except: TUNING: 150 kHz.	Same as steps No. 1 and 2.	Same as step No. 2.
5	Same as step No. 1.	Same as step No. 1, except: TUNING: 200.	Same as steps No. 1, 2, and 3.	Same as step No. 2.
6	Same as step No. 1.	same as step No. 1, except: TUNING: 250 kHz.	Same as steps No. 1, 2, and 3.	Same as step No. 2.
7	Same as step No. 1.	Same as step No. 1, except: TUNING: 2,500. Range: B.	Same as steps No. 1, 2, and 3.	Same as step No. 2.
8	Same as step No. 1.	Same as step No. 7, except: TUNING: 2,800.	Same as steps No. 1, 2, and 3.	Same as step No. 2.
9	Same as step No. 1.	Same as step No. 7, except: TUNING: 3,400.	Same as steps No. 1, 2, and 3.	Same as step No. 2.
10	Same as step No. 1.	Same as step No. 7, except: TUNING: 3,800.	Same as steps No. 1, 2, and 3.	Same as step No. 2.

Table 6-13. Audio Power Output With Internal Crystal Oscillator Test-Continued

Step No.	Control Settings		Test Procedure	Performance Standard
	Test Equipment	Equipment under test		
11	Same as step No. 1.	Same as step No. 1, except: TUNING: 65.00. RANGE: C.	Same as steps No. 1, 2, and 3.	Same as step No. 2.
12	Same as step No. 1.	Same as step No. 11, except: TUNING: 85.00.	Same as steps No. 1, 2, and 3.	Same as step No. 2.
13	Same as step No. 1.	Same as step No. 11, except: TUNING: 110.00.	Same as steps No. 1, 2, and 3.	Same as step No. 2.
14	Same as step No. 1.	Same as step No. 11, except: TUNING: 130.00.	Same as steps, No. 1, 2, and 3.	Same as step No. 2.

6-41. Audio Power Output With External Rf Input Signal Test

a. Test Equipment and Materials.

(1) Oscilloscope AN/USM-151(*).

(2) Rf Signal Generator Set AN/URM-25F.

(3) Rf Signal Generator AN/URM-44A.

(4) Rf Signal Generator AN/URM-49(*).

(5) Multimeter TS-352B/U.

(6) 600-ohm dummy load.

b. Test Connections and Conditions. Set up the equipment as shown in figure 6-23. Do not connect the AN/USM-151(*), except the 600-ohm dummy load, or the rf signal generators until indicated.

c. Procedures. Follow the procedures given in table 6-14.

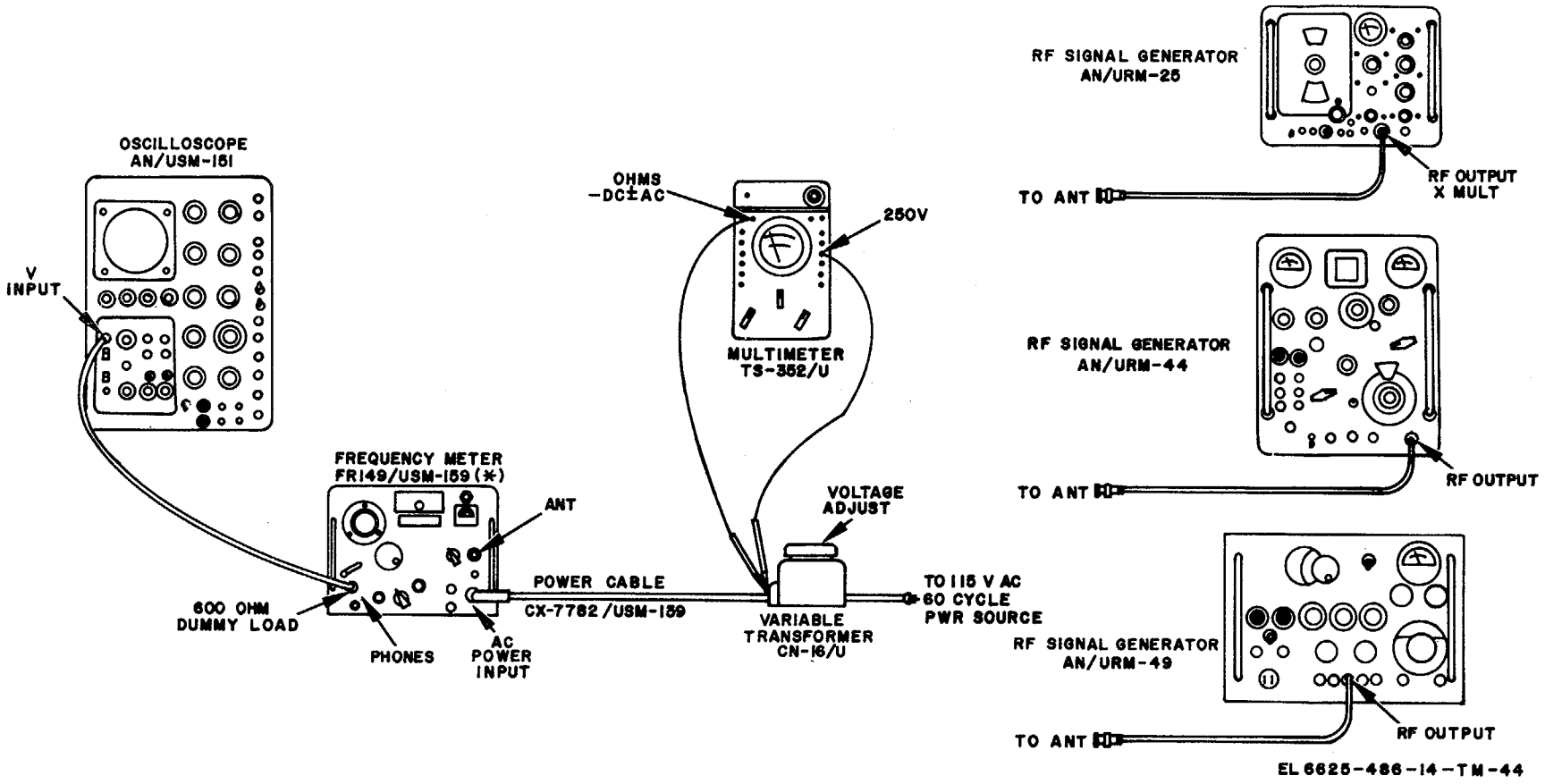


Figure 6-23. Audio power output with external rf input signal test setup.

Table 6-14. Audio Power Output With External Rf Input Signal Test

Step No.	Control Settings		Test Procedure	Performance Standard
	Test Equipment	Equipment under test		
1	*AN/USM-151*(*) MODE: A ONLY. VOLTS/CM: 1. POLARITY: NORMAL. TRIGGERING MODE: AC. TRIGGERING SLOPE: + INT. 5X MAGNIFIER: OFF. HORIZONTAL DISPLAY: MAIN SWEEP NORMAL. ATTEN: X1. SLOPE: +. AMPLITUDE CALIBRATOR: 5.	FUNCTION: OPER. AUDIO GAIN: Fully clockwise. RANGE SW: A. TUNING: 125 kHz.	*a.* Turn on the equipment and let it warmup for 30 minutes. *CN-16/U* *b.* Adjust voltage adjust to 103 volts as read on TS-352B/U.	*a.* None. *b.* None.
	AN/URM-25F: Frequency 125 kHz. FREQUENCY BAND SWITCH: C.		*c.* Connect CALIBRATE OUT to CHANNEL A INPUT on AN/USM-151 and adjust FOCUS, BRILLIANCE, ASTIGMATISM, HORIZONTAL CENTERING, and VERTICAL CENTERING controls for clear, sharp, and properly centered square wave on oscilloscope. Calibrate oscilloscope to indicate 5 volts peak-to-peak. Disconnect lead from CALIBRATE OUT connector. *AN/USM-151(*)* *d.* Connect CHANNEL A INPUT to 600-ohm dummy load, and plug dummy load into one of AN/USM-159(*) PHONES jack. *AN/URM-25F* *e.* Connect output to AN/USM-159(*) ANT. jack. Adjust AN/URM-26F MULTIPLIER AND MICROVOLTS controls to obtain 0.1-volt output as measured on output meter. *f.* Adjust AN/USM-159 (*) CORRECTOR control to obtain maximum amplitude on AN/USM-151(*) oscilloscope.	*c.* None. *d.* None. *e.* None. *f.* AN/USM-161(*) indicates 2.16 volts peak-to-peak (1 mw).
2	Same as step No. 1, except: *AN/URM-25F*: Frequency: 1.00 MHz. FREQUENCY BAND SWITCH: E.	Same as step No. 1	Adjust AN/USM-159(*) CORRECTOR control for maximum amplitude of display on AN/USM-151(*) oscilloscope.	AN/USM-151(*) oscilloscope indicates 0.486 peak-to-peak.
3	Same as step No. 1, except: *AN/URM-25F*: FREQUENCY BAND SWITCH: C. Frequency: 190 kHz.	Same as step No. 1, except: TUNING: 190 kHz.	Same as step No. 2.	Same as step No. 1.

Table 6-14. Audio Power Output with External Rf Input Signal Test-Continued

Step No.	Control Settings		Test Procedure	Performance Standard
	Test Equipment	Equipment under test		
4	Same as step No. 1, except: *AN/URM-25F*: FREQUENCY BAND SWITCH: E. Frequency: 1.52 MHz.	Same as step No. 3.	Same as step No. 2.	Same as step No. 2.
5	Same as step No. 1, except: *AN/URM-25F*: FREQUENCY BAND SWITCH: D. Frequency: 250 kHz.	Same as step No. 1, except: TUNING: 250 kHz.	Same as step No. 2.	Same as step No. 1.
6	Same as step No. 1, except: *AN/URM-25F*: FREQUENCY BAND SWITCH: F. Frequency: 2.5 MHz.	Same as step No. 5.	Same as step No. 2	Same as step No. 2.
7	Same as step No. 6.	Same as step No. 1, except: RANGE: B. TUNING: 2,500 kHz.	Same as step No. 2.	Same as step No. 1.
8	Same as step No. 6, except: *AN/URM-25F:* Frequency: 3.75 MHz.	Same as step No. 7, except: TUNING: 3,750 kHz.	Same as step No. 2.	Same as step No. 1.
9	Same as step No. 6, except: *AN/URM-25F*: Frequency: 5.00 MHz.	Same as step No. 7, except: TUNING: 5,000 kHz.	Same as step No. 2	Same as step No. 1.
10	Same as step No. 1, except: *AN/URM-25F:* FREQUENCY BAND SWITCH: H. Frequency: 20 MHz.	Same as step No. 7.	Same as step No. 2.	Same as step No. 2.
11	Same as step No. 10, except: *AN/URM-25F*: Frequency: 30 MHz.	Same as step No. 8.	Same as step No. 2.	Same as step No. 2.
12	Same as step No. 10, except: *AN/URM-25F*: Frequency: 40 MHz.	Same as step No. 9.	Same as step No. 2, except: Disconnect AN/URM-25F when finished with test.	Same as step No. 2.
13	Same as step No. 1, except: *AN/URM-44A*: FREQUENCY RANGE: C. FREQUENCY: 65 MHz. MOD SELECTOR: CW. XTAL CAL: 5 MC.	Same as step No. 9.	Adjust ATTEN control for 0.1-volt output as indicated on OUTPUT VOLTS meter. Adjust FINE FREQUENCY ADJUST for zero beat as heard in headset. Connect RF OUTPUT to AN/USM-159(*) ANT. jack. Turn CORRECTOR control for maximum output as indicated on AN/USM-151(*) oscilloscope.	Same as step No. 2.
14	Same as step No. 13.	Same as step No. 1, except: RANGE: C. Frequency: 65 MHz.	Same as step No. 13.	Same as step No. 1.

Table 6-14. Audio Power Output with External Rf Input Signal Test-Continued

Step No.	Control Settings		Test Procedure	Performance Standard
	Test Equipment	Equipment under test		
15	Same as step No. 13, except: *AN/URM-44A*: FREQUENCY RANGE: D. FREQUENCY: 100 MHz.	Same as step No. 14, except: TUNING: 100 MHz.	Same as step No. 13-	Same as step No. 1.
16	Same as step No. 15, except: *AN/URM-44A*: FREQUENCY: 130 MHz.	Same as step No. 14, except: TUNING: 130 MHz.	Same as step No. 13.	Same as step No. 1.
17	Same as step No. 13 except: *AN/URM-44A*: FREQUENCY RANGE: E. FREQUENCY: 260 MHz.	Same as step No. 14.	Same as step No. 13.	Same as step No. 2.
18	Same as step No. 17, except: *AN/URM-44A*: FREQUENCY: 400 MHz.	Same as step No. 14, except: TUNING: 100 MHz.	Same as step No. 13.	Same as step No. 2.
19	AN/URM-49(*): Same as step No. 14. SIGNAL FREQUENCY MC: 520 MHz. MODULATION SELECTOR: CW.		Disconnect AN/URM-44A. Connect AN/URM-49(*) to AN/USM-159(*) ANT. connector. Adjust PWR SET control for midscale reference mark. Adjust OUTPUT ATTENUATOR for 0.1 volt.	Same as step No. 2.
20	Same as step No. 14, except: *AN/URM-49(*):* SIGNAL FREQUENCY MC: 800 MHz.	Same as step No. 15.	Same as step No. 19.	Same as step No. 2.
21	Same as step No. 14, except: *AN/URM-49(*):* SIGNAL FREQUENCY MC: 1,000 MHz.	Same as step No. 14, except: TUNING: 125 MHz.	Same as step No. 19.	Same as step No. 2.
22	Same as step No. 19, except: *AN/URM-49(*):* SIGNAL FREQUENCY MC: 520 MHz.	Same as step No. 14, except: TUNING: 130 MHz.	Same as step No. 19.	Same as step No. 2.
23		Repeat steps 1 through 22 with power cord of AN/USM-159(*) disconnected from front panel.		

6-42. Performance Test Summary

a. Frequency Drift with Change in Line Voltage.

(1) Ac line voltage changes between 103 and 230 Vac.

(2) Frequency drift should not exceed ± 0.005 %.

b. Crystal Oscillator Frequency.

(1) Check at 1 MHz and 2.5 MHz.

(2) Must be within 5 Hz of 1 MHz, and 12.5 Hz of 2.5 MHz.

c. Frequency Resetability. Must be within ± 0.005 %.

d. Dial Lock Frequency Shift. Must be within ±0.0025 % (limits at ± 125 Hz at 5 MHz).

e. Modulator Repetition Rate. Must be 900 Hz ± 300.

f. Spurious Crystal Checkpoint Rejection. Must be down 20 db from true beat.

g. Audio Power Output with Internal Crystal Oscillator. Must be 0.5 mw (minimum).

h. Audio Power Output with External Rf Input Signal.

(1) Check at fundamental frequencies and harmonic frequencies.

(2) Must be at least 1.0 mw, and 0.05 mw, respectively.

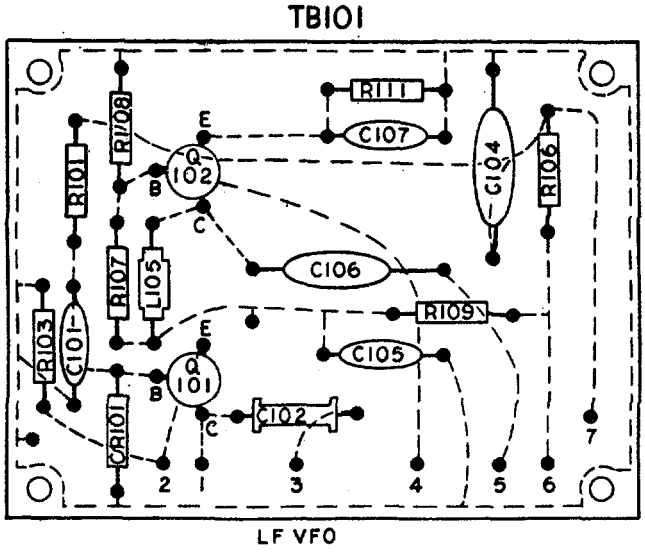
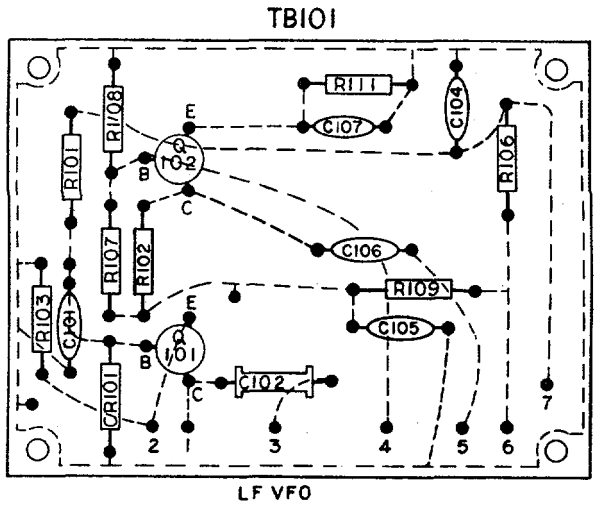


Figure 6-24. FR-149/USM-159, low frequency ufo circuit wiring diagram.

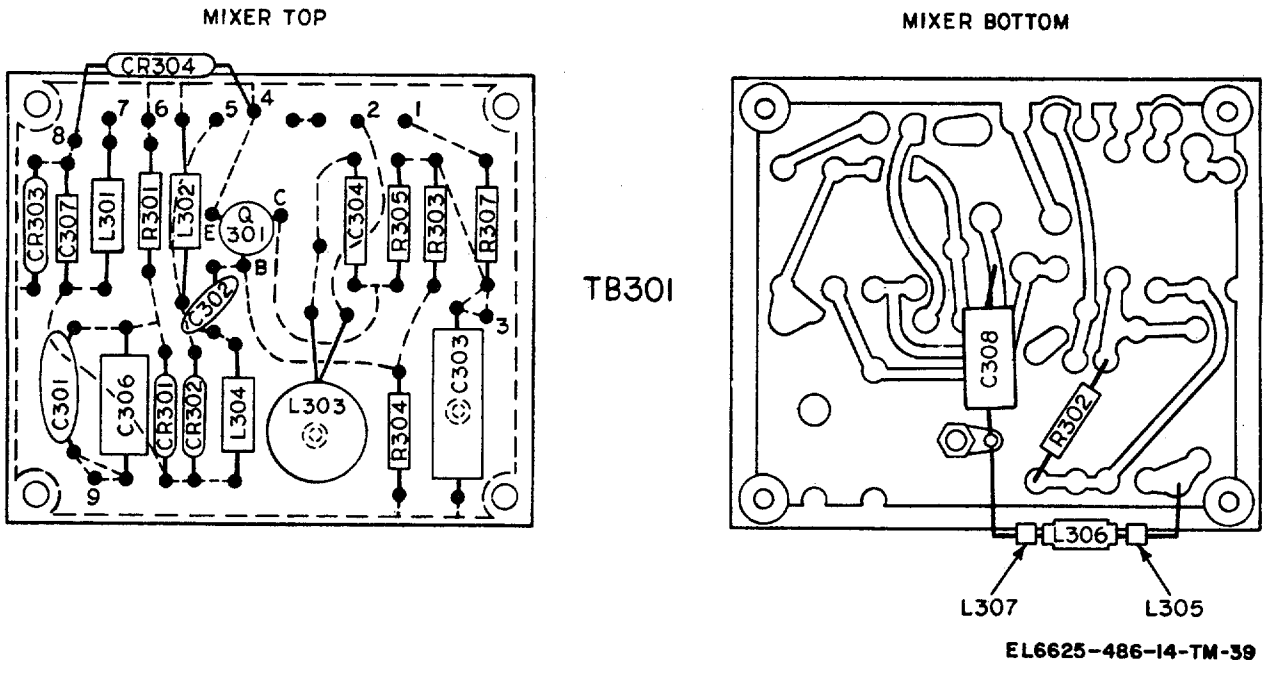


NOTES

1. CIRCUIT VIEWED FROM SIDE ON WHICH PARTS ARE MOUNTED.
2. —— PARTS & PIGTAILS ON FRONT OF BOARD.
3. – – – WIRING ON BACK OF BOARD.

EL6625-486-14-TM-46

Figure 6-25. FR-149A/USM-159 and FR-149B/USM-159, low frequency ufo circuit wiring diagram.



EL6625-486-14-TM-39

Figure 6-26. FR-149/USM-159, mixer circuit wiring diagram.

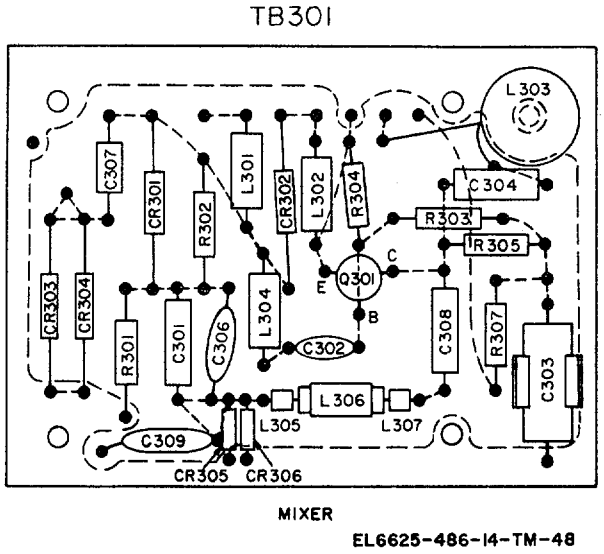
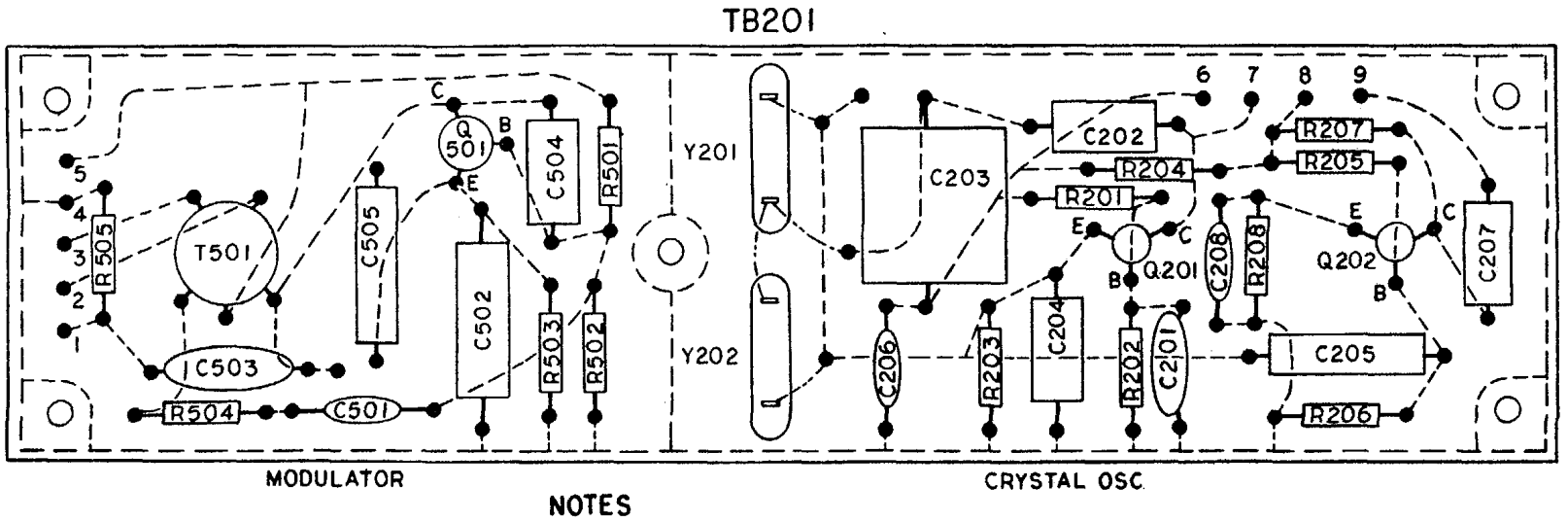


Figure 6-27. FR-149A/USM-159 and FR-149B/USM-159, mixer circuit wiring diagram.

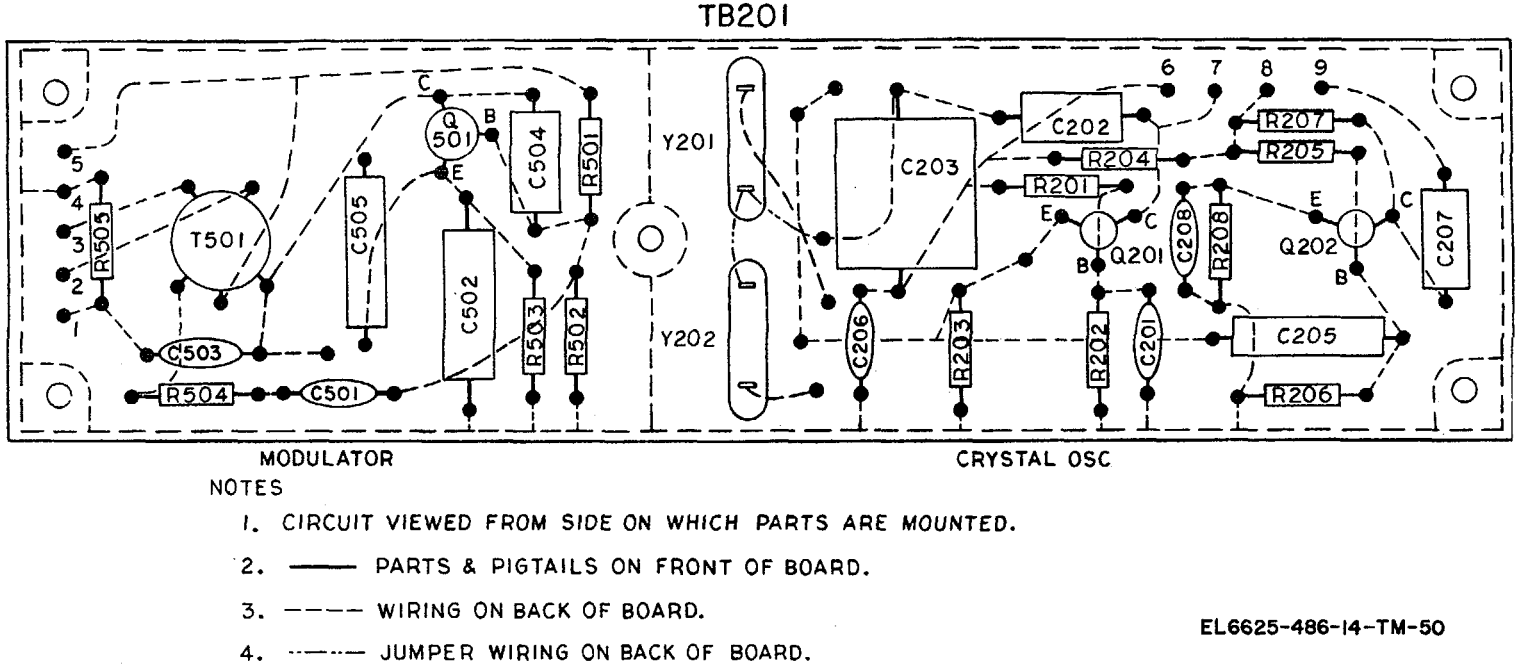


NOTES

1. CIRCUIT VIEWED FROM SIDE ON WHICH PARTS ARE MOUNTED.
2. ——— PARTS & PIGTAILS ON FRONT OF BOARD.
3. – – – – WIRING ON BACK OF BOARD.
4. ·—·—· JUMPER WIRING ON BACK OF BOARD.

EL6625-486-14-TM-49

Figure 6-28. FR-149/USM-159, crystal oscillator and modulator circuit wiring diagram.



NOTES

1. CIRCUIT VIEWED FROM SIDE ON WHICH PARTS ARE MOUNTED.
2. —— PARTS & PIGTAILS ON FRONT OF BOARD.
3. – – – – WIRING ON BACK OF BOARD.
4. ·——·— JUMPER WIRING ON BACK OF BOARD.

EL6625-486-14-TM-50

Figure 6-29. FR-149A/USM-159A and FR-149B/USM-159, crystal oscillator and modulator circuit wiring diagram.

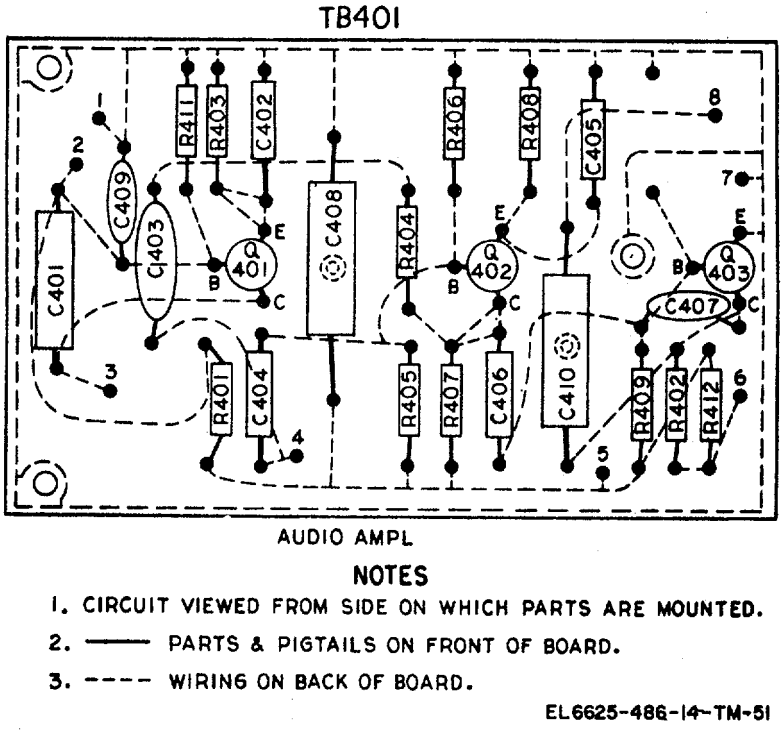


Figure 6-30. FR-149/USM-159 and FR-149A/USM-159, audio amplifier circuit wiring diagram.

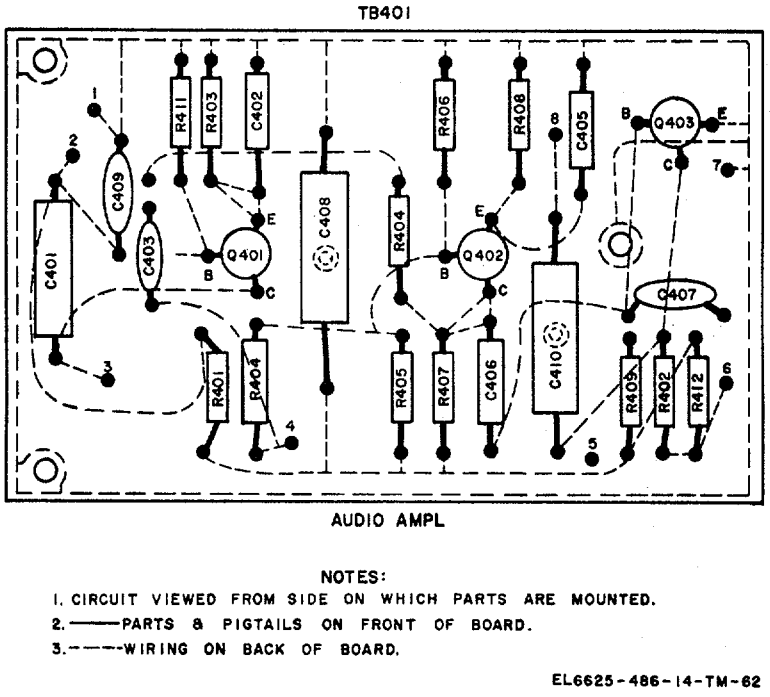


Figure 6-31. FR-149B/USM-159, audio amplifier circuit wiring diagram.

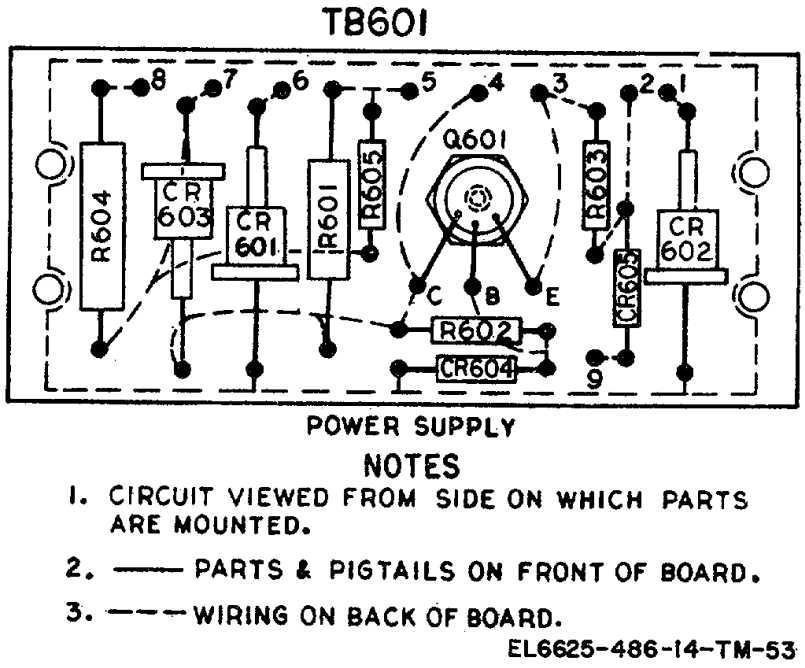


Figure 6-32. FR-149(*)/USM-159, power supply circuit wiring diagram.

APPENDIX A

REFERENCES

DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (types 7, 8, and 9) Supply Bulletins, and Lubrication Orders.
DA Pam 310-7	US Army Equipment Index of Modification Work Orders.
TB 11-6625-486-35/1	Calibration Procedure for Frequency Meter AN/USM-159.
TB 746-10	Field Instructions for: Painting and Preserving Electronics Command Equipment.
TM 11-6625-200-15	Operator's, Organizational, DS, GS, and Depot Maintenance Manual: Multimeters ME-26A/U, ME-26B/U, ME-26C/U and ME-26D/U.
TM 11-6625-212-15	Operator, Organizational, DS, GS, and Depot Maintenance Manual Including Repair Parts and Special Tool Lists: Frequency Meters AN/USM-26 and AN/USM-26A.
TM 11-6625-280-15	Organizational, Field and Depot Maintenance Manual: Signal Generators AN/URM-49, AN/URM-49A, AN/URM-49B, and AN/URM-49C.
TM 11-6625-466-15	Operator's, Organizational, Field and Depot Maintenance Manual: Oscilloscope AN/USM-151.
TM 38-750	The Army Maintenance Management System (TAMMS).
TM 740-90-1	Administrative Storage of Equipment.
TM 750-244-2	Procedures for Destruction of Electronics Materiel to Prevent Enemy Use (Electronics Command).

APPENDIX C

MAINTENANCE ALLOCATION

Section I. INTRODUCTION

C-1. General

This appendix provides a summary of the maintenance operations for the equipment. It authorizes categories of maintenance for specific maintenance functions on repairable items and components and the tools and equipment required to perform each function. This appendix may be used as an aid in planning maintenance operations.

C-2. Maintenance Function

Maintenance functions will be limited to and defined as follows:

a. Inspect. To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination.

b. Test. To verify serviceability and to detect incipient failure by measuring the mechanical or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. Service. Operations required periodically to keep an item in proper operating condition, i.e., to clean, preserve, drain, paint, or to replenish fuel/lubricants/ hydraulic fluids or compressed air supplies.

d. Adjust. Maintain within prescribed limits by bringing into proper or exact position, or by setting the operating characteristics to the specified parameters.

e. Align. To adjust specified variable elements of an item to about optimum or desired performance.

f. Calibrate. To determine and cause corrections to be made or to be adjusted on instruments or test measuring and diagnostic equipment used in precision measurement. Consists of the comparison of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any-discrepancy in the accuracy of the instrument being compared.

g. Install. The act of emplacing, seating, or fixing into position an item, part, module (component or assembly) in a manner to allow the proper functioning of the equipment/system.

h. Replace. The act of substituting a serviceable like-type part, subassembly, model (component or assembly) for an unserviceable counterpart.

i. Repair. The application of maintenance services (inspect, test, service, adjust, align, calibrate, replace) or other maintenance actions (welding, grinding, riveting, straightening, facing, remachining, or resurfacing) to restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module/component/assembly, end item or system.

j. Overhaul. That periodic maintenance effort (service/action) necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards (e.g., DMWR) in appropriate technical publications. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like-new condition.

k. Rebuild. Consists of those services/actions necessary for the restoration of unserviceable equipment to a like-new condition in accordance with original manufacturing standards. Rebuild is the highest degree of materiel maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours, miles, etc) considered in classifying Army equipment/components.

C-3. Column Entries

a. *Column 1, Group Number*. Column 1 lists group numbers, the purpose of which is to identify components, assemblies, subassemblies and modules with the next higher assembly.

b. Column 2, Component/Assembly. Column 2 contains the noun names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. Column 3, Maintenance Functions. Column 3 lists the functions to be performed on the item listed in column 2.

d. Column 4, Maintenance Category. Column 4

specifies, by the listing of a "worktime" figure in the appropriate subolumn(s), the lowest level of maintenance authorized to perform the function listed in column 3. This figure represents the active time required to perform that maintenance function at the indicated category of maintenance. If the number or complexity of the tasks within the listed maintenance function vary at different maintenance categories, appropriate "worktime" figures will be shown for each category. The number of man-hours specified by the "worktime" figure represents the average time required to restore an item (assembly, subassembly, component, module, end item or system) to a serviceable condition under typical field operating conditions. This time includes preparation time, troubleshooting time and quality assurance/quality control time in additional to the time required to perform the specific tasks identified for the maintenance functions authorized in the maintenance allocation chart. Subcolumns of column 4 are as follows:

C - Operator/Crew
O - Organizational
F - Direct Support
H - General Support
D - Depot

e. *Column 5, Tools and Equipment*. Column 5 specifies by code, those common tool sets (not individual tools) and special tools, test, and support equipment required to perform the designated function.

C-4. Tool and Test Equipment Requirements (Table 1)

a. *Tool or Test Equipment Reference Code*. The numbers in this column coincide with the numbers used in the tools and equipment column of the MAC. The numbers indicate the applicable tool or test equipment for the maintenance functions.

b. Maintenance Category. The codes in this column indicate the maintenance category allocated the tool or test equipment.

c. Nomenclature. This column lists the noun name and nomenclature of the tools and test equipment required to perform the maintenance functions.

d. National/NATO Stock Number. This column lists the National/NATO stock number of the specific tool or test equipment.

e. Tool Number. This column lists the manufacturer's part number of the tool followed by the Federal Supply Code for manufacturers (5-digit) in parentheses.

SECTION II MAINTENANCE ALLOCATION CHART
FOR
AN/USM-159, AN/USM-159A, AN/USM-159B

(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY C	O	F	H	D	(5) TOOLS AND EQUIPMENT
00	FREQUENCY METER AN/USM-159, AN/USM-159A AND AN/USM-159B	Inspect	0.5					
		Install	0.5					10
01	FREQUENCY METER FR-149(*)/USK-159	Inspect		0.5		0.5		
		Test				1.0		1 thru 10,12
		Adjust				0.5		1 thru 10,12
		Replace				0.5		1 thru 10,12
		Repair				2.0		1 thru 10,12
		Overhaul					2.0	1 thru 12
0101	AUDIO AMPLIFIER	Test				0.2		
		Repair				0.2		1
0102	CRYSTAL OSCILLATOR AND MODULATOR	Test				0.2		
		Repair				0.2		1,3
0103	MIXER	Test				0.2		
		Repair				0.2		1,3
0104	POWER SUPPLY	Test				0.2		
		Repair				0.2		1
0105	OSCILLATOR NETWORK ASSEMBLY	Test				0.2		
		Repair				0.2		1,3
010501	VARIABLE FREQUENCY OSCILLATOR	Test				0.2		
		Repair				0.2		1,3
0106	FILM DRIVE ASSEMBLY	Test				0,2		
		Repair				0.2		1
0107	CAPACITOR ASSEMBLY	Test				0.2		
		Repair				0.2		1
010701	OSCILLATOR ASSEMBLY	Test				0.2		
		Repair				0.2		1
01070101	CERAMIC PLATE ASSEMBLY	Inspect				0.1		
		replace				0.2		10
01070102	PLATE CASE ASSEMBLY	Inspect				0.1		
		Repair				0.2		10
010702	SHAFT ASSEMBLY	Inspect				0.1		
		Repair				0.2		10
0108	REAR PANEL ASSEMBLY	Inspect				0.1		
		Repair				0.2		10
0109	BATTERY BOX ASSEMBLY	Inspect				0.1		
		Repair				0.2		10
02	ANTENNA ASSEMBLY AT-564(*)/U	Inspect		0.2				
		Repair				0.5		10
03	CASE AND COVER ASSEMBLY HOURS SHOWN INCLUDE SUBASSEMBLIES 0301 AND 0302	Inspect		0.2				10
		Repair				0.5		
0301	COVER ASSEMBLY	Inspect		0.1				
		Repair				0.1		10

SECTION II MAINTENANCE ALLOCATION CHART
FOR
AN/USM-159, AN/USM-159A, AN/USM-159B

(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY C	O	F	H	D	(5) TOOLS AND EQUIPMENT
0302	CASE ASSEMBLY	Inspect		0.1				
		Repair				0.2		10
04	CABLE ASSEMBLY, POWER ELECTRICAL CX-12005/ USM-159 OR CX-7782/USM-159	Inspect		0.2				
		Replace		0.3				
		Repair				0.5		10
05	CORD ASSEMBLIES CD -307A and CG-409E/U	Inspect		0.2				
		Replace		0.3				
		Repair				0.5		10

TABLE I. TOOL AND TEST EQUIPMENT REQUIREMENTS FOR AN/USM-159, AN/USM-159A, AN/USM-159B

Tool Or Test Equipment Ref Code	Maintenance Category	Nomenclature	National/NATO Stock Number	Tool Number
1	H,D	MULTIMETER TS-352B/U	6625-553-0142	
2	H,D	MULTIMETER ME-26/U	6625-360-2493	
3	H,D	FREQUENCY METER AN/USM-207(*)	6625-543-1356	
		NOTE		
		TO BE REPLACED BY AN/USM-20(*)		
4	H,D	FREQUENCY CONVERTER, ELECTRONIC MX-1637A/U (P/O AN/USM-26(*))	6625-553-4006	
5	H,D	OSCILLOSCOPE AN/USM-151(*)	6625-892-4401	
		NOTE		
		TO BE REPLACED BY AN/USM-281A		
6	H,D	TRANSFORMER, VARIABLE POWER CN-16/U	5950-235-2086	
7	H,D	SIGNAL GENERATOR AN/URM-25F	6625-643-1548	
8	H,D	SIGNAL GENERATOR AN/URM-44A	6625-990-7700	
9	H,D	SIGNAL GENERATOR AN/URM-49(*)	6625-669-5131	
10	H	TOOL KIT TK-105/G	5180-610-8177	
11	D	RADIO INTERFERENCE MEASURING SET AN/URM-85 (*)	6625-776-0595	
12	H,D	SIGNAL GENERATOR AN/URM-127	6625-783-5965	
		DEPOT MAY USE ANY OTHER EQUIPMENT REQUIRED TO OVERHAUL OR REBUILD THIS EQUIPMENT.		

APPENDIX D

ORGANIZATIONAL, DIRECT SUPPORT, AND GENERAL SUPPORT MAINTENANCE REPAIR PARTS AND SPECIAL TOOLS LISTS (INCLUDING DEPOT MAINTENANCE REPAIR PARTS AND SPECIAL TOOLS)

Section I. INTRODUCTION

D-1. Scope

This appendix lists spares and repair parts; special tools; special test, measurement, and diagnostic equipment (TMDE), and other special support equipment required for performance of organizational, direct support, and general support maintenance of the AN/USM-159, AN/USM-159A, AN/USM-159B. It authorizes the requisitioning and issue of spares and repair parts as indicated by the source and maintenance codes.

D-2. General

This Repair Parts and Special Tools List is divided into the following sections:

a. Section II. Repair Parts List. A list of spares and repair parts authorized for use in the performance of maintenance. The list also includes parts which must be removed for replacement of the authorized parts. Parts lists are composed of functional groups in numeric sequence, with the parts in each group listed in figure and item number sequence.

b. Section III. *Special Tools List*. Not applicable.

c. Section IV. *National Stock Number and Part Number Index*. A list, in National item identification number (NIIN) sequence, of all National stock numbers (NSN) appearing in the listings, followed by a list, in alphameric sequence, of all part numbers appearing in the listings. National stock numbers and part numbers are cross-referenced to each illustration figure and item number appearance.

D-3. Explanation of Columns

a. Illustration. This column is divided as follows:

(1) *Figure number*. Indicates the figure number of the illustration on which the item is shown.

(2) *Item number*. The number used to identify item called out in the illustration.

b. Source, Maintenance, and Recoverability (SMR) codes.

(1) *Source code*. Source codes indicate the manner of acquiring support items for maintenance, repair, or overhaul of end items. Source codes are entered in the first and second positions of the uniform SMR Code format as follows:

Code	*Definition*
PA	Item procured and stocked for anticipated or known usage.
XD	A support item that is not stocked. When required, item will be procured through normal supply channels.

NOTE

Cannibalization or salvage may be used as a source of supply for any items source coded above except those coded XA and aircraft support items as restricted by AR 700-42.

(2) *Maintenance code*. Maintenance codes are assigned to indicate the levels of maintenance authorized to USE and REPAIR support items. The maintenance codes are entered in the third and fourth positions of the Uniform SMR Code format as follows:

(*a*) The maintenance code entered in the third position will indicate the lowest maintenance level authorized to remove, replace, and use support the item. The maintenance code entered in the third position will indicate one of the following levels of maintenance:

Code	*Application/Explanation*
O	Support item is removed, replaced, used at the organizational level.
H	Support item is removed, replaced, used at the general support level.

(*b*) The maintenance code entered in the fourth position indicates whether the item is to be repaired and identifies the lowest maintenance level with the capability to perform complete repair (i.e., all authorized maintenance functions). This position will contain one of the following maintenance codes:

Code	*Application/Explanation*
H	The lowest maintenance level capable of complete repair of the support item is the general support level.
Z	Nonreparable. No repair is authorized.

(3) *Recoverability code*. Recoverability codes are assigned to support items to indicate the disposition action on unserviceable items. The recoverability code is entered in the fifth position of the Uniform SMR Code as follows:

Recoverability codes	*Definition*
Z	Nonreparable item. When unserviceable, condemn and dispose at the level indicated in position 3.

Recoverability codes	*Definition*
H	Reparable item. When uneconomically reparable, condemn and dispose at the general support level.

c. National Stock Number. Indicates the National stock number assigned to the item and will be used for requisitioning purposes.

d. Part Number. Indicates the primary number used by the manufacturer (individual, company, firm, corporation, or Government activity), which controls the design and characteristics of the item by means of its engineering drawings, specifications, standards, and inspection requirements to identify an item or range of items.

NOTE

When a stock numbered item is requisitioned, the repair part received may have a different part number than the part being replaced.

e. Federal Supply Code for Manufacturer (FSCM). The FSCM is a 5-digit numeric code listed in SB 708-42 which is used to identify the manufacturer, distributor, or Government agency, etc.

f. Description. Indicates the Federal item name, and if required, a minimum description to identify the item.

g. Unit of Measure (U/M). Indicates the standard of the basic quantity of the listed item as used in performing the actual maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e.g., ea, in, pr, etc). When the unit of measure differs from the unit of issue, the lowest unit of issue that will satisfy the required units of measure will be requisitioned.

h. Quantity Incorporated in Unit. Indicates the quantity of the item used in the breakout shown on the illustration figure, which is prepared for a functional group, subfunctional group, or an assembly. A "V" appearing in this column in lieu of a quantity indicates that no specific quantity is applicable, (e.g., shims, spacers, etc).

D-4. Special Information

Usable on codes are shown in the description column. Uncoded items are applicable to all models. Identification of the usable on codes used in this publication are:

Code	*Used on*
AMW	AN/USM-159
5K3	AN/USM-159A
5K4	AN/USM-159B

D-5. How to Locate Repair Parts

a. When National stock number of part number is unknown.

(1) *First.* Using the table of contents, determine the functional group within which the item belongs. This is necessary since illustrations are prepared for functional groups and listings are divided into the same groups.

(2) *Second*. Find the illustration covering the functional group to which the item belongs.

(3) *Third.* Identify the item on the illustration and note the illustration figure and item number of the item.

(4) *Fourth.* Using the Repair Parts Listing, find the figure and item number noted on the illustration.

b. When National stock number or part number is known.

(1) *First*. Using the Index of National Stock Numbers and Part Numbers, find the pertinent National stock number or part number. This index is in NIIN sequence followed by a list of part numbers in alphameric sequence, cross-referenced to the illustration figure number and item number.

(2) *Second*. After finding the figure and item number, locate the figure and item number in the repair parts list.

D-6. Abbreviations
Not applicable.

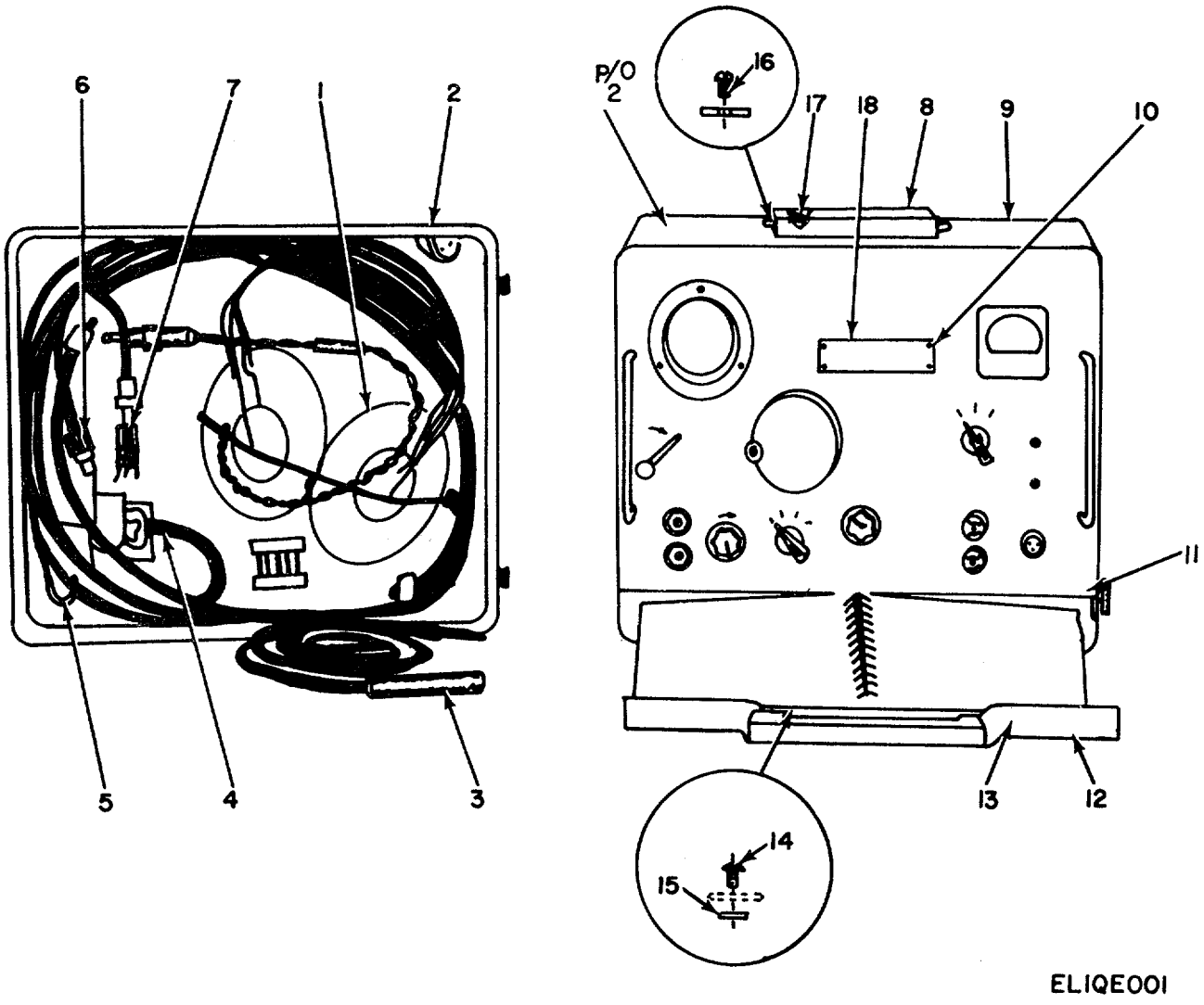


Figure D-1. Frequency Meter AN/USM-159, AN/USM-159A and AN/USM-159B.

(1) ILLUSTRATION (a) FIG NO.	(b) ITEM NO.	(2) SMR CODE	(3) FEDERAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
						GROUP 00 FREQUENCY METER AN/USM-159, AN/USM-159A, AN/USM-159B		
D-1	1	PAOZZ	5965-00-892-3353	H216U	80058	HEADSET	EA	1
D-1	2	XDHHH		SMD346092	80063	CASE & COVER ASSY	EA	1
D-1	3	PAOHH	5995-00-164-7716	CD307A	80058	CORD ASSY	EA	1
D-1	4	PAHHH	5995-00-889-0553	CX7782USM159	80058	CABLE ASSY, PWR OR	EA	1
D-1	4	PAHHH	5995-00-252-2338	CX12005USM159	80058	CABLE ASSY, PWR	EA	1
D-1	5	PAOHH	6625-00-539-9365	AT564( )/U	80058	ANTENNA ASSY AMW, 5K3	EA	1
D-1	6	PAOHH	6660-00-504-2437	CG409U	80058	CORD ASSY	EA	1
D-1	7	PAOZZ	5935-00-930-7461	UG641AU	80058	CONNECTOR, ADAPT	EA	1
D-1	8	XDHZZ		SMC346096	80063	HANDLE , BOW	EA	1
D-1	9	PAHHH	6625-00-892-5361	FR149USM159	80058	FREQUENCY METER AMW	EA	1
D-1	9	XDHHH		FR149AUSM159	80058	FREQUENCY METER 5K3	EA	1
D-1	9	XDHHH		FR149BUSM159	80058	FREQUENCY METER 5K4	EA	1
D-1	10	PAHZZ	5305-00-054-5635	MS51957-1	96906	SCREW, MACHINE	EA	4
D-1	11	XDHZZ		SMD346097	80063	DRAWER ASSY	EA	1
D-1	12	XDHZZ		SMC345972	80063	PANEL, DRAWER	EA	1
D-1	13	XDHZZ		SMD345966	80063	DRAWER	EA	1
D-1	14	PAHZZ	5305-00-059-3659	MS51958-63	96906	SCREW, MACHINE	EA	2
D-1	15	PAHZZ	5310-00-942-5110	MS35335-88	96906	WASHER, LOCK	EA	1
D-1	16	PAHZZ	5305-00-554-6655	MS51957-31	96906	SCREW, MACHINE	EA	1
D-1	17	XDHZZ		SMB345968	80063	ROD, THREADED	EA	1
D-1	18	XDHZZ		SMC346005	80063	PLATE, ID	EA	1

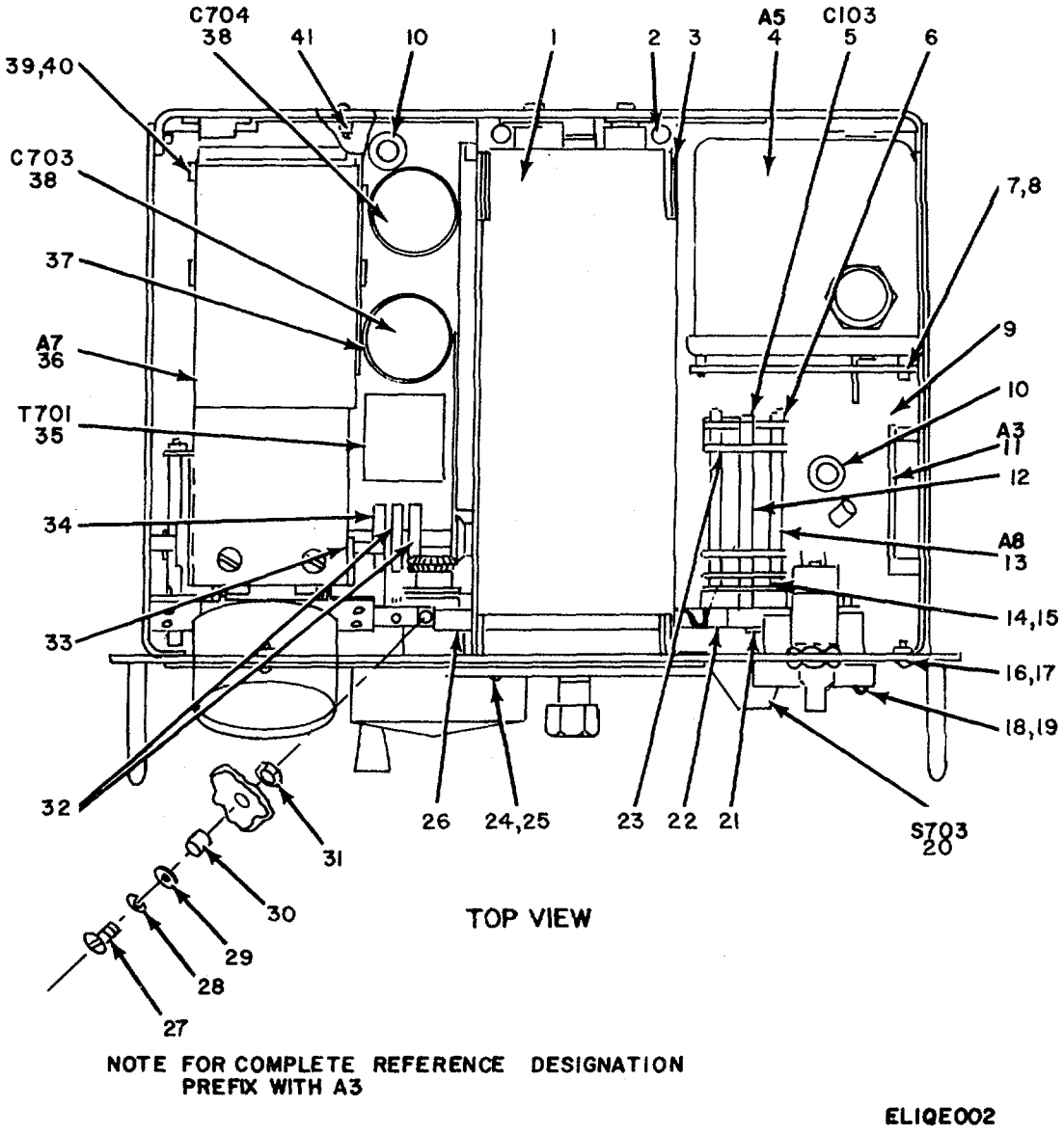


Figure D-2. Frequency Meter FR-149()/USM-159 (Sheet 1 of 4).

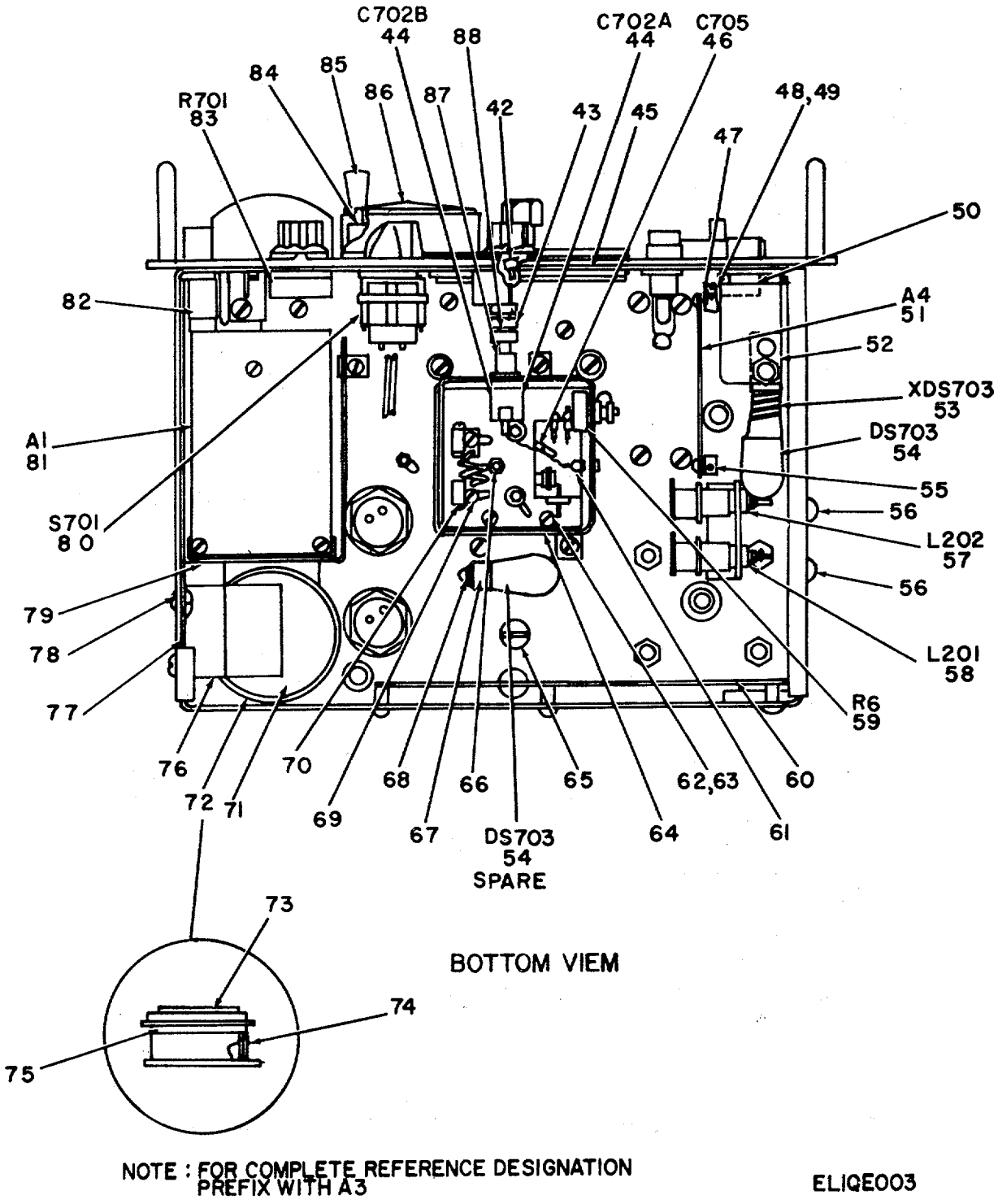


Figure D-2. Frequency Meter FR-149()/USM-159 (Sheet 2 of 4).

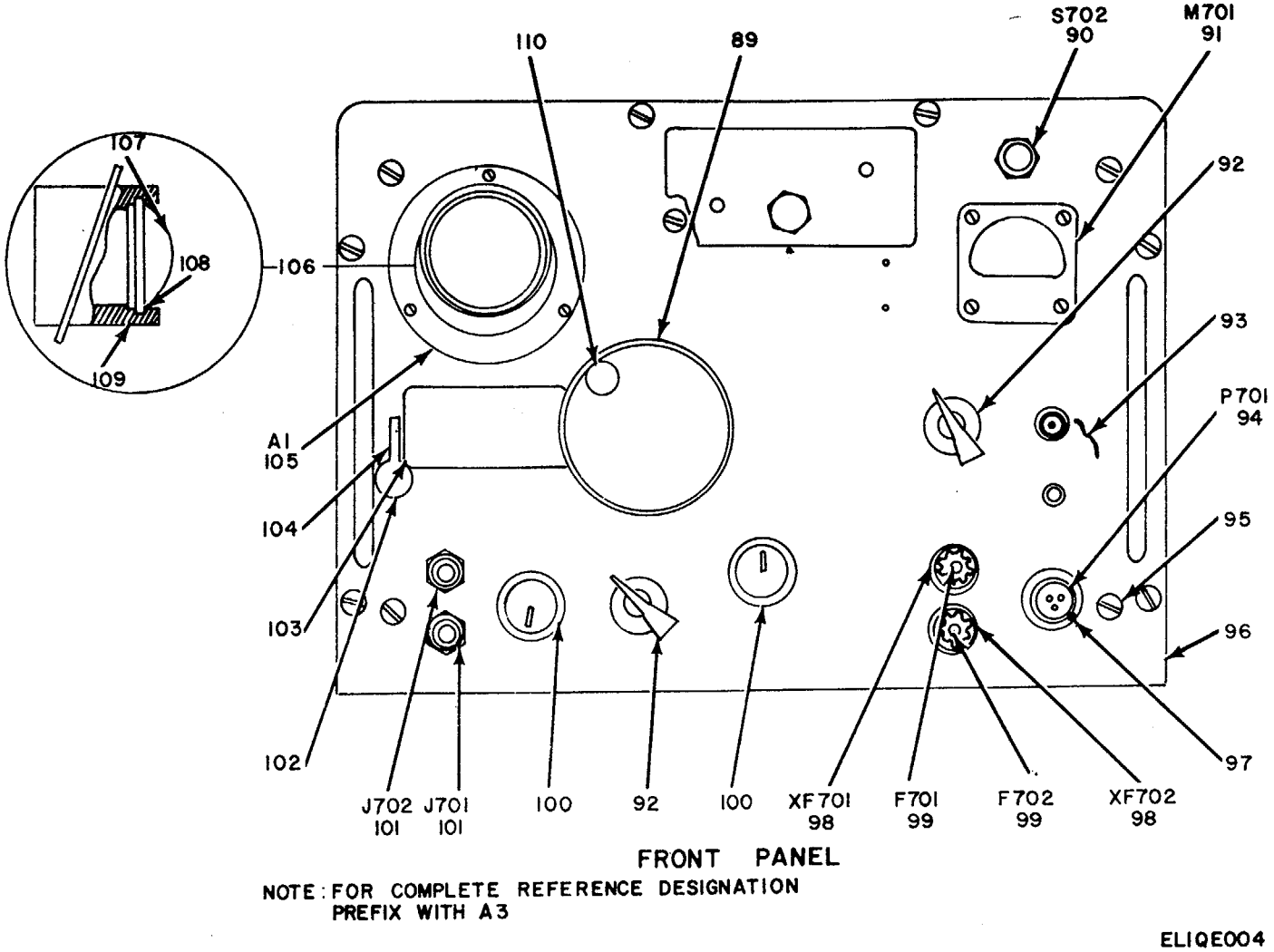


Figure 2. Frequency Meter FR-149()/USM-159 (Sheet 3 of 4).

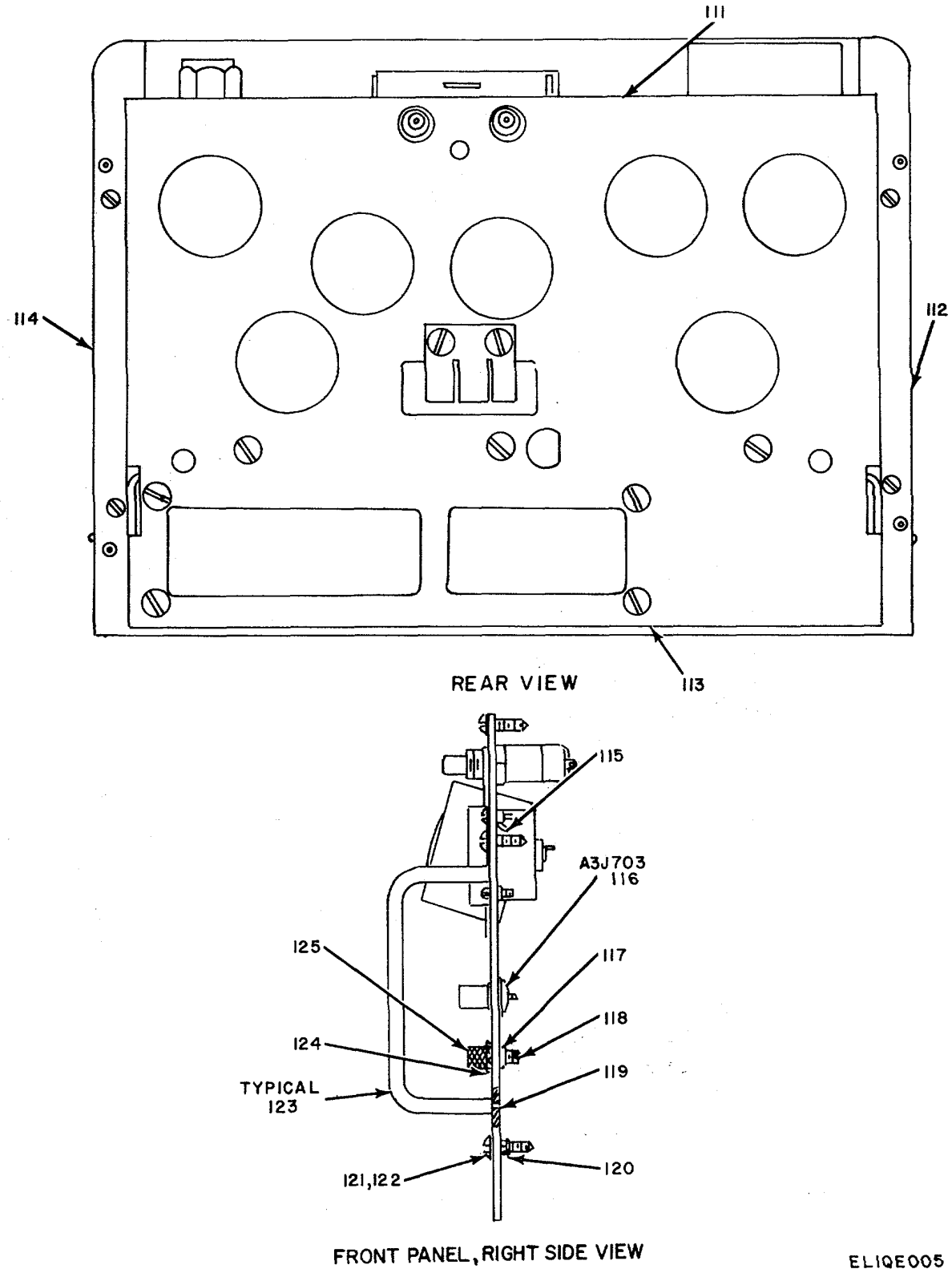


Figure 2. Frequency Meter FR-149()/USM-159 (Sheet 4 of 4).

(1) ILLUSTRATION (a) FIG NO.	(1) ILLUSTRATION (b) ITEM NO.	(2) SMR CODE	(3) FEDERAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
						GROUP 01 FREQUENCY METER FA-149( )/USM159		
D-2	1	PAHHH	6625-00-957-3611	SMD346030	80063	BATTERY BOX ASS ALSO USED ON FAL49AUSNIS9 AND FR149BUSM159.....AMW	EA	1
D-2	2	PAHZZ	5305-00-054-6652	MS51957-28	96906	SCREW,MACHINE ALSO USED ON FR149AUSM159 AND FR149BUSM159.....AMW	EA	12
D-2	3	XDHZZ		SMC345914	80063	RUNNER,BRACKET ALSO USED ON FRI49AUSN159 AND FR149BUSM159.....AMW	EA	1
D-2	4	XDHHH		SMC346104	80063	NETWORK ASSY,US ALSO USED ON FR1I49AUSMIS9 AND FR149BUSM159.....AMW	EA	1
D-2	5	PAHZZ	5910-00-681-3001	SMC747144-5	80063	CAPACITOR,FXD,C ALSO USED ON FAI49AUSHI59 AND FR149BUSM159.....AMW	EA	1
D-2	6	PAHZZ	5310-00-934-9762	MS35649-286	96906	WASHER,LOCK ALSO USED ON FRI49AUSN159 AND FR1498USM159 .....AMW	EA	5
D-2	7	PAHZZ	5310-00-270-8810	MS35650-104	96906	NUT.PLAINNHEXAG ALSO USED ON FRA49AUSN159 AND FR149BUSM159.....AMW	EA	4
D-2	8	PAHZZ	5310-00-942-5110	MS35335-88	96906	WASHER,LOCK ALSO USED ON FRI49AUSN159 AND FR1498USM159 . .....AMW	EA	4
D-2	9	XDHZZ		SMD346065	80063	CHASSIS ASSY ALSO USED ON FRI49AUSN159 AND FR149BUSM159..... AMW	EA	1
D-2	10	PAHZZ	5325-00-543-3942	2901	70485	GRGNNET,RUBER ALSO USED ON Flt49AUS#L59 AND FR149BUSM159.....AMW	EA	2
D-2	11	XDHHH		SMD352034	80063	MIXER ALSO USED ON FRL49AUS#159 AND FR149BUSM159.....AMW	EA	1
D-2	12	XDHZZ		SMB345905	80063	BRACKETT,MTG 5K3	EA	1
D-2	13	XDHZZ		SMB546107	80063	SWITCH ASSY,RUT ALSO USED ON FRI49AUSS159 AND FL149BUSM159 .....AMW	EA	1
D-2	14	PAHZZ	5305-00-054-6670	MS51957-45	96906	SCREWN.ACHINE USED ONLY ON FRL49AUS159..... .5K3	EA	2
D-2	15	XDHZZ		MS05335-87	96906	WASHER.LOCK ALSO USED ON FRI49AUSNL59 AND FR1498BUSM159.....AMW	EA	12
D-2	16	PAHZZ	5305-00-054-6654	MS51957-30	96906	SCREW,MACHINE ALSO USED ON FR149AUSIS59 AND FR149BUSM159.....AMW	EA	12
D-2	17	PAHZZ	5303-00-939-0903	MS35335-86	96906	NASHER.LOCK ALSO USED ON FAR49AUSN159 AND FR149BUSM159.....AMW	EA	23
D-2	18	PAHZZ	5305-00-054-5647	MS35335-85	96906	SLREN,PACHINE ALSO USED ON FRL49AUSNL59 AND FR149BUSM159.....AMW	EA	6
D-2	19	PAHZZ	5310-00-939-1063	SMA346014	96906	WASHER,LOCK ALSO USED ON FRL49AUSNI59 AND FR149BUSM159.....AMW	EA	17
D-2	20	XDHZZ		SMA346014	80063	SWITCH9,OTARY ALSO USED ON FR149AUSIL59 AND FR149BUSM159.....AMW	EA	1
D-2	21	PAHZZ	5305-00-054-6653	MS51957-29	96906	SCREN.NACHINE ALSO USED ON FR149AUS1159 AND FR149BUSM159 .....AMW	EA	1
D-2	22	XDHZZ		SMB345919	80063	BAR,HTC ALSO USED ON FRI49AUSALS9 AND FR149BUSM159 .....AMW	EA	1
D-2	23	XDHZZ		SMB345906	80063	BRACKET1NTG ALSO USED ON FRL49AUSN159 AND FR1498BUSM159.....AMW	EA	1
D-2	24	PAHZZ	5305-00-763-6962	MS51959-27	96906	SCREN.NACHINE ALSO USED ON FRI49AUSIS59 AND FR149BUSM159.....AMW	EA	2
D-2	25	PAHZZ	5310-00-934-9761	MS35649-264	96906	NUT,PLAIN,HEXAG ALSO USED ON FR149AUSN119 AND FR149BUSM159.....AMW	EA	7
D-2	26	XDHZZ		SMC352027	80063	LEVER ASSY ALSO USED ON FRL49AUSN159 AND FR149BUSM159.....AMW	EA	1
D-2	27	XDHZZ		SMB346010	80063	SCREW, MACHINE ALSO USED ON FR149AUSN159 AND FR149BUSM159.....AMW	EA	1

(1) ILLUSTRATION (a) FIG NO.	(b) ITEM NO.	(2) SMR CODE	(3) FEDERAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
D-2	28	XDHZZ		SMB345928	80063	WASHER,FLAT ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	1
D-2	29	XDHZZ		BOW479S10	73287	WASHER,SPRING ALSO USED ON FR149AUSM159 AND FR1498USM159- .....AMW	EA	1
D-2	30	XDHZZ		SMB345921	80063	SPACERISLEEVE ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	1
D-2	31	PAHZZ	5310-00-934-9748	MS35649-244	96906	NUT,PLAIN,HEXAG ALSO USED ON FR149AUSM159 AND FR149BUSM159.....AMW	EA	8
D-2	32	XDHZZ		SMB346071	80043	HUB ASSY ALSO USED ON FAI49AUSMN59 AND FRI498USM159.....AMW	EA	2
D-2	33	XDHZZ		SMB345938	80063	INSULATOR WASHE ALSO USED ON FR149AUSM159 AND FR149BUSM159.....AMW	EA	1
D-2	34	PAHZZ	5305-00-719-5330	MS51963-21	96906	SETSCREW ALSO USED ON FRI49AUSI5S9 AND FR149BUSM159 .....AMW	EA	4
D-2	35	PAHZZ	5950-00-237-2624	SMR346012	80063	TRANSFORNER,PWD ALSO USED ON FR149AUSM159 AND FR149BUSM159.....AMW	EA	1
D-2	36	PAHHH	6625-00-955-5538	SMD346086	80063	FILN DRIVE ANSY ALSO USED ON FRI49AUSM59 AND FR149BUSM159. .....AMW	EA	1
D-2	37	XDHZZ		SMB345891	80063	WASHER,NN ALSO USED ON FRI49AUSM159 AND FR149BUSM159 .....AMW	EA	2
D-2	38	PAHZZ	5910-00-917-5362	CE44C222E	81349	CAPACITOR,ELCTL ALSO USED ON FR149AUSM159 AND FR149BUSM159.....AMW	EA	2
D-2	39	PAHZZ	5310-00-917-5978	MS15795-807	96906	WASHER,FLAT ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	4
D-2	40	PAHZZ	53U5-00-054-6672	MS51957-47	96906	SCRE,.MACHINE ALSO USED ON FR149AUSM159 AND FR149BUSM159.....AMW	EA	4
D-2	41	XDH2Z		SMB346052	80063	BRACKET ASSY ALSO USED ON FR149AUSM159 AND FR149BUSM159.....AMW	EA	1
D-2	42	XLHZZ		3-8-32NEF21-2	99813	NUT,JAN ALSO USED ON FR149AUSM159 AND FR149BUSM159 -.....AMW	EA	1
D-2	43	XDHZZ		SMB345996	80063	COUPLING,INSUL, ALSO USED ON FR149AUSM159 AND FA149BUSM159.....AMW	EA	1
D-2	44	PAHZZ	5910-00-960-3810	SCMC345990	8J063	CAPACITOR,VAR ALSO USED ON FR149AUSM159 AND FR149BUSM159.....AMW	EA	2
D-2	45	XDHZZ		SM03461O6	80063	WIRING HARNESS ALSO USED ON FR149AUSM159 AND FR419BUSM159.....AMW	EA	I
D-2	46	PAHLZ	5910-00-5830283	DM15C050K	72136	CAPACITOR,FXD,N ALSO USED ON FR149AUSM159 AND FR149BUSM159,.....AMW	EA	1
D-2	47	XDHZZ		SMB345803	80063	BRACKET.LEFT HA ALSO USED ON FR149AUSM159 AND FR149BUSM159..... EA	1	
D-2	48	PAHZZ	5310-00-782-1349	MS15795-804	96906	WASHER, FLAT ALSO USED ON FR149AUSM159 AND FR149BUSM159.. .....AMW	EA	8
D-2	49	PAHZZ	5305-00-054-5648	MS51957-14	969061	SCREW,MACHINE ALSO USED ON FR149AUSM1I59 AND FR149BUSM159.....AMW	EA	1
D-2	50	PAHZZ	5940-00-156-7344	2104-06-00	76665	TERMINAL,LUG ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW.	EA	1
D-2	51	XDHHH		SNC352U40	80063	POKER SUPPLY ALSO USED ON FRI49AUSM159 ANO FR149BUSM59 .....AMW	EA	1
D-2	52	XDHZZ		A2770	99850	RF FILTER USED ONLY ON FR1498USN159 .....5K4	EA	1
D-2	53	PAHZZ	6250-00-698-3132	18-74	95263	LANPHOLDER ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	1
D-2	54	PADZZ	6240-00-143-3049	MS15579-4	96906	LAMP,INCAND ALSO USED ON FR149AUSM159 AND FR149BUSMI59 .....AMW	EA	1
D-2	55	XDHZZ		SMB345802	80063	BRACKET,RIGHT ALSO USED ON FR149AUSM159 AND F4149BUSM159 .....AMW	EA	1

(1) ILLUSTRATION (a) FIG NO.	(b) ITEM NO.	(2) SMR CODE	(3) FEDERAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
2	56	XDHZZ		SMB345894	10063	BUTTON,PLUG ALSO USED ON FR149AUSM159 AND FR149BUSM159.....AMW	EA	2
D-2	57	PAHZZ	5950-00-951-7014	SMB34039	80063	COIL ASSY ALSO USED ON FR149AUSN159 AND FR149BUSM159.....AMW	E.A	1
D-2	58	PAHZZ	5950-00-951-7012	SMB346038	80063	COIL ASSY ALSO USED ON FR149AUSM159 AND FR149BUSM159.....AMW	-EA.	1
D-2	59	XDHZZ		RV5LAYSB1028	81349	RESISTOARVAR ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	1
D-2	60	XDHHH		SMD352032	80063	CRYSTAL OSC & N ALSO USED ON FR149AUSM159 AND FRI49BUSM159.....AMW	EA	1
D-2	61	PAHZZ	5940-00-91-9919	2045-1	71279	TERMINAL,STANDO ALSO USED ON FA149AUSM159 AND FR149BUSM159 .....AMW	EA	1
D-2	62	PAHZZ	5310-00-722-5998	MS15795-805	96906	WASHER.FLAT ALSO USED ON FR149AUSM159 AND FR149BUSM159.....	EA	5
D-2	63	PAHZZ	5305-00-054-6657	MS51957-33	96906	SCREW.ACHINE ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	1
D-2	64	XDHZZ		SMC346046	80063	SHIELD ASSY ALSO USED UN FR149AUS1M59 AND FR149BUSM159.....AMW	EA	1
D-2	65	XDH2Z		SMB345932		8U063SCREW,SHOULDER ALSO USED ON FR149AUSM159 AND FR149USM159 .....AMW	EA	1
D-2	66	PAHZZ	5305-00-054-667	MS51957-48	96906	SCREN,NACHINE ALSO USED ON FRL49AUSN159 AND FA149BUSNL59 .....AMW	EA	1
D-2	67	PAHZZ	5340-0-59-0296	HP7N	09922	CLAMPICABLE ALSO USED ON FR149AUM159 AND FR149BUSM159 .....AMW	EA	1
D-2	68	XDHZZ		SMB345912	80063	SPACER,SLEEVE ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	1
D-2	69	PAHZZ	530-00-054-6651	MS51957-27	96906	SCREN.MACHINE USD ONLY ON FRI49AUSHL59 .....SK3	EA	2
D-2	70	XDHHH		SMD346077	80063	CAPACITOR ASSY USED ONLY ON FR149AUSM159 AMW	EA	1
D-2	71	XDHZZ		SMB346022	80063	FILN,MASIER.PRG ALSO USED UN FR149AUSM159 AND FR149BUSM159 .....AMW	EA	1
D-2	72	XDHZZ		SMB346018	80063	CAN ASSY,FILN ALSO USED ON FRI49AUSI159 AND FRL49BUSN159 .....AMW	EA	1
D-2	73	XDHZZ		SMB346017	80063	CAN&CCVER ALSO USED ON FAI49AUSN159 AND FRI49bUSM59..... AMW	EA	1
D-2	74	XDHIZ		SMB346021	60063	FILM,IASTER ALSO USED ON FR149AUSM1I59 AND FR149BUSM159 .....AMW	EA	1
D- 2	75	XDHZZ		SMB346019	4003	FILN,UNEXPOSED ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	1
D-2	76	XDHZZ		SMB346041	60063	BRACKET ASSY ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	1
D-2	77	XDHZZ		SMB345931	80063	BRACKET ALSO USED CN FR149AUSM159 AND FR149BUSM159 .....AMW	EA	1
D- 2	78	PAHZZ	5310-00-680-4919	CL632-2C	46384	NUT,SLFLKG,CLIN ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW		EA
	2							
D-2	79	AXUHL		SAC346045	800631	SHIELD ASSY ALSO USED UN FR149AUSM159 AND FR149BUSM159 .....AMW	.· EA	1
D-2	80	XDHZZ		SMA346013	80063	SLITCH.ROTARY ALSO USED ON FR149AUSM159 AND FA149BUSM159 .....AMW	.· EA	1
D- 2	81	XDHHH		SMC352036	80063	AUDIO ANPLIFIEA USED ONLY ON FA149AUSM159 ...5K3	EA	1
D- 2	82	XDHZZ		A2774	99850	ARF FILTER USED UNLY ON RF1I49BUSM159 .....5K4	EA	1
D- 2	83	PAHZZ	5905-00-643-5626	RV4NAYSDSO2A	I1349	RESITOR,VAR ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	1
D- 2	84	XDHZZ		5133-12SM1	79136	RING, RETAINING ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	.EA	1

(1) ILLUSTRATION (a) FIG NO.	(b) ITEM NO.	(2) SMR CODE	(3) FEDERAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
D-2	85	XDHZZ		SNB345921	40063	HANDLE ALSO USED ON F149AUSM159 AND FR1419BUSM159 AMW.....AMW	EA	
D-2	86	XDHZZ		SMC345926	80063	KNOB.....ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW.	EA	1
D-2	87	XDHZZ		SMB345930	40063	BUSNHIG-SHAFT,P ALSO USED ON FR149AUSM159 AND FR149BUSM159 ..... AMW	EA	1
D-2	88	XDHZZ		SMB345910	80063	SUAMWSTIRAIGHN ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW.	EA	1
D-2	89	XDHZZ		SMB346048	80053	KNOB ASSY ALSO USED ON R149AUSM159 AND FR149BUSM159 .....AMW	EA	1
D-2	90	XDHZZ		SMB346015	80063	SWITCN.PUSH ALSO USED ON FR149AUSM159 AND FR149BUSM159.....AMW	EA	1A
D-2	91	PAHZZ	6625-00-958-3297	SMC346003	80063	VOLTMETEI ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	1
D-2	92	XDHZZ		SMB345999	800603	KNOD.POINTER ALSO USED ON FR149AUSM159 AND FR149BUSM159.....AMW	EA	2
D-2	93	XDHZZ		SMD345922	80060	PANE,FRONT ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	1
D-2	94	PAHZZ	5935-00-726- 0708	MS102R105L3P	96904	CONNECTOR,PEPT ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	1
D-2	95	PANZZ	5305-00-054-6668	NS51957-43	95906	SCREW.MACHINE ALSO USE ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	19
D-2	96	XDHZZ		SND34093	80053	FRONT PANEL ASS ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	1
D-2	97	PAHZZ	5305-00-770-2579	MS51959-15	96906	SCENM, MACHINE ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	4
D-2	98	XDHZZ		SMN345991	80063	FUSEHOLDER ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW ·	EA	1
D-2	99	PAOZZ	5920-00-229-1312	MS90078-18	96906	FUSE, CARTRIDGE ALSO USED ON FR1419AUSM159 AND FR149BUSM159 .....AMW	EA	2
D-2	100	XDHZZ		SMB344001	80053	KNOB ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	2
D-2	101	PAHZZ	5935-00-683-2746	JJ034	81349	.JACK,TELEPHONE ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	2
D-2	102	PAOZZ	5355-00-957-8563	SMB345869	0063	KNQO ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	1
D-2	103	XDHZZ		SMB352019	80063	PLATE,INSTA ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	1
D-2	104	XDHZZ		SMB345868	80063	HANDIOLE ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	1
D-2	105	XDHHH		SMB346068	80053	VIEWE, ASSY ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	1
D-2	106	PAHHH	6625-00-956-9779	SMB34606'7	80053	VIEW SUASSYV .....AMW..	EA	1
D-2	107	PAHZZ	6625-00-957-5563	SMB311404	80043	LENS, CONVEX .....AMW	EA	1
D-2	110	XDHZZ		SMB345918	80063	RING,.RETAINING .....AMW	EA	1
D-2	109	XDHZZ		SM345923	80053	SPRING,CPRSN .....AMW	EA	1
D-2	110	PAHZZ.	5305-00-719-5342	MS51963-34	96906	SET,SCREW,ALSO USEO ON FR149AUSM159 AND FR149BUSM159 ..... AMW	EA	1
D-2	111	XDHZZ		SMD346059	80063	PANEL ASSY.AEAR ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	1
D-2	112	XDHZZ		SMC346061	80063	SIDE PLATE ASSY ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	1
D-2	113	XDHZZ		SMC345924	80063	COVEAR.BOTTON ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	1
D-2	114	XDNZZ		SMC34062	80063	SIDE PLATE ASSY ALSO USED ON FR149AUSM159 AND FR149BUM159 .....AMW	EA	1
D-2	115	XDHZZ		2104-04-00	76665	LUG,SCLDER ALSO USED ON FR149AUSM159 AND FR149BUSM159-.....AMW	EA	1

(1) ILLUSTRATION (a) FIG NO.	(b) ITEM NO.	(2) SMR CODE	(3) FEDERAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
D-2	116	PAHZZ	5935-00-552-7660	MS27035-6258	96906	CONNECTOR.RPCT, ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	1
D-2	117	XDHZZ		1-4-28NF2	99813	NUT,JAN ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	1
D-2	118	XDHZZ	5940-00-990-1858	SMN345883	80063	STUD,SHOULDERED ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	1
D-2	119	PAHZZ	5305-00-727-8832	MS51959-29	96906	SCREW,HACHINE ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	4
D-2	120	XDHZZ		WA510	76665	RING,RETAINING ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	6
D-2	121	XDHZZ		SMB346009	80063	SCRELWCAPTIVE ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	6
D-2	122	XDHZZ		SMB345915	80063	WASHER,NH ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	6
D-2	123	XDHZZ		SBM345925	80063	HANDLE.BOW ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	2
D-2	124	XDHZZ	5310-00-261-7160	1214-05	78189	WASHER,LOCK ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	1
D-2	125	XGHZZ		SMB345882	80063	NUT,KNURLED ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	1

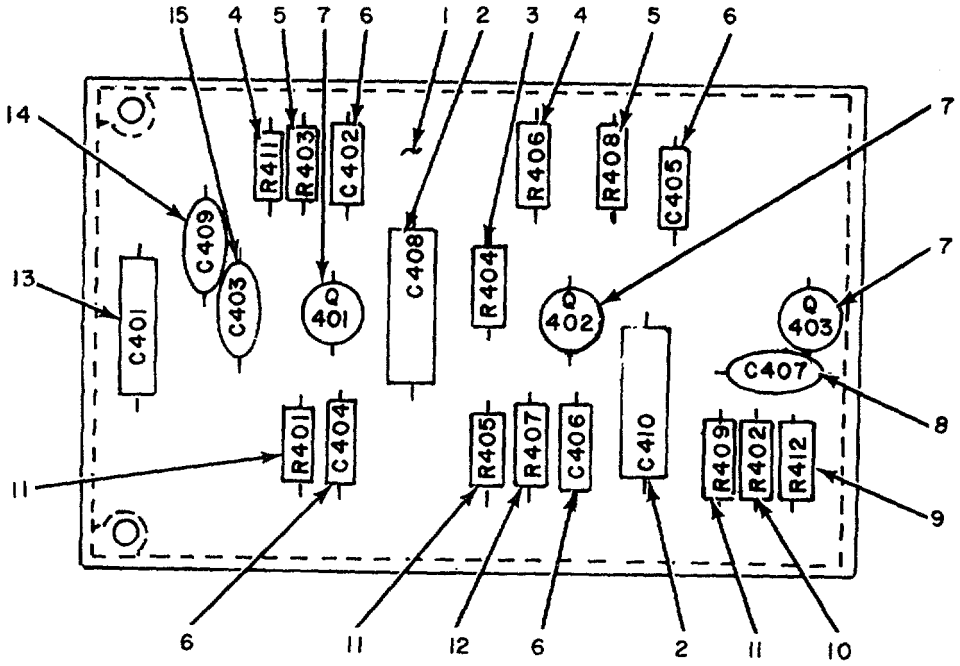


Figure D-3. Audio Amplifier.

(1) ILLUSTRATION (a) FIG NO.	(b) ITEM NO.	(2) SMR CODE	(3) FEDERAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
						GROUP 0101 AUDIO AMPLIFIER		
D-3	1	XDHZZ		SMD352035	80063	B0ARD,PW .....5K3..	EA	1
D-3	2	XDHZZ		CS13BC227M	81349	CAPACITOR.ELCTL USED ONLY ON FR149AUS5159 5K3..	EA	2
D-3	3	PAHZZ	5905-00-279-2616	RC20GF153J	81349	RESISTOR,FXD, CM .....5K3..	EA	1
D-3	4	PAHZZ	5905-00-185-8510	RC20GF103J	81349	RESISTOR,FXD,CM .....5K3..	EA	2
D-3	5	PAHZZ	5905-00-279-3505	RC206GF392J	81349	RESISTOR, FXD,CM..... 5K3..	EA	2
D-3	6	PAHZZ	5910-00-189-4248	M39003-01-2977	81349	CAPACITOR,ELCL .....5K3..	EA	4
D-3	7	PAHZZ	5961-00-683-4182	2N526	81349	TRANSISTOR .....5K3..	EA	3
D-3	8	PAHZZ	5910-00-983-6866	CK61BX471K	81349	CAPACITOR,FXD,C.....5K3..	EA	1
D-3	9	PAHZZ	5905-00-252-4018	RC20GF470J	81349	RESISTOR,FXD,C .....5K3..	EA	1
D-3	10	PAHZZ	5905-00-279-3511	AC20GF511J	81349	RESISTOR,FXD,CM .....5K3..	EA	1
D-3	11	PAHZZ	5905-00-279-3499	RC20GF273J	81349	RESISTCR,FXD,CM .....5K3..	EA	3
D-3	12	PAHZZ	5905-00-195-6453	RC20GF562J	81349	RESISTOR,FX,CM.....5K3..	EA	1
D-3	13	XDHZZ		CM20FD561JN3	81349	CAPACITOR,FXD,M. .....5K3..	EA	1
D-3	14	PAHZZ	5910-00-823-1068	CK62AW472M	81349	CAPACITOR,FXD,C .....5K3..	EA	1
D-3	15	PAHZZ	5910-00-822-5683	CK63AW103M	81349	CAPACITOR 1,FXD,C.....5K3..	EA	1

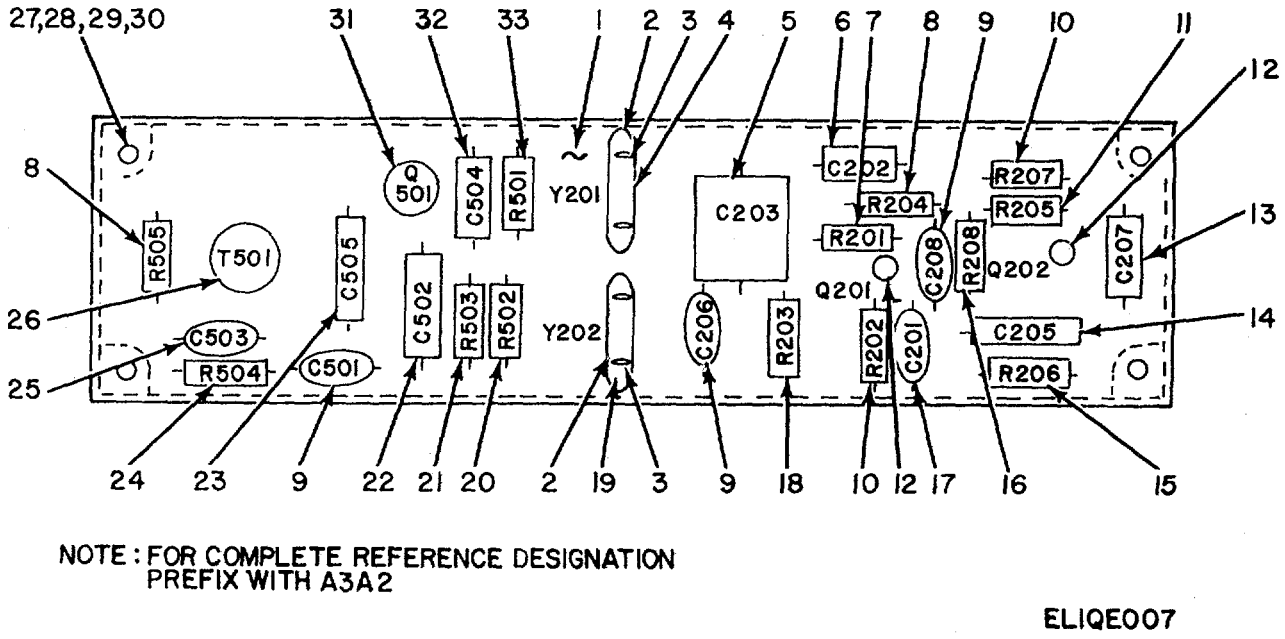


Figure D-4. Crystal Oscillator and Modulator.

(1) ILLUSTRATION (a) FIG NO.	(b) ITEM NO.	(2) SMR CODE	(3) FEDERAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
						GROUP 0102 CIYSTAL OSCILLATOR AND MODULATOR		
D-4	1	XDHZZ		SMD352031	80063	BOARD.PW .....AMW	EA	1
D-4	2	PAHZZ	5935-00-581-6941	TS0205C01	81349	SOCKET,CRYSTAL .....AMW	EA	2
D-4	3	XDHZZ		SMB345804	80063	CLIP,CAYSTAL. .....AMW	EA	2
D-4	4	XDHZZ		CR130U2500KC	81349	CAYSTAL UNIT,QU .....AMW	EA	1
D-4	5	XDHZZ		CM20FD182JN3	81349	CAPACITOR,FXD,M .....AMW	EA	1
D-4	6	XDHZZ		CM15F221JN3	11349	CAPACITDOR,FXD, M .....AMW	EA	1
D-4	7	PAHZZ	5905-00-279-3502	RC20GF123J	81349	RESISTER,FXD,CM .....AMW	EA	1
D-4	8	PAHZZ	5905-00-190-8889	RC20GF101J	81349	RESISTER,FXD,CM. .....AMW	EA	2
D-4	9	PAHZZ	5910-00-957-9272	20C202	93561	CAPACTOR,FX D , M .....AMW	EA	3
D-4	10	PAHZZ	5905-00-171-1999	RC2UGF821J	81349	RESISTOR,FXD,CM .....AMW	EA	2
D-4	11	PAHZZ	5905-00-279-3504	RC20GF472J	81349	RFSISTOR,FXD,CM.....AMW	EA	1
D-4	12	PAHZZ	5961-00-849-1582	2N501A	81349	TRANSISTOR . .....AMW	EA	2
D-4	13	PAHZZ	5910-00-855-2717	CM15F511JN3	61149	CAPACITOR,FXD,M .....AMW	EA	1
D-4	14	XDHZZ		CM20FD102JN3	81349	CAPACITOR.,FXD. .....AMW	EA	1
D-4	15	PAHZZ	5905-00-190-8880	RC20GF122J	81349	RESISTOR, FXD,CM.....AMW	EA	1
D-4	16	PAHZZ	5905-00-195-6791	RC20GF681J	81349	RESISTOR,FXD,CM .....AMW	EA	1
D-4	17	XDHZZ		BB65203VZSZ	93561	CAPACITOR,FXD,C.....AMW	EA	1
D-4	18	PAHZZ	5905-00-111-4742	RCR20G391JS	81349	RESISTOR,FXD,CM.....AMW	EA	1
D-4	19	XDHZZ		CR130U1000KC	81349	CRYSTAL UNIT,QU .....AMW	EA	1
D-4	20	PAHZZ	5905-00-279-2019	RC20GF512J	81349	RESISTER,FXD,CM.....AMW	EA	1
D-4	21	PAHZZ	5909-00-279-1897	RC20GF560J	81349	RESISTOR,FXD,CM .....AMW	EA	1
D-4	22	XDHZZ		CS13BC227M	81349	CAPACITOR,ELCTL .....AMW	EA	1
D-4	23	XDHZZ		CM29FD681JN3	81349	CAPACITOR,FXD,M .....AMW	EA	1
D-4	24	PAHZZ	5905-00-279-3505	RC20GF392J	81349	RESISTOR,FXD,CM .....AMW	EA	1
D-4	25	XDHZZ		41C172	93561	CAPACIT FXD,C .....AMW	EA	1
D-4	26	PAHZZ	5950-00-892-8179	SMC346011	80063	TRANSFORMER,MOD .....AMW	EA	1
D-4	27	XDHZZ		SMB345890	80003	WASHER,NM .....AMW	EA	2
D-4	28	PAHZZ	5310-00-595-6211	MS15795-803	96906	WASHER,FLAT .....AMW	EA	2
D-4	29	PAHZZ	5305-00-054-5651	MS51957-17	96906	SCREW, MACHINE .....AMW	EA	2
D-4	30	PAHZZ	5310-00-934-9748	MS35649-244	96906	NUT,PLAIN.HEXAG .....AMW	EA	2
D-4	31	PAHZZ	5961-00-683-4182	2N526	81349	TANSISTOR .....AMW	EA	1
D-4	32	PAHZZ	5910-00-717-0169	CM15101G03	81349	CAPACITOR,FXD,CM.....AMW	EA	1
D-4	33	PAHZZ	5905-00-185-8510	RC20GF103J	81349	RESISTOR,FXD,CM .....AMW	EA	1

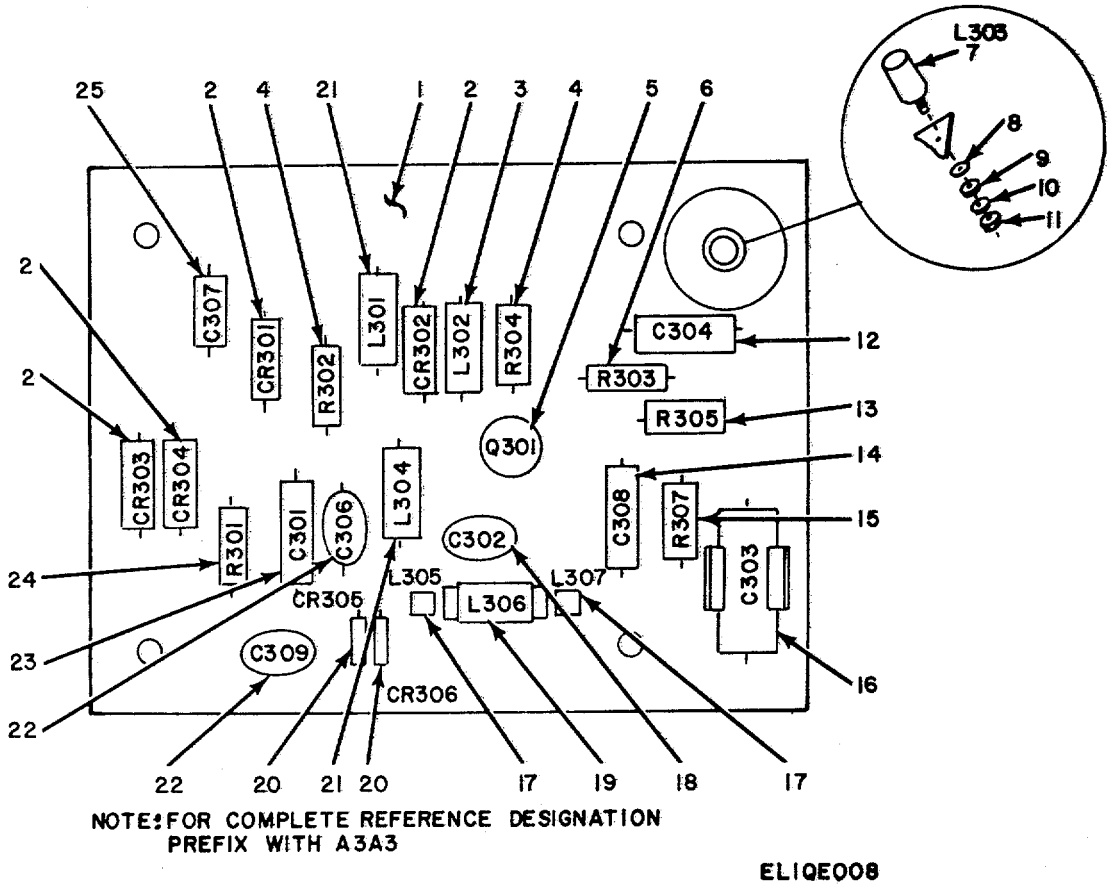


Figure D-5. Mixer.

(1) ILLUSTRATION (a) FIG NO.	(b) ITEM NO.	(2) SMR CODE	(3) FEDERAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
						GROUP 0103 MIXER		
D-5	1	XDHZZ		SM0352033	80063	BOARD,PW .....AMW	EA	1
D-5	2	PAHZZ	5961-00-912-4907	IN82AG	81349	SEMICONDUCTOR,D.....AMW	EA	4
D-3	3	XDHZZ		17624-8	11711	CHOKE.RF .....AMW	EA	1
D-5	4	PAHZZ	5095-00-279-1876	RC20GF222J	81349	RESISTOA,FXD,CM .....AMW	EA	2
D-5	5	PAHZZ	5961-00-844-6717	SMD352033	81349	TRANSISTOR .....AMW	EA	1
D-5	6	PAHZZ	5905-00-279-3497	RC20GF393J	81349	RESISTOR.FXD,CM .....AMW	EA	1
D-5	7	PAHZZ	5950-00-053-3702	SMB8346070	80063	CHOKE ASSY .....AMW	EA	1
D-5	8	XDHZZ		SMB345933	80063	WASHER,NM .....AMW	EA	1
D-5	9	PAHZZ	5310-00-595-6761	MS15795-802	96906	WASHER,FLAT. .....AMW	EA	1
D-5	10	PAHZZ	5310-00-022-1117	MS35333-103	96906	WASHER,LOCK ALSO USED ON FR149AUSM159 AND FR149BUSM159 .....AMW	EA	1
D-5	11	PAHZZ	5310-00-818-6459	MS35649-26	96906	NUT,PLAM,HEXAG.....AMW	EA	1
D-5	12	PAHZZ	5910-00-189-4248	M39003-01-2977	81349	CAPACITOR,ELCTL .....AMW	EA	1
D-5	13	PAHZZ	5905-00-279-3504	RC20GF472J	81349	RESISTOR,FXO,CN.....AMW	EA	1
D-5	14	PAHZZ	5910-00-807-2595	CM15C680JN3	81349	CAPACITOR,FXD .....AMW	EA	1
D-5	15	PAHZZ	5905-00-195-6453	RC20GF562J	81349	RESISTOR,FXD,CM .....AMW	EA	1
D-5	16	XDHZZ		SMB34607	81349	CAPACITOR.ELLCTL. .....AMW	EA	1
D-5	17	XDHZZ		SMB346007	80063	BREAD,SHIELDING .-.....AMW	EA	2
D-5	18	XDHZZ		20C20	93561	CAPACITOR,FXD,M. .....AMW	EA	1
D-5	19	XDHZZ		SMB345970	80063	CHOKE ASSY .....AMW	EA	1
D-5	20	PAHZZ	5961-00-022-5664	1N914	81349	SEMICONDUCTOR,D.....AWM	EA	2
D-5	21	XDHZZ		17624-4	11711	CHOKE,RF .....A MW	EA	2
D-5	22	PAHZZ	5910-00-435-6776	5HKS20	93561	CAPACLIOR.FXODM .....AMW	EA	2
D-5	23	PAHLZ	5910-00-816-6613	CM15C470JN3	81349	CAPACITORFXO, ...AMW	EA	1
D-S	24	PAHZZ	5905-00-279-3513	RC20GF221J	81349	RESISTOR TIR,FXD, CM, ...AMW	EA	1
D-5	25	PAHZZ	5910-00-681-3001	SMC747144-5	80063	CAPACITOR.FXD,C.....AMW	EA	1

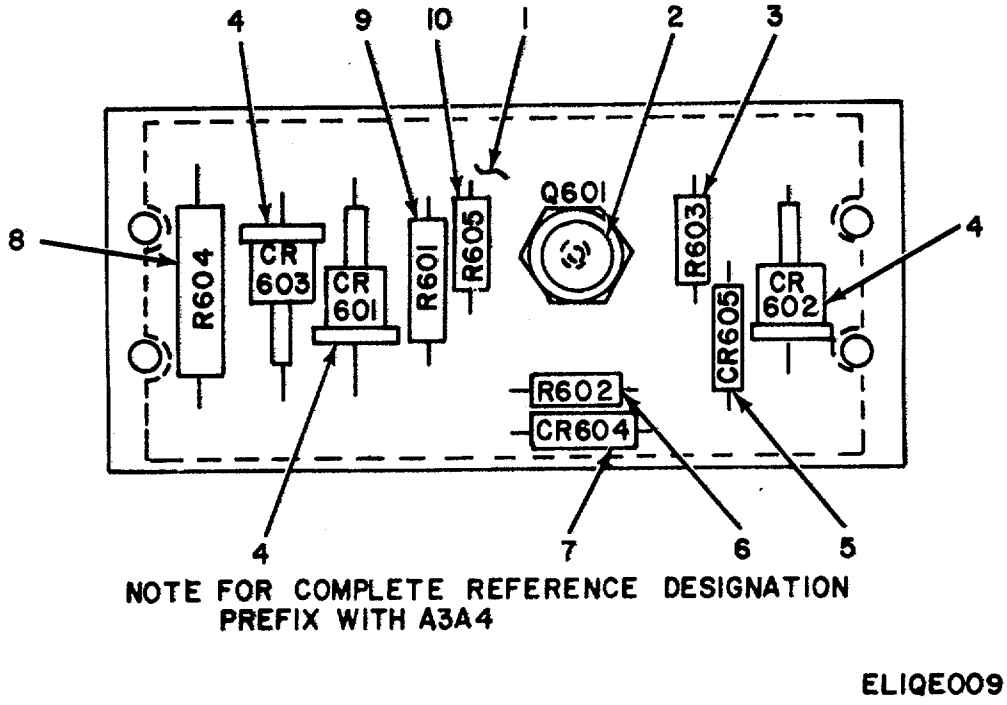
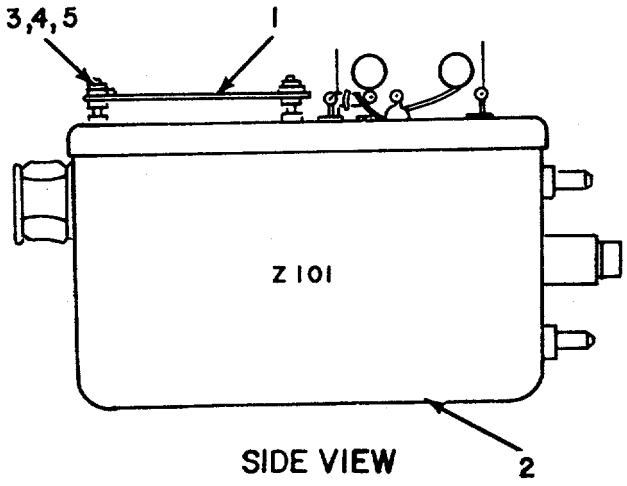
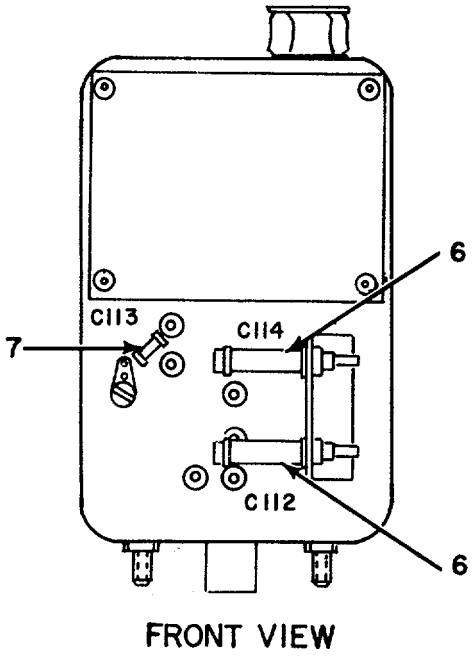


Figure D-6. Power Supply.

(1) ILLUSTRATION (a) FIG NO.	(1) ILLUSTRATION (b) ITEM NO.	(2) SMR CODE	(3) FEDERAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
						GROUP 0104 POWER SUPPLY		
D-6	1	XDHZZ		SM0352039	80063	BOARD,PW .....AMW	EA	1
D-6	2	PAHZZ	5961-00-776-0964	2N2553	81349	TRANSISTOR .....AMW	EA	1
D-6	3	PAHZZ	5905-00-190-6869	RCZOGF101J	81349	RESISTOR,FXD,CM .....AMW	EA	1
D-6	4	PAHZZ	5961-00-519-6977	1N538	81349	SEMICONDUCTOR,D .....AMW	EA	3
D-6	5	PAHZZ	5961-00-469-9931	1N752A	81349	SEMICCNDUCTO R.D .....AMW	EA	1
D-6	6	PAHZZ	5905-00-192-3973	RC20GF471J	81349	RESISTUR,FXD,CM .....AMW	EA	1
D-6	7	XDHZZ		1N734A	81349	SEMICONDUCTOR,D .....AMW	EA	1
D-6	8	PAHZZ	5905-00-905-5383	RN70C9881D	81349	RISISTOR,FXD.FI .....AMW	EA	1
D-6	9	PAHZZ	5905-00-279-2643	RC32GF912J	81349	RESISTOR,FX,CM .....AMW	EA	1
D-6	10	PAHZZ	5905-00-249-4200	RC20GF912J	81349	RESISTOR.FXU,CM .....AMW	EA	1





NOTE : FOR COMPLETE REFERENCE DESIGNATION PREFIX WITH A3A5

ELIQE010

Figure D-7. Oscillator Network Assembly.

(1) ILLUSTRATION (a) FIG NO.	(1) ILLUSTRATION (b) ITEM NO.	(2) SMR CODE	(3) FEDERAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
						GROUP 0105 OSCILLATOR NETWORK ASSEMBLY		
D-7	1	XDHHH		SMC352038	80063	OSCILLATOR, VF .....AMW	EA	1
D-7	2	PAHZZ	6625-00-955-9468	SMD346098	80063	OSCILLATUR,NET .....AMW	EA	1
D-7	3	PAHIZ	5310-00-93-i063	MS35335-85	96906	WASHER,LOCK .....AMW	EA	4
D-7	4	PAHZZ	5310-0-0782-1349	MS15195-804	96906	WASHER,FLAT .....AMW	EA	8
D-7	5	PAHZZ	5310-00-934-9748	MS35649-244	96906	NUT.PLAIN.HEXAG .....AMW	EA	1
D-7	6	PAHZZ	5910-00-713-2025	VC11G	73899	CAPACITOR, VAR .....AMW	EA	2
D-7	7	PAHZZ	5910-00-577-7902	CC20UJ070C	81349	CAPACITOR,FXD.C .....AMW	EA	1

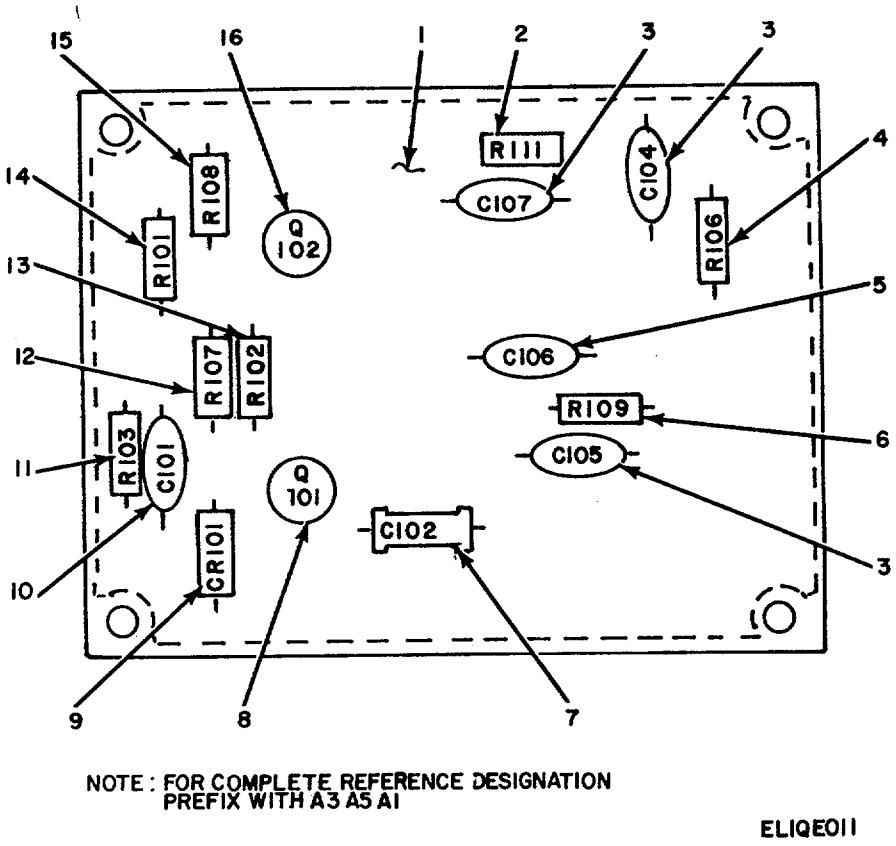


Figure D-8. Variable Frequency Oscillator.

(1) ILLUSTRATION (a) FIG NO.	(1) ILLUSTRATION (b) ITEM NO.	(2) SMR CODE	(3) FEDERAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
						GROUP 010501 VAIAILE FRQUENCY OSCILLATOR		
D-8	1	XDHZZ		SMD352037	80063	BOARD,PW ..... AMW	EA	1
D-8	2	PAHZZ	5905-00-171-2006	RC20GF271J	81349	RESISTOR,FXD,CM .....AMW	EA	1
D-8	3	PAHZZ	5910-00-733-5689	5C02347D850083	93561	CAPACITOR,FXD,C.....AMW	EA	3
D-8	4	PAHZZ	5905-00-195-6806	RC20GF102J	81349	RESISTOR,FXD,CM .....AMW	EA	1
D-8	5	PAHZZ	5910-00-822-5683	CK63AW103M	81349	CAPACITOR,FXD,C.....AMW	EA	1
D-8	6	PAHZZ	5905-00-192-3973	RC20GF471J	81349	RESISTOR,FXD,CM .....AMW	EA	1
D-8	7	XDHZZ		SMB34598 7	80063	CAPACITOR, FXD,C.....AMW	EA	1
D-8	8	PAHZZ	5961-00-892-0727	JAN2N700A	81349	TANSISTOR ..... AMW	EA	1
D-8	9	PAHZZ	5996-00-682-2587	JAN1N662	81349	SEIMCONDUCTOR,D .....AMW	EA	1
D-8	10	PAHZZ	5910-00-957-9272	20C202	93561	CAPACITOR,FXD,M .....AMW	EA	1
D-8	11	PAHZZ	5905-00-190-8881	RC20GF182J	81349	RESISTOR,FXD,CM .....AMW	EA	1
D-8	12	PAHZZ	5905-00-279-3503	RC20GF682J	81349	RESISTOR,FXD.CM .....AMW	EA	1
D-8	13	PAHZZ	5905-00-192-3971	RC20GF331J	81349	RESISTER,FXD,CM,.....AMW	EA	1
D-8	14	PAHZZ	5905-00-299-1971	RC20GF822J	81349	RESTOR,FXDCM .....AMW	EA	1
D-8	15	PAHZZ	5905-00-279-1880	RC20GF272J	81349	RESISTOR,FXD,CM .....AMW	EA	1
D-8	16	PAHZZ	5961-00-849-1582	2N501A	81349	TRANSISTOR ..... AMW	EA	1

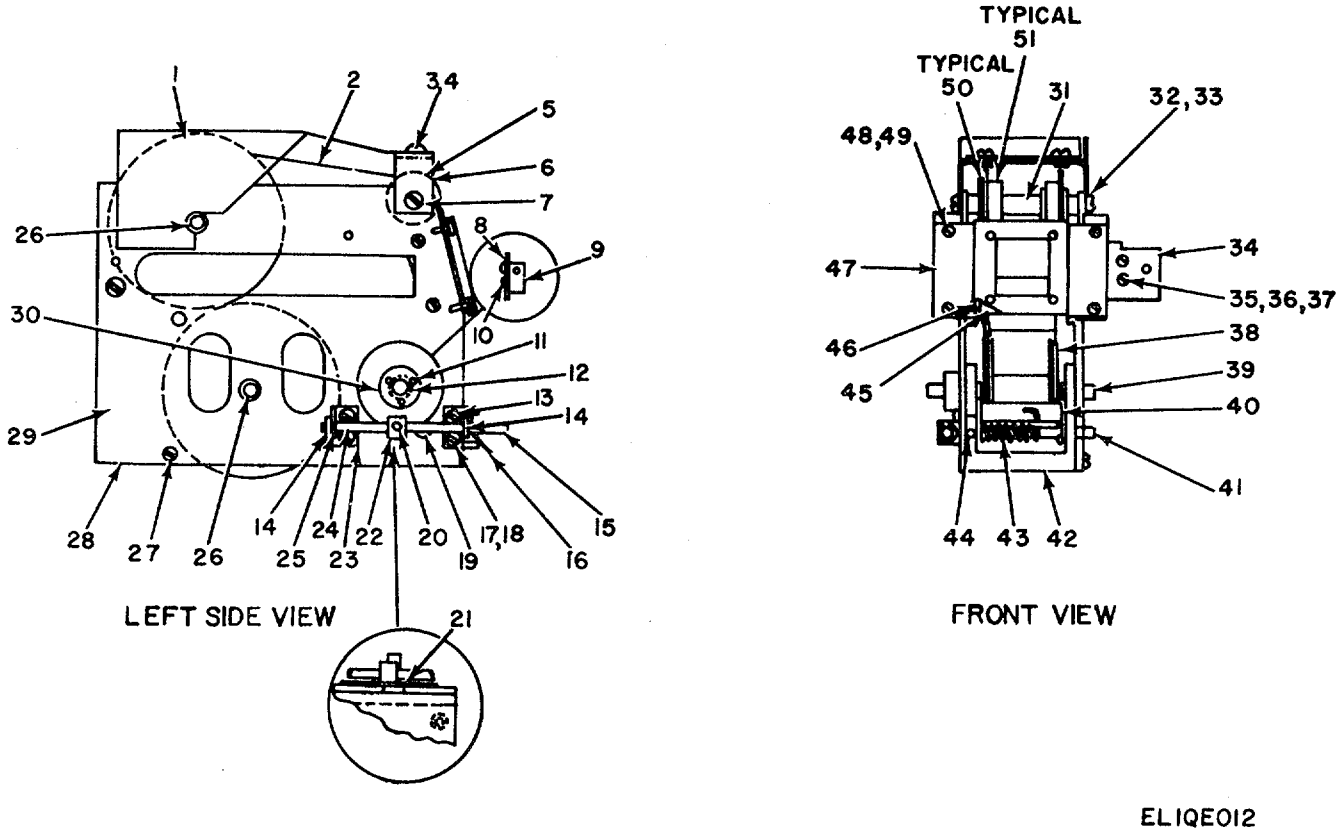


Figure D-9. Film Drive Assembly (Sheet 1 of 2).

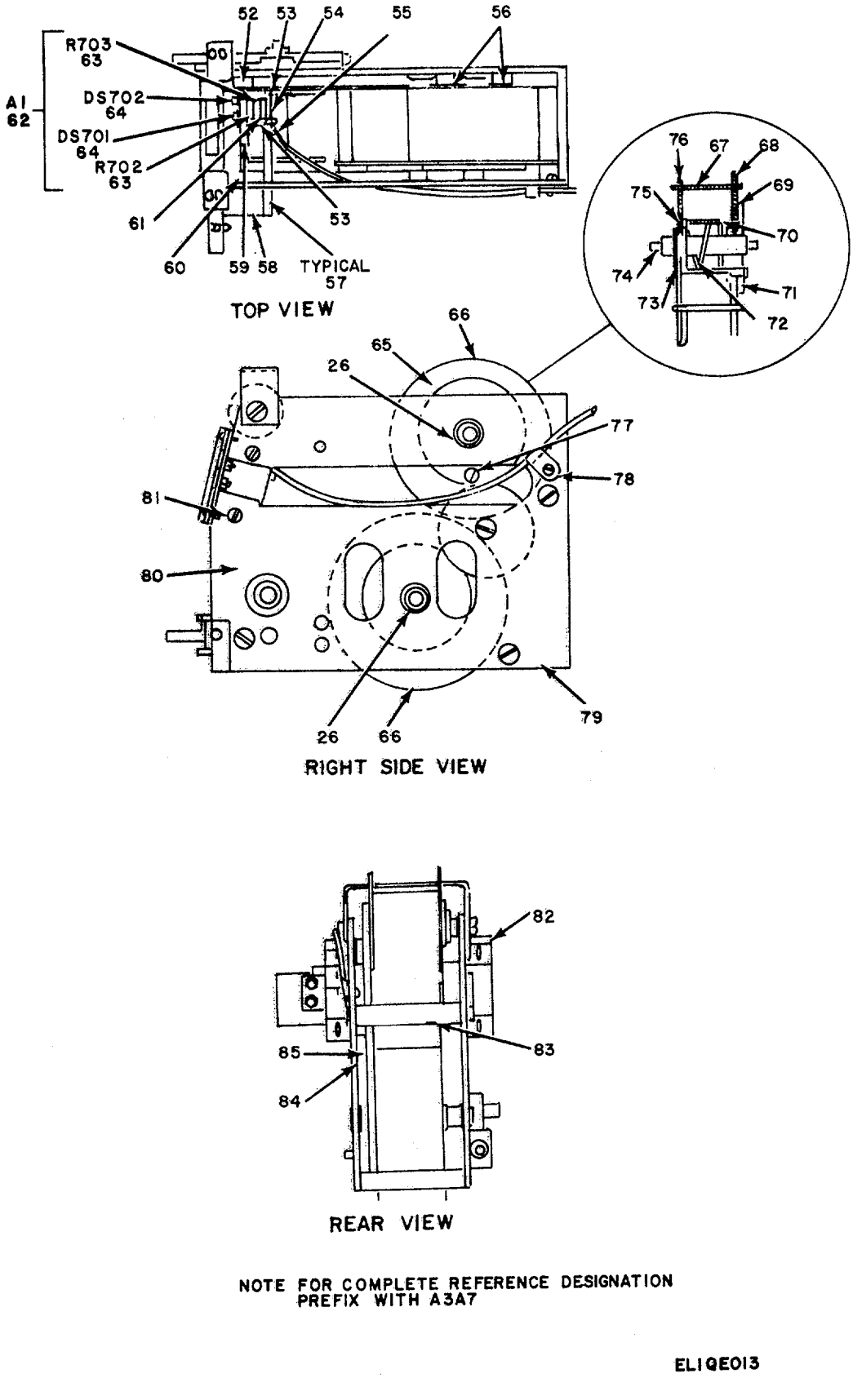
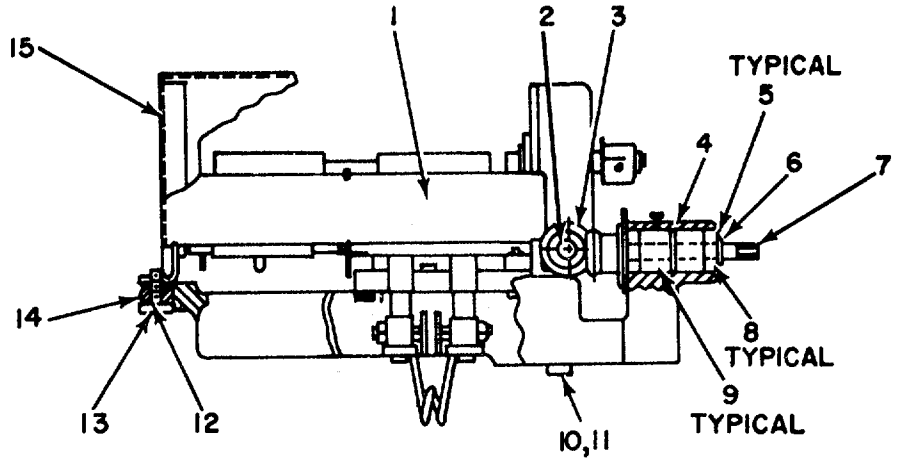


Figure D-9. Film Drive Assembly (Sheet 2 of 2).

(1) ILLUSTRATION (a) FIG NO.	(b) ITEM NO.	(2) SMR CODE	(3) FEDERAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
						GROUP 0106 FILM DRIVE ASENBLY		
D-9	1	XDHZZ		SMC345871	80063	SHIELD,FILM.....AMW	EA	1
D-9	2	XDHZZ		SMB346020	80063	FILM,ORIGINAL.....AMW	EA	1
D-9	3	PAHZZ	5305-00-054-6653	MS51957-29	96906	SCREW,MACHINE.....AMW	EA	4
D-9	4	PAHZZ	5310-00-939-0903	MS35335-86	96906	WASHER,LOCK.....AMW	EA	7
D-9	5	XDHZZ		SMB345870	80063	BRACKET,DOUBLE.....AMW	EA	1
D-9	6	XDHZZ		SB346060	80063	BRACKET ASSY.....AMW	EA	1
D-9	7	PAHZZ	5310-00-680-4919	CL632-2C	46384	NUT,SLFLKG,CLIN.....AMW	EA	2
D-9	8	XDHZZ		SMB345864	80063	DISK.....AMW	EA	1
D-9	9	XDHZZ		SMB345863	80063	HUB-DISK.....AMW	EA	1
D-9	10	PAHZZ	5305-00-253-5607	MS21318-8	96906	SCREW,MACHINE.....AMW	EA	3
D-9	11	XDHZZ		SMB346053	80063	DISK ASSY.....AMW	EA	1
D-9	12	XDHZZ		SMB345880	80063	SPACER,METALLIC.....AMW	EA	1
D-9	13	XDHZZ		SMB345865	80063	RACKET,MTG.....AMW	EA	1
D-9	14	PAHZZ	5365-00-954-5166	5133-31C	79136	RING,RETAINING.....AMW	EA	2
D-9	15	XDHZZ		SMC346040	80063	SHAFT ASSY.....AMW	EA	1
D-9	16	XDHZZ		TYPE2CRES062DLAX 3-8LG	73957	PIN,GROOVED.....AMW	EA	1
D-9	17	PAHZZ	5305-00-763-6962	MS1959-27	96906	SCREW,MACHINE.....AMW	EA	3
D-9	18	PAHZZ	5310-00-934-9761	MS35649-264	96906	NUT,PLAIN,HEXAG.....AMW	EA	1
D-9	19	XDHZZ		MS35335-80	96906	WASHER,LOCK.....AMW	EA	2
D-9	20	XDHZZ		TYPE4CRES062D1AX 3-8LG	73957	PIN,GROOVED.....AMW	EA	1
D-9	21	XDHZZ		SMB345879	80063	DISK,PLASTIC.....AMW	EA	1
D-9	22	XDHZZ		SMB345861	80063	CAM,PLASTIC.....AMW	EA	1
D-9	23	XDHZZ		SMB345860	80063	BRACKET,MTG.....AMW	EA	1
D-9	24	XDHZZ		SMB345862	80063	SHAFT,SLOTTED.....AMW	EA	1
D-9	25	XDHZZ		SMD346086-5	80063	WASHER,SPRING T.....AMW	EA	1
D-9	26	XDHZZ		SMB345977	80063	BEARING,SLEEVE.....AMW	EA	4
D-9	27	PAHZZ	5305-00-054-6651	NS51957-27	96906	SCREW,MACHINE.....AMW	EA	4
D-9	28	XDHZZ		SMC36034	80063	SIDE PLATE ASSY.....AMW	EA	1
D-9	29	XDHZZ		SMC345840-2	80063	PLATE,SIDE,LEFT.....AMW	EA	1
D-9	30	PAHZZ	5305-00-719-5346	MS51963-35	96906	SETSCREW.....AMW	EA	3
D-9	31	XDHZZ		SMB345852	80063	SPACER,SHOULDER.....AMW	EA	1
D-9	32	PAHZZ	5310-00-905-5159	MS35335-87	96906	WASHER,LOCK.....AMW	EA	5
D-9	33	PAHZZ	5305-00-054-6670	MS51957-45	96906	SCREW,MACHINE.....AMW	EA	5
D-9	34	XDHZZ	5355-00-952-3898	SMB345857	80063	VIEWER,PLASTIC.....AMW	EA	1
D-9	35	XDHZZ	5305-00-054-5647	MS51957-13	96906	SCREW,MACHINNE.....AMW	EA	2
D-9	36	PAHZZ	5310-00-939-1063	MS35649-244	96906	NUT,PLAIN,HEXAG.....AMW	EA	4
D-9	37	PAHZZ	5310-00-939-1063	MS35335-85	96906	WASHER,LOCK.....AMW	EA	10
D-9	38	XDHZZ		SMD345851	80063	SPROCKET.....AMW	EA	1

(1) ILLUSTRATION (a) FIG NO.	(b) ITEM NO.	(2) SMR CODE	(3) FEDERAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
D-9	39	XDHZZ		SMB345854	80063	SHAFT SOLID ..... AMW	EA	1
D-9	40	XDHZZ		SMB346080	80063	ROLLER LEVEL AS ..... AMW	EA	1
D-9	41	XDHZZ		SMB345872	80063	SHAFT,SLOTTED ..... AMW	EA	1
D-9	42	XDHZZ		SMC346033	80063	BEARING BLOCK A ..... AMW	EA	1
D-9	43	XDHZZ		MSB345873	80063	SPING,TENSION ..... AMW	EA	1
D-9	44	PAHZZ	5305-00-719-5330	MS51963-21	96906	SETSCREW ..... AMW	EA	1
D-9	45	XDHZZ		SMB345867	80063	ROLLER,METAL ..... AMW	EA	1
D-9	46	XDHZZ		SMB345866	80063	SHAFT,SOLID- ..... AMW	EA	1
D-9	47	XDHZZ		SMB346044	80063	MASK ASSY ..... AMW	EA	1
D-9	48	PAHZZ	5310-00-782-1349	MS15795-804	96906	WASHER,FLAT ..... AMW	EA	6
D-9	49	PAHZZ	5305-00-054-5648	MS51957-14	96906	SCEW,MACHIN ..... AMW	EA	8
D-9	50	XDHZZ		5133-357SMI	79136	KING,RETAINING ..... AMW	EA	4
D-9	51	XDHZZ		SMB345853	80063	ROLLER,PLASTIC ..... AMW	EA	2
D-9	52	XDHZZ		SMB345855-1	80063	BRACKET,MTG ..... AMW	EA	1
D-9	53	XDHZZ		SMB345877	80063	SPACER,SLEEVE ..... AMW	EA	2
D-9	54	PAHZZ	5305-00-763-1828	MS51959-20	96906	SCEREW,MACHINE ..... AMW	EA	2
D-9	55	PAHZZ	5940-00-173-8409	9-4	79963	LUG,SOLDER ..... AMW	EA	1
D-9	56	XDHZZ	5365-00-663-2744	5133-18MI	79963	LUG,SOLDER ..... AMW	EA	2
D-9	57	XDHZZ		SMB345856	80063	SPACER,SLEEVE ..... AMW	EA	2
D-9	58	XDHZZ		SMC345876	80063	BRACKET,MTG - ..... AMW	EA	1
D-9	59	XDHZZ		SMB346074	80063	COMPONENT BOARD ..... AMW	EA	1
D-9	60	XDHZZ		SMB345855-2	80063	BRACKET,MTG ..... AMW	EA	1
D-9	61	XDHZZ		SMB346089	80063	WIRING HARNESS .A ..... AMW	EA	1
D-9	62	XDHZZ		SMB346043	80063	BOARD SUBASSEMB ..... AMW	EA	1
D-9	63	PAHZZ	5905-00-171-2004	RC20GF223J	81349	RESISTOR,FXD,CM ..... AMW	EA	2
D-9	64	PAHZZ	6240-00-577-8456	NE2E	08804	LAMP GLOW ..... AMW	EA	2
D-9	65	XDHZZ		MSC346042	80063	REEL ASSY ..... AMW	EA	1
D-9	66	XDHZZ		SMC346075	80063	DRUM ASSY ..... AMW	EA	2
D-9	67	XDHZZ		SMC345841	80063	DRUM,REEL ..... AMW	EA	1
D-9	68	XDHZZ		SMB345842	80063	SPRING REEL.,END ..... AMW	EA	1
D-9	69	XDHZZ		SMB352030	80063	WASHER,NM ..... AMW	EA	3
D-9	70	PAHZZ	5305-00-975-2069	MS18064-8	96906	SETSCREW ..... AMW	EA	1
D-9	71	XDHZZ		SMB345646	80063	GEAR,SPUR ..... AMW	EA	1
D-9	72	XDHZZ		SMB345847	80063	SPRING,TENSION ..... AMW	EA	1
D-9	73	PAHZZ	5365-00-755-1152	5100-37MF	79163	RING,RETAINING ..... AMW	EA	1
D-9	74	XDHZZ		SMB345844	80063	SHAFT,FILM DRUM ..... AMW	EA	1
D-9	75	XDHZZ		SMB345878	80063	TUBE,BRASS ..... AMW	EA	1
D-9	76	XDHZZ		SMB345843	80063	SPRING REEL,END ..... AMW	EA	1
D-9	77	PAHZZ	5305-00-054-5637	MS51957-3	96906	SCREW,MACHINE ..... AMW	EA	1
D-9	78	XDHZZ		SMB345983	80063	CLAMP,CABLE ..... AMW	EA	1

(1) ILLUSTRATION (a) FIG NO.	(b) ITEM NO.	(2) SMR CODE	(3) FEDERAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
D-9	79	XDHZZ		SMC346035	80063	SIDE PLATE ASSY .....AMW	EA	1
D-9	80	XDHZZ		SMC345840-1	80063	PLATE,SIDE,RH .....AMW	EA	1
D-9	81	PAHZZ	5305-00-054-5650	MS51957-16	96906	SCREW,MACHINE .....AMW	EA	2
D-9	82	XDHZZ		SMB345881	80063	BRACKET,MTG .....AMW	EA	1
D-9	83	XDHZZ		SMB345850	80063	SPACER,SHOULDER .....AMW	EA	1
D-9	84	XDHZZ		SMB345848	80063	SHAFT,SHOULDER-E .....AMW	.EA	1
D-9	85	XDHZZ		SMB345849	80063	GEAR,SPUR..... .AMW	EA	1



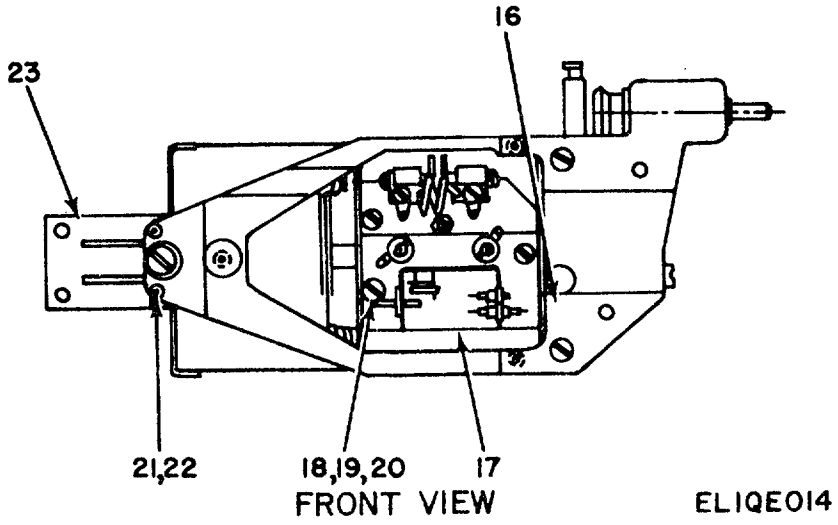


Figure D-10. Capacitor Assembly (Sheet 1 of 2).

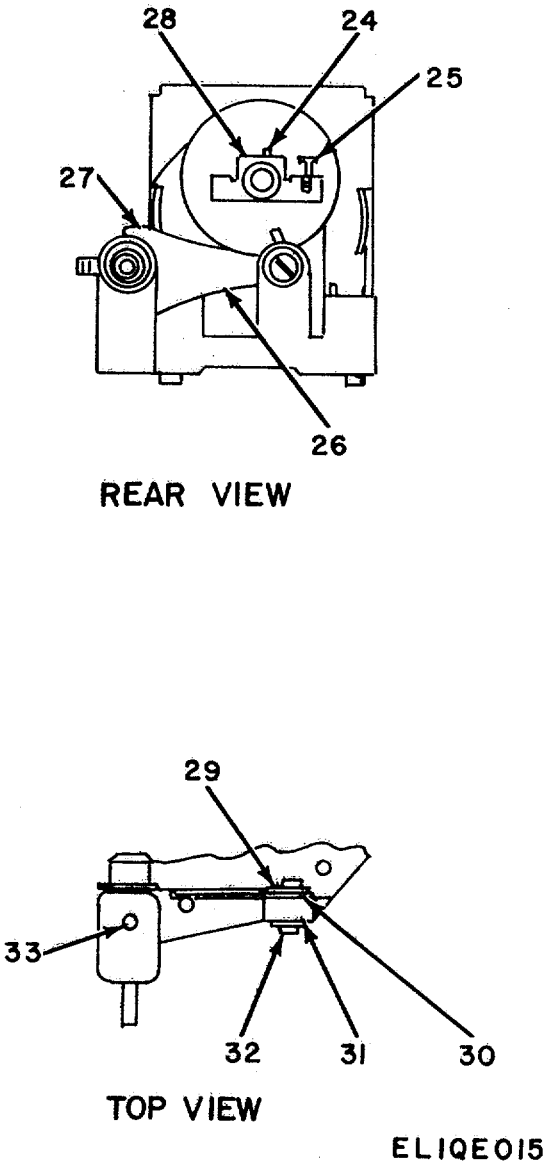
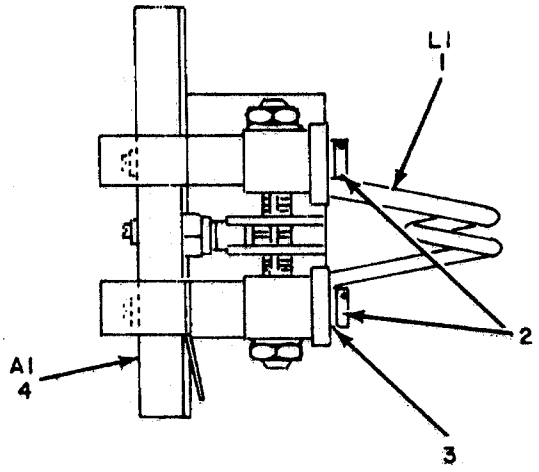
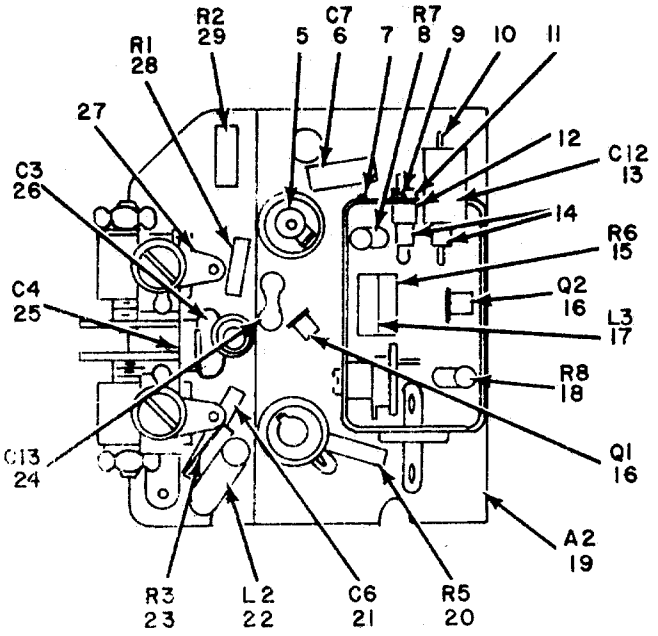


Figure D-10. Capacitor Assembly (Sheet 2 of 2)

(1) ILLUSTRATION (a) FIG NO.	(1) ILLUSTRATION (b) ITEM NO.	(2) SMR CODE	(3) FEDERAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
						GROUP 0107 CAPACITOR ASSENSLY		
D-10	1	PAHZZ	5910-00-960-3791	SMC345989	80063	CAPACITOR,VAR	EA	1
D-10	2	PAHZZ	5305-00-719-5329	MS51963-20	96906	SETSCREW	EA	2
D-10	3	XDHZZ		SMB345813	80063	GEAR,MITER	EA	1
D-10	4	XDHZZ		SMD346077-3	80063	WASHER,SPRING T	EA	1
D-10	5	XDHZZ		5133-25M1	79136	RING,RETAINING	EA	2
D-10	6	XDHZZ		SMB345837	80063	WASHER,FLAT	EA	2
D-10	7	PAHHH	6625-00-955-9469	SMB346056	80063	SHAFT, ASSY	EA	I
D-10	8	XDHZZ	3110-00-516-5330	SMB345978	80063	BEARING,BALL	EA	2
D-10	9	XDHZZ		SMB345808	80063	SPACER, SLEEVE	EA	2
D-10	10	PAHZZ	5305-00-724-5834	MS51963-87	96906	WASHER,LOCK	EA	2
D-10	11	PAHZZ	5305-00-054-6675	MS51957-50	96906	SCREW, MACHINE	EA	2
D-10	12	XDHZZ		SMB345818	80063	SPACER,SLEEVE	EA	1
D-10	13	XDHZZ		SMB345817	80063	SCREW,MACHINE	EA	1
D-10	14	XDHZZ		SMB345819	80063	GROMMET,RUBBER	EA	1
D-10	15	XDHZZ		SMC346058	80063	SHIELD ASSY	EA	1
D-10	16	XDHZZ		SMD345807	80063	BLOCK,BEARING	EA	1
D-10	17	XDHZZ		SMD346069	80063	OSCILLATOR ASSY	EA	1
D-10	18	PAHZZ	5305-00-054-6654	MS51957-30	96906	SCREW,MACHINE	EA	3
D-10	19	PAHZZ	5310-00-595-6333	MS15795-705	96906	WASHER,FLAT	EA	3
D-10	20	PAHZZ	5310-00-939-0903	MS35335-86	96906	WASHER,LOCK	EA	3
D-10	21	PAHZZ	5310-00-939-1063	MS35335-85	96906	WASHER,LOCK.	EA	2
D-10	22	PAHZZ	5305-00-054--5649	MS51957-15	96906	SCREW,MACHINE	EA	2
D-10	23	XDHZZ		SMB345836	80063	STRIP,GROUND	EA	1
D-10	24	PAHZZ	5305-00-719-5330	MS5I963-21	96906	SETSCREW	EA	2
D-10	25	PAHZZ	5305-00-054-5651	MS51957-17	96906	SCREW,MACHINE	EA	1
D-10	26	XDHZZ		SMB45816	80063	SPRING,WIRE	EA	1
D-10	27	XDHZZ		SMB345814	80063	PLATE,STOP	EA	1
D-10	28	PAHZZ	6625-00-955-9473	SMB346073	80063	STOP ASSY	EA	1
D-10	29	PAHZZ	5365-00-954-5166	5133-31C	79136	RING,RETAINING	EA	1
D-10	30	XDHZZ		SMB345815	80063	STUD,SHOULDERED	EA	1
D-10	31	PAHZZ	5330-00-942-5110	MS35335-88	96906	WASHER,LOCK	EA	1
D-10	32	PAHZZ	5305-00-050-9230	MS51957-64	96906	SCREW,MACHINE	EA	1
D-10	33	PAHZZ	5305-00-054-5647	MS51957-13	96906	SCREW,MACHINE .	EA	1



SIDE VIEW



TOP VIEW

NOTE: FOR COMPLETE REFERENCE DESIGNATION PREFIX WITH A3A9A4

ELIQE016

Figure D-11. Oscillator Assembly.

(1) ILLUSTRATION (a) FIG NO.	(1) ILLUSTRATION (b) ITEM NO.	(2) SMR CODE	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
						GROUP 010701 OSCILLATOR ASSEMBLY		
D-11	1	PAHZZ	5950-00-955-9524	SMC346064	80063	COIL ASSY, RANGE	EA	1
D-11	2	PAHZZ	5305-00-054-6651	MS51957-27	96906	SCREW, MACHINE	EA	2
D-11	3	PAHZZ	5310-00-722-5998	MS15795-805	96906	WASHER, FLAT	EA	2
D-11	4	XDHHH		SMC346054	80063	PLATE ASSY, CER	EA	1
D-11	5	XDHZZ		M229	94312	SHIELD, BEAD	EA	1
D-11	6	XDHZZ		CM15F511J	81349	CAPACITOR, FXD, M	EA	1
D-11	7	PAHZZ	5325-00-286-2598	1070	70485	GROMMET, RUBBER	EA	1
D-11	8	PAHZZ	5905-00-279-1876	RC20GF222J	81349	RESISTOR, FXD, CN	EA	1
D-11	9	PAHZZ	5310-00-934-9748	MS35649-244	96906	NUT, PLAIN, HEXAG	EA	1
D-11	10	PAHZZ	5940-00-964-7448	1481A	08145	TERMINAL STANDO	EA	1
D-11	11	PAHZZ	5940-00-258-1813	4040-4	77147	LUG, SOLDER	EA	1
D-11	12	PAHZZ	5310-00-939-1063	MS35335-85	96906	WASHER, LOCK	EA	1
D-11	13	PAHZZ	5910-00-984-7787	CM15FD121GP	81349	CAPACITOR, FXD, M	EA	1
D-11	14	XDHZZ		1480C	08145	TERMINAL STANDO	EA	2
D-11	15	PAHZZ	5905-00-279-3503	RC20GF682J	81349	RESISTOR, FXD, CM	EA	1
D-11	16	XDHZZ		2N3282	81349	TRANSISTOR	EA	2
D-11	17	XDHZZ		17624-8	11711	CHOKE, RF	EA	1
D-11	18	PAHZZ	5905-00-279-1894	RC20GF820J	81349	RESISTOR, FXD, CM	EA	1
D-11	19	XDHHH		SMC346049	80063	CASE ASSY, PLATE	EA	1
D-11	20	PAHZZ	5905-00-171-2006	RC20GF271J	81349	RESISTOR, FXD., CM	EA	1
D-11	21	PAHZZ	5910-00-615-4288	CC20UJ620G	81349	CAPACITOR, FXD, C	EA	1
D-11	22	PAHZZ	5950-00-957-0529	SMB346066	80063	COIL ASSY	EA	1
D-11	23	PAHZZ	5905-00-195-6453	RC20GF62J	81349	RESISTOR, FXD, CM	EA	1
D-11	24	XDHZZ		CM15C220K	81349	CAPACITOR, FXD, M	EA	1
D-11	25	PAHZZ	5910-00-636-2488	CC20UK020C	81349	CAPACITOR, FXD, C	EA	1
D-11	26	PAHZZ	5910-00-583-0283	DM15C050X	72136	CAPACITOR, FXD, M	EA	1
D-11	27	PAHZZ	5940-00-050-2308	MS35431-3	96906	LUG, SOLDER	EA	1
D-11	28	PAHZZ	5905-00-279-3504	RC20GF472J	81349	RESISTOR, FXD, CM	EA	1
D-11	29	PAHZZ	5905-00-279-3513	RC20GF221J	81349	RESISTOR, FXD, CM	EA	1

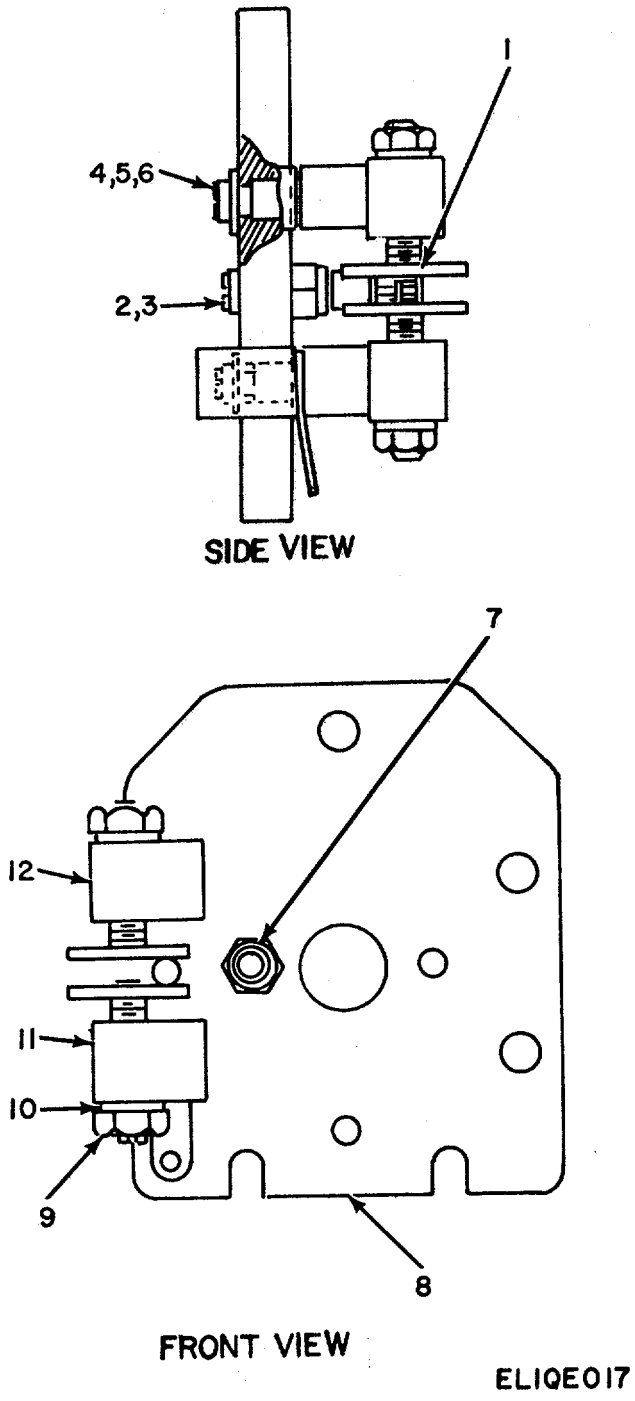


Figure D-12. Ceramic Plate Assembly.

(1) ILLUSTRATION (a) FIG NO.	(1) ILLUSTRATION (b) ITEM NO.	(2) SMR CODE	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
						GROUP 01070101 CERAMIC PLATE ASSEMBLY		
D-12	1	PAHZZ	6625-00-955-9472	SMB346050	80063	PLATE ASSY	EA	2
D-12	2	PAHZZ	5305-00-054-5649	MS51957-15	96906	SCREW, MACHINE	EA	1
D-12	3	PAHZZ	5310-00-939-1063	MS35335-85	96906	WASHER, LOCK	EA	1
D-12	4	PAHZZ	5305-00-054-6651	MS51957-27	96906	SCREW, MACHINE	EA	1
D-12	5	PAHZZ	5310-00-722-5998	MS15795-805	96906	WASHER, FLAT	EA	I
D-12	6	PAHZZ	5310-00-939-0903	MS15335-86	96906	WASHER, LOCK	EA	1
D-12	7	PAHZZ	5940-00-812-8152	3650-1	71279	TERMINAL, STANDO	EA	1
D-12	8	XDHZZ	5910-00-955-2054	SMC345823	80063	PLATE, CERAMIC	EA	1
D-12	9	PAHZZ	5310-00-934-9759	MS35649-284	96906	NUT, PLAIN, HEXAG	EA	1
D-12	10	XDHZZ		SMB345829	80063	WASHER, NM	EA	1
D-12	11	PAHZZ	6625-00-955-9471	SMB346031	80063	POST ASSY, CAPAC	EA	1
D-12	12	XDHZZ		SMB346032	80063	POST ASSY, CAPAC	EA	1

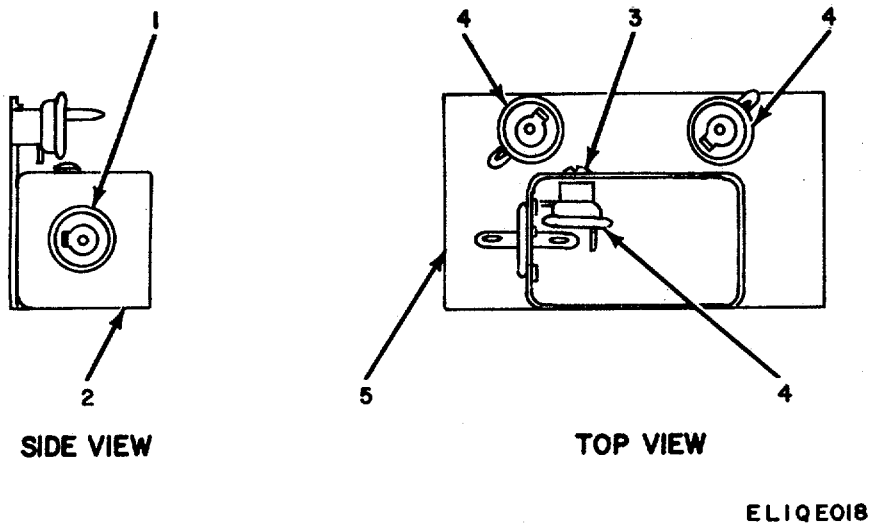


Figure D-13. Plate Case Assembly.

(1) ILLUSTRATION (a) FIG NO.	(1) ILLUSTRATION (b) ITEM NO.	(2) SMR CODE	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
						GROUP 01070102 PLATE CASE ASSEMBLY		
D-13	1	XDHZZ		CB11RD511K	81349	CAPACITOR, FXD, M	EA	1
D-13	2	XDHZZ		SMB346036	80063	CASE, PLATE	EA	
D-13	3	XDHZZ		3-48BINDHDCRESMS 3-16LG	97852	SCREW, MACHINE	EA	1
D-13	4	XDHZZ		CB21RD511J	81349	CAPACITOR, FXD, M	EA	3
D-13	5	XDHZZ		SMB345822	80063	PLATE, CASE	EA	

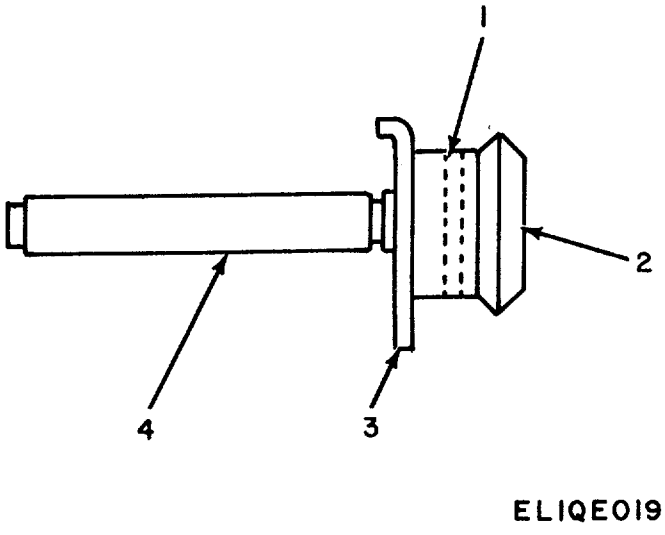


Figure D-14. Shaft Assembly.

(1) ILLUSTRATION (a) FIG NO.	(1) ILLUSTRATION (b) ITEM NO.	(2) SMR CODE	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
						GROUP 010702 SHAFT ASSEMBLY		
D-14	1	XDHZZ		1-16X5-8MEDDUTY	00287	PIN, SPIRAL	EA	1
D-14	2	XDHZZ		SMB345810	80063	GEAR, MITER	EA	1
D-14	3	XDHZZ		SMB346055	80063	WASHER ASSY, STO	EA	1
D-14	4	XDHZZ		SMB345809	80063	SHAFT, STRAIGHT	EA	1

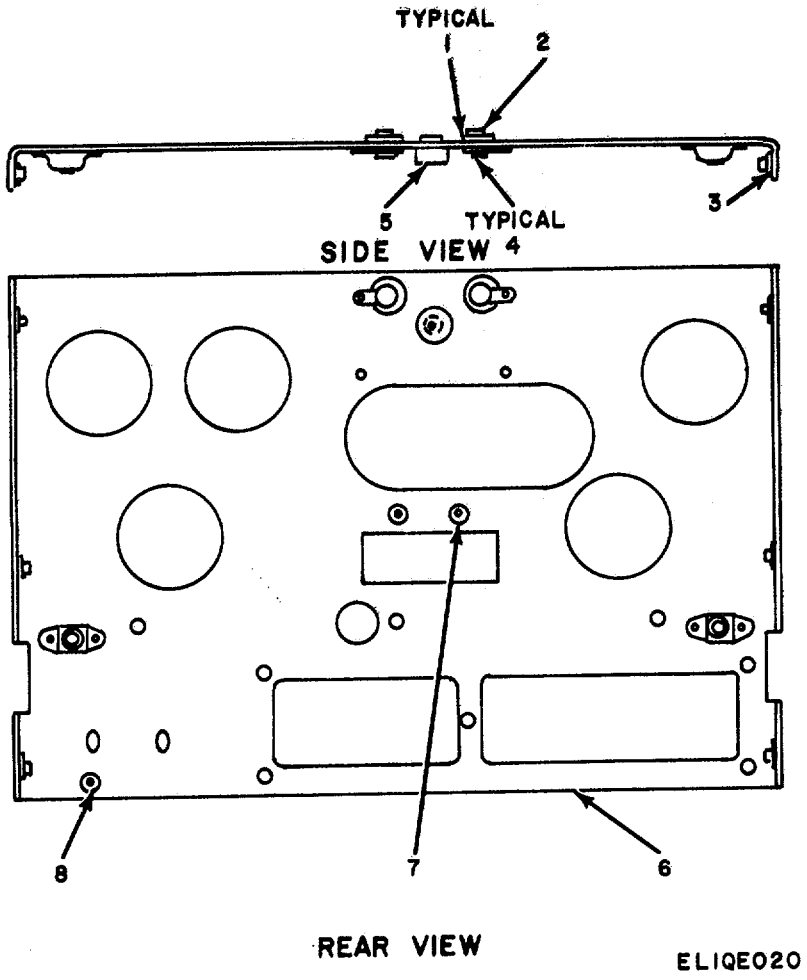


Figure D-15. Rear Panel Assembly.

(1) ILLUSTRATION (a) FIG NO.	(1) ILLUSTRATION (b) ITEM NO.	(2) SMR CODE	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
						GROUP 0108 REAR PANEL ASSEMBLY		
D-15	1	XDHZZ		SMB3459 11	80063	SPACER, SLEEVE .....AMW	EA	4
D-15	2	PAHZZ	5310-00-595-6333	MS15795-705	96906	WASHER, FLAT .....AMW	EA	2
D-15	3	PAHZZ	5310-00-655-9677	CL832-2C	46384	NUT, SLFLKG, CLIN .....AMW	EA	6
D-15	4	XDHZ	Z	SMB346047	80063	CONTACT ASSY.....AMW	EA	2
D-15	5	XDHZZ		SMB345913	80063	BUSHING, SLEEVE .....AMW	EA	1
D-15	6	XDHZZ		SMD345901	80063	PANEL, REAR . .....AMW	EA	1
D-15	7	XDHZZ		C1632-2C	46384	NUT, SLFLKG, CLIN .....AMW	EA	2
D-15	8	XDHZ Z	5310-00-679-5532	CL440-2C	46384	NUT, SLFLKG, CLIN .....AMW	EA	2

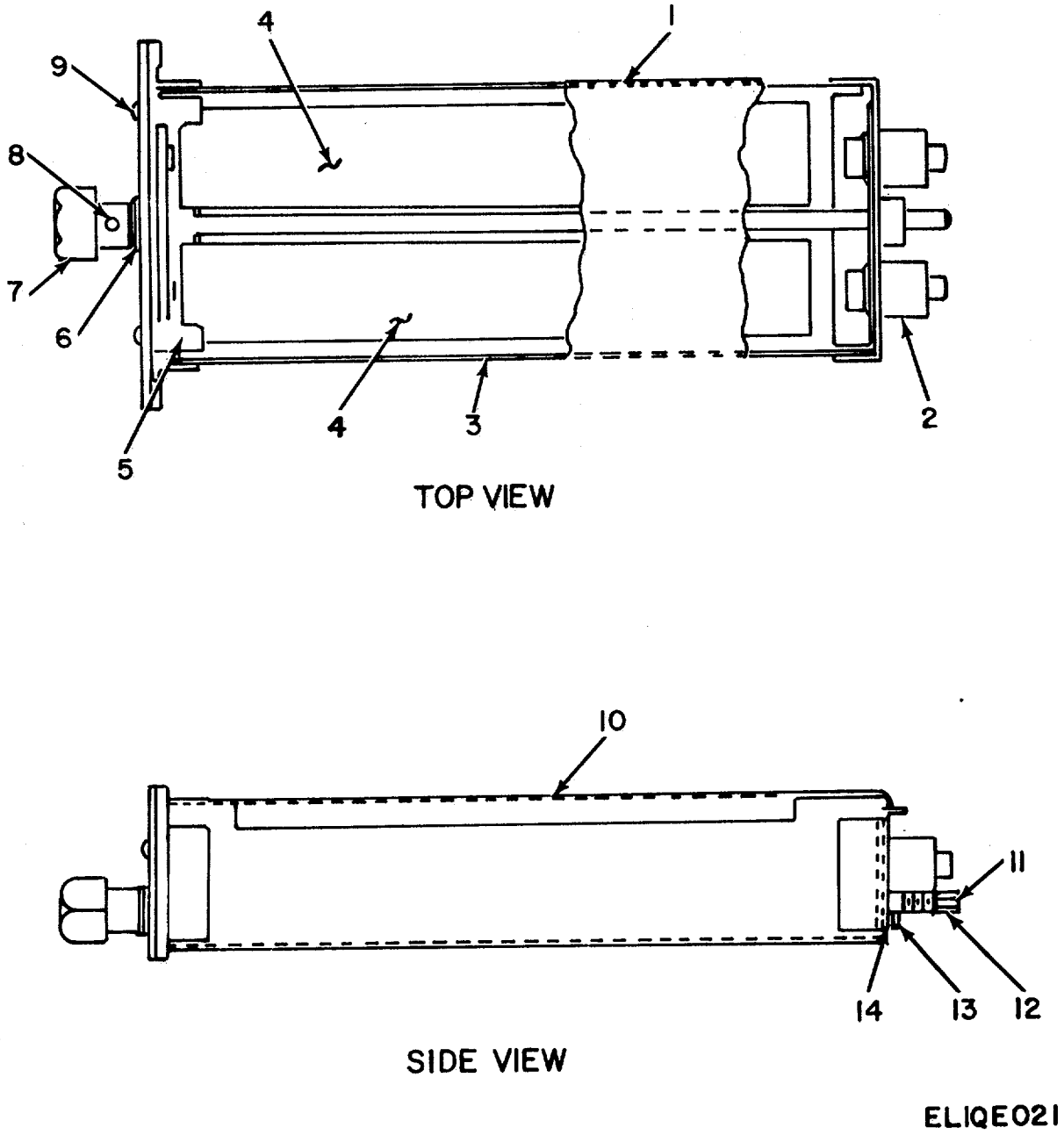


Figure D-16. Battery Box Assembly.

(1) ILLUSTRATION (a) FIG NO.	(1) ILLUSTRATION (b) ITEM NO.	(2) SMR CODE	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
						GROUP 0109 BATTERY BOX ASSEMBLY		
D-16	1	XDHZZ		SMC346029	80063	COVER ASSY ..... AMW	EA	1
D-16	2	XDHZZ		SMC346024	80063	PLATE, CONTACT, R .....AMW	EA	1
D-16	3	XDHZZ		SMC345952	80063	COVER ..... AMW	EA	1
D-16	4	XDHZZ		SMB345951	80063	CUSHION BATTERY .....AMW	EA	2
D-16	5	XDHZZ		SMB345953	80063	CUSHION COVER .....AMW	EA	1
D-16	6	XDHZZ		SMB345885	80063	WASHER, FLAT .....AMW	EA	1
D-16	7	PAHZZ	5355-00-990-4260	SMB345884	80063	KNOB, BOUND .....AMW	EA	1
D-16	8	PAHZZ	5305-00-719-5330	MS51963-21	96906	SETSCREW ..... .AMW	EA	1
D-16	9	XDHZZ	5325-00-275-4491	SE35	61957	EYELET, METALLIC.....AMW	EA	1
D-16	10	XDHZZ		SMD346028	80063	BATTERY BOX SUB .....AMW	EA	1
D-16	11	PAHZ Z	5315-00-058-969 8	79-012-062-0312	72962	PIN, ROLL..... AMW	EA	1
D-16	12	XDHZZ		DMB346026	80063	SHAFT LOCK ASSY .....AMW	EA	1
D-16	13	PAHZ Z	5310-00-595-6772	MS15795-808	96906	WASHER, FLAT .....AMW	EA	1
D-16	14	XDHZZ		SMB345954	80063	SHAFT, LOCK..... ..... AMW	EA	1

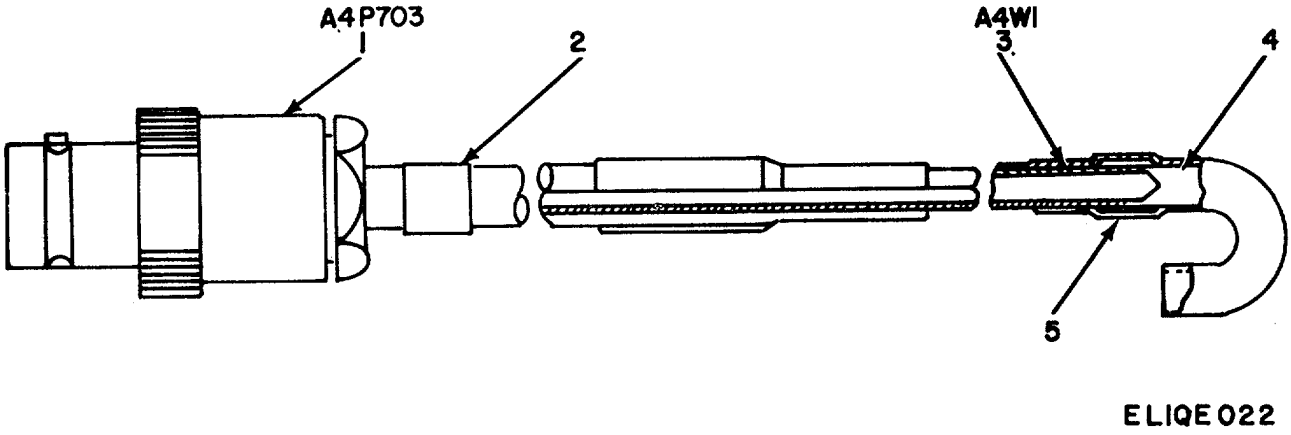


Figure D-17. Antenna Assembly AT-564( )/U.

(1) ILLUSTRATION (a) FIG NO.	(1) ILLUSTRATION (b) ITEM NO.	(2) SMR CODE	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
						GROUP 02 ANTENNA ASSEMBLY AT-564 ( )/U		
D-17	1	PAHZZ	5935-00-577-2281	UG-89C/U	80058	JACK, RF USED ON MODEL AT564U AND AT564AU AMW, 5K3	EA	1
D-17	1	PAHZZ	5935-00-177-2706	UG-898/U	80058	JACK, RF USED ON MODEL AT564AU .....AMW, 5K3	EA	1
D-11	2	XDHZZ		SMB283983	80063	MARKER, CABLE.....AMW, 5K3	EA	1
D-17	3	PAHZ Z	6145-00-542-6092	RG58CU	81349	CABLE, ELEC.....AMW, 5K3	EA	1
D-17	4	XDHZZ		SMB283925	80063	HOOK ANTENNA.....AMW, 5K3	EA	1
D-17	5	XDHZZ		SMC283978	80063	SLEEVE, HOLLOW.....AMW, 5K3	EA	1

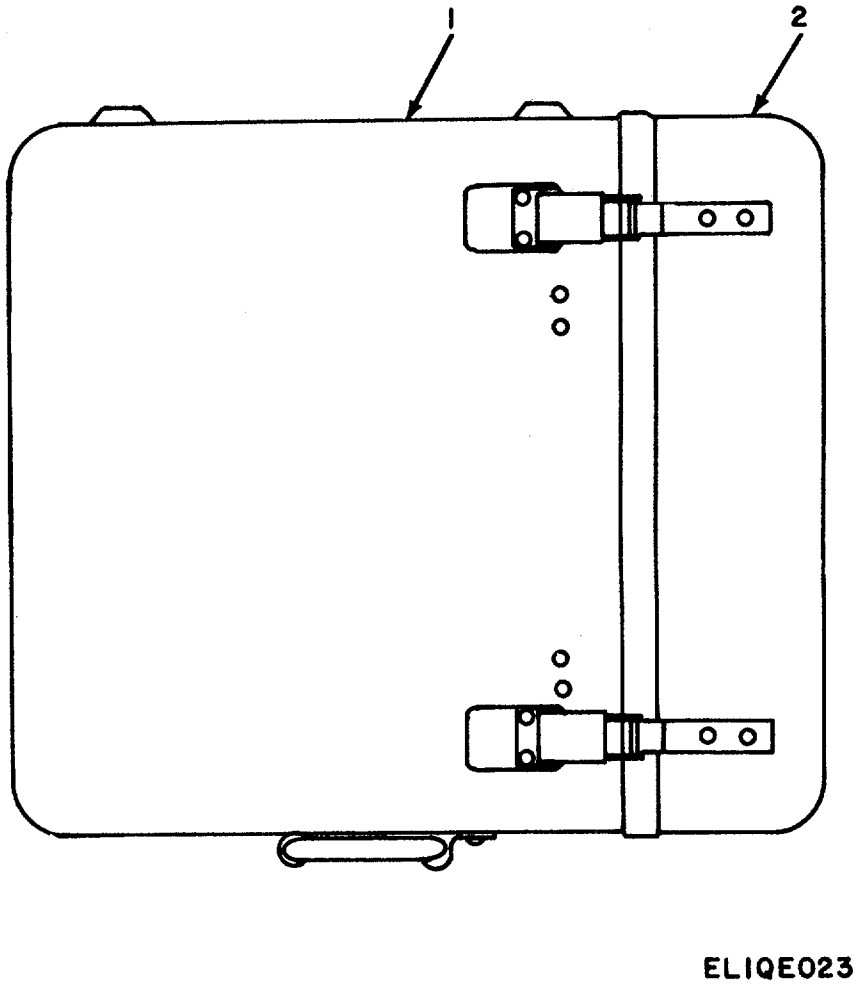


Figure D-18. Case and Cover Assembly.

(1) ILLUSTRATION (a) FIG NO.	(1) ILLUSTRATION (b) ITEM NO.	(2) SMR CODE	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
						GROUP 03 CASE AND COVER ASSEMBLY		
D-18	1	XDHHH		SMD346091	80063	CASE ASSY.....	EA	1
D-18	2	XDHHH		SMB346090	80063	COVER ASSY	EA	1

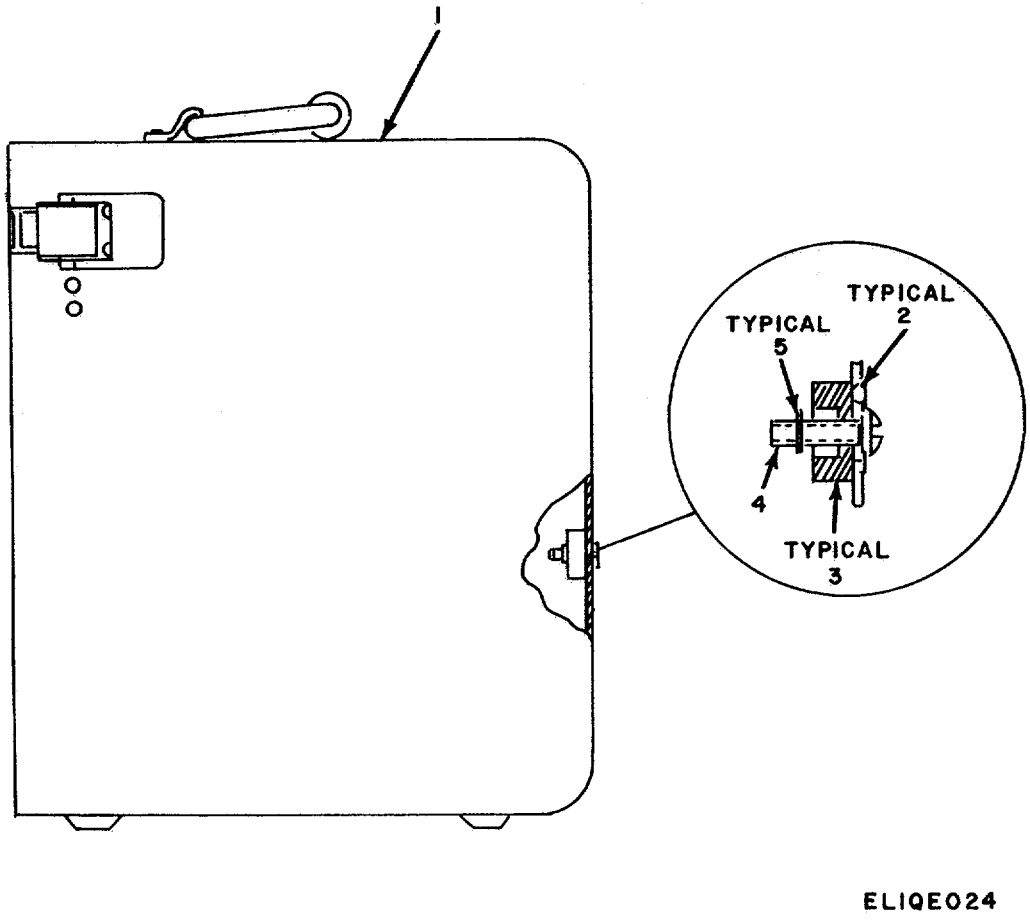


Figure D-19. Case Assembly.

(1) ILLUSTRATION (a) FIG NO.	(1) ILLUSTRATION (b) ITEM NO.	(2) SMR CODE	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
						GROUP 0301 CASE ASSEMBLY		
D-19	1	XDHZZ		SMD346076	80063	CASE	EA	1
D-19	2	PAHZ Z	5330-00-171-9984	914-2	86579	PACKING, PREFORM		
D-19	3	XDHZZ		SMB345960	80063	BUSHING, SHOULDE	EA	2
D-19	4	XDHZZ		SMB346051	80063	SCREW, MACHINE	EA	2
D-19	5	XDHZZ		WA510	76665	RING, RETAINING	EA	2

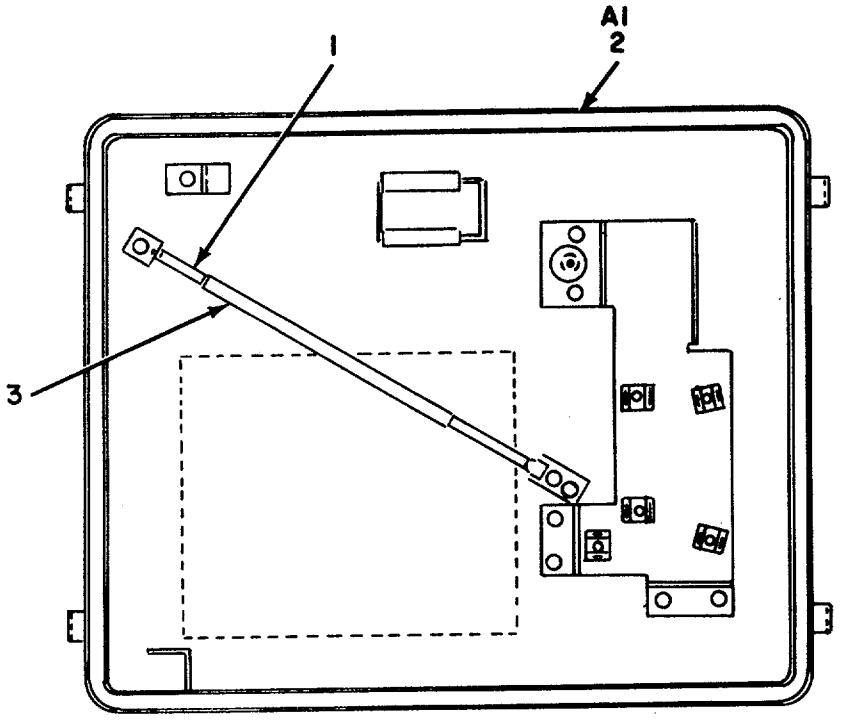


Figure D-20. Cover Assembly.

(1) ILLUSTRATION (a) FIG NO.	(1) ILLUSTRATION (b) ITEM NO.	(2) SMR CODE	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
						GROUP 0302 COVER ASSEMBLY		
D-20	1	XDHZZ		SMB345974	80063	SPRING, TENSION.....	EA	1
D-20	2	XDHZZ		SMD346088	80063	COVER, WELDMENT	EA	1
D-20	3	XDHZZ		SMB345975	80063	TUBE, HOLLOW	EA	1

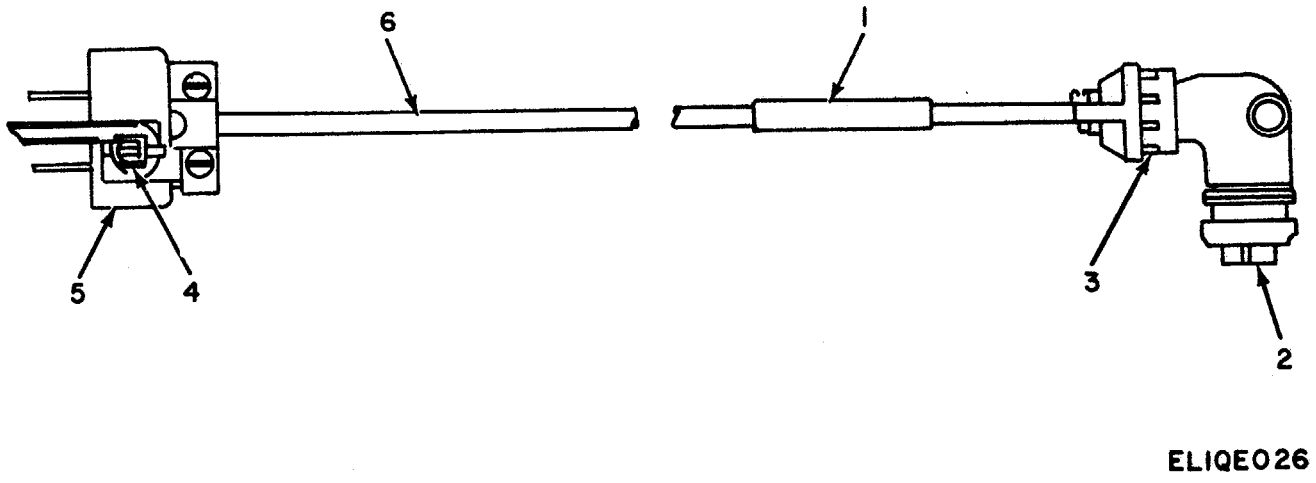


Figure D-21. Cable Assembly, Power Electrical CX-7782/USM-159.

(1) ILLUSTRATION (a) FIG NO.	(1) ILLUSTRATION (b) ITEM NO.	(2) SMR CODE	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
						GROUP 04 CABLE ASSEMBLY, POWER ELECTRICAL CX-7782/USM-159 OR CX-12005/USM-159		
D-21	1	XDHZZ		SMB345886	80063	MARKER, CABLE	EA	1
D-21	2	PAHZZ	5935-00-259-7410	MS3108B10SL35	96906	CONNECTOR, PLUG	EA	1
D-21	3	PAHZZ	5935-00-280-2200	MS3057-48	96906	CLAMP, CABLE	EA	1
D-21	4	PAHZZ	5940-00-503-9824	32561	00779	TERMINAL, LUG	EA	1
D-21	5	XDHZZ		MC24663	96906	CONNECTOR, PLUG	EA	1
D-21	6	PAHZ Z	5935-00-843-7362	MS24663	80063	CABLE, ELEC	FT	6

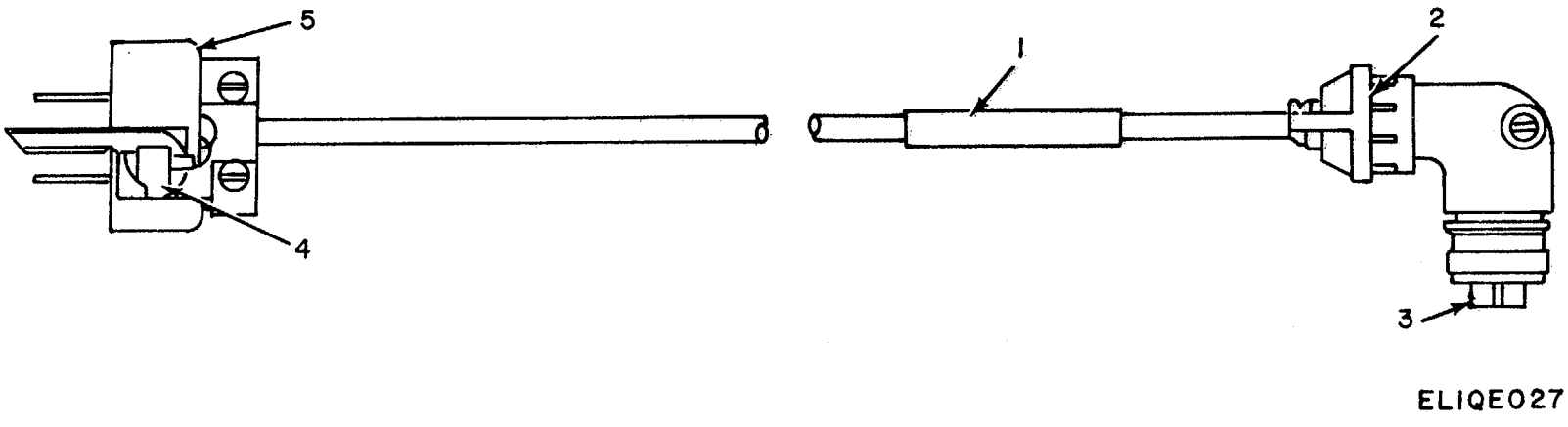


Figure D-22. Cable Assembly, Power Electrical CX-12005/USM-159.

(1) ILLUSTRATION (a) FIG NO.	(1) ILLUSTRATION (b) ITEM NO.	(2) SMR CODE	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
D-22	1	XDHZZ	5975-00-669-9473	SMB165914	80063	BAND, IDENT	EA	1
D-22	2	XDHZZ	5935-00-280-220 0	MS3057-4-B	96906	CLAMP	EA	1
D-22	3	PAHZZ	5935-00-259-741 0	MS3108B10SL3S	81349	CONNECTOR, PLUG	EA	1
D-22	4	XDHZZ		SMC146485-2	80063	LUG, TERMINAL	EA	1
D-22	5	PAHZZ	5935-00-843-7362	UP131M	80058	CONNECTOR, PLUG	EA	1

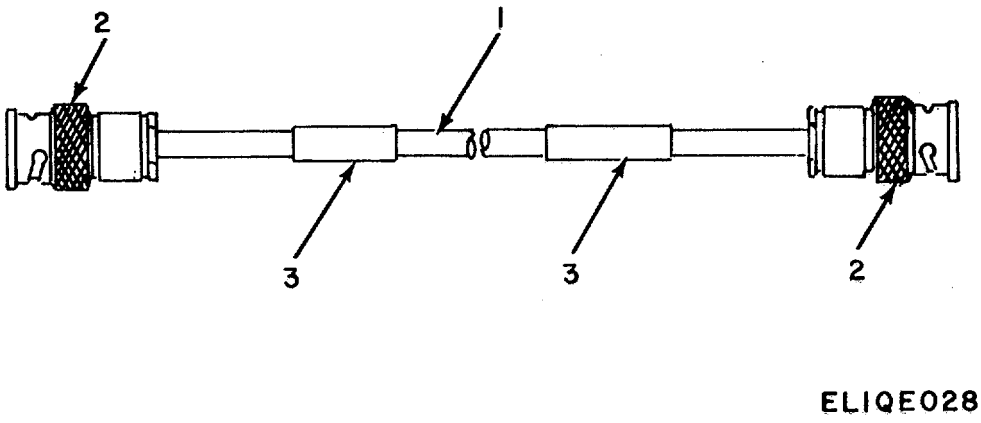


Figure D-23. Cord Assembly CG-409/U.

(1) ILLUSTRATION (a) FIG NO.	(1) ILLUSTRATION (b) ITEM NO.	(2) SMR CODE	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
						GROUP 05 CORD ASSEMBLY CG-409/U		
D-23	1	PAHZ Z	6145-00-542-609 2	RG58CU	81349	CABLE, ELEC.....	FT	V
D-23	2	XDHZZ		MS35168-88	96906	CONNECTOR, PLUG	EA	2
D-23	3	XDHZZ		SCB34065	80063	MARKER, CABLE.....	EA	2

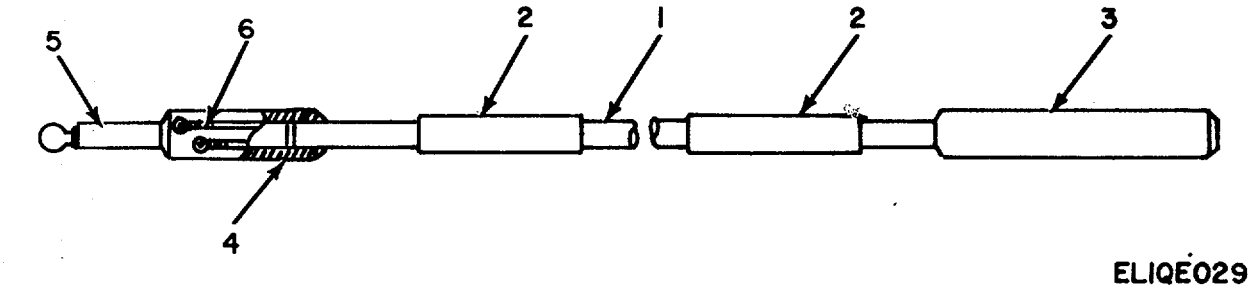


Figure D-24. Cord Assembly CD-307A.

(1) ILLUSTRATION (a) FIG NO.	(1) ILLUSTRATION (b) ITEM NO.	(2) SMR CODE	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION *USABLE ON CODE*	(7) U/M	(8) QTY INC IN UNIT
						GROUP 06 CORD ASSEMBLY CO-307A		
D-24	1	PAHZ Z	6145-00-583-3142	COS2-22	81349	CORD, ELEC	FT	V
D-24	2	XDHZZ		SCB34065	80063	MARKER, CABLE	EA	2
D-24	3	PAHZ Z	5935-00-194-3081	JJ026	81349	JACK, TELEPHONE	EA	2
D-24	4	XDHZZ		SCB7674	80063	CLAMP, CABLE	EA	2
D-24	5	PAHZZ	5935-00-192-4760	PJ055B	81349	PLUG, TELEPHONE	EA	1
D-24	6	PAHZZ	5940-00-950-1803	MS35430-1	96906	TERMINAL, LUG	EA	4

NOTE: LATEST NATIONAL STOCK NUMBER AND PART NUMBER ASSIGNMENTS ARE INCLUDED AT END OF INDEX

Stock Number	Figure No.	Item No.
5310-00-022-1117	D-5	10
5961-00-022-5664	D-5	20
5305-00-050-9230	D-10	32
5950-00-053-3702	D-5	7
5305-00-054-5635	D-1	10
5350-00-054-5631	D-9	77
5305-00-054-5647	D-2	18
5305-00-054-5647	D-9	35
5305-00-054-5647	D-10	33
5305-00-054-5648	D-2	49
5305-00-054-5648	D-9	49
5305-00-054-5649	D-10	22
5305-00-054-5649	D-12	2
5305-00-054-5650	D-9	81
5305-00-054-5651	D-4	29
5305-00-054-5651	D-10	25
5305-00-054-6651	D-2	69
5305-00-054-6651	D-9	27
5305-00-054-6651	D-11	2
5305-00-054-6651	D-12	4
5305-00-054-6653	D-2	21
5305-00-054-6653	D-9	3
5305-00-054-6654	D-2	16
5305-00-054-6654	D-10	18
5305-00-054-6655	D-1	16
5305-00-054-6668	D-2	95
5305-00-054-6672	D-2	40
5305-00-054-6675	D-10	11
5315-00-058-9698	D-16	11
5305-00-059-3659	D-1	14
6240-00-143-3049	D-2	54
5995-00-164-7716	D-1	3
5905-00-171-1999	D-4	10
5905-00-171-2006	D-8	2
5905-00-171-2006	D-11	20
5940-00-173-8409	D-9	55
5905-00-185-8510	D-3	4
5905-00-185-8510	D-4	33
5905-00-190-8881	D-8	11
5905-00-190-8889	D-4	8
5905-00-190-8889	D-6	3
5905-00-192-3977	D-8	13
5905-00-192-3913	D-6	6
5905-00-192-3973	D-8	6
5935-00-192-4760	D-24	5
5935-00-194-3081	D-24	3
5905-00-195-6453	D-3	12
5905-00-195-6453	D-5	15
5905-00-195-6453	D-11	23
5905-00-195-6806	D-8	4
5920-00-022-1312	D-2	99
5950-00-237-2624	D-2	35
5905-00-249-4200	D-6	10
5995-00-252-2338	D-1	4
5905-00-252-4018	D-3	9
5305-00-253-5607	D-9	10
5935-00-299-7410	D-22	3
5310-00-261-7160	D-2	124
5310-00-270-8810	D-2	7
5325-00-275-4491	D-16	9
5905-00-279-1876	D-5	4
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5905-00-279-1880	D-8	15
5905-00-279-1894	D-11	18
5905-00-279-1897	D-4	21
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5905-00-279-3511	D-3	10
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5325-00-286-2598	D-11	7
5905-00-299-1971	D-8	14
5940-00-503-9824	D-21	4
6660-00-504-2437	D-1	6
6625-00-539-9365	D-1	5
5325-00-543-3942	D-2	10
5935-00-552-7660	D-2	116
5935-00-577-2281	D-17	1
5910-00-577-7902	D-7	7
5935-00-581-6941	D-4	2
5310-00-595-6211	D-4	28
5310-00-595-6333	D-10	19
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5340-00-598-0296	D-2	67
5910-00-615-4288	D-11	21
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5905-00-643-5626	D-2	83
5365-00-663-2744	D-9	56
5975-00-669-9473	D-22	1
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5310-00-680-4919	D-2	78
5310-00-680-4919	D-9	7
5935-00-683-2746	D-2	101
5961-00-683-4182	D-3	7
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5305-00-763-7828	D-9	54
5305-00-770-2579	D-2	97
5961-00-776-0964	D-6	2
5310-00-782-1349	D-2	48
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5910-00-807-2595	D-5	14
5940-00-812-8152	D-12	7
5910-00-816-6613	D-5	23
5310-00-818-6459	D-5	11
5910-00-822-5683	D-3	15
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5910-00-823-1068	D-3	14
5961-00-844-6717	D-5	5
5961-00-849-1582	D-4	12
5961-00-849-1582	D-8	16
5910-00-855-2717	D-4	13
5310-00-880-5978	D-2	39
5995-00-889-0553	D-1	4
5965-00-892-3353	D-1	1
6625-00-892-5361	D-1	9
5950-00-892-8179	D-4	26
5310-00-905-5159	D-9	32
5940-00-914-9919	D-2	61
5310-00-939-0903	D-2	17
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5310-00-939-1063	D-2	19
5310-00-939-1063	D-7	
5310-00-939-1063	D-9	
5310-00-939-1063	D-10	2.
5310-00-939-1063	D-11	12
5310-00-939-1063	D-12	3
5310-00-942-5110	D-1	15
5310-00-942-5110	D-2	8
5310-00-942-5110	D-10	3
5940-00-950-1803	D-24	

NOTE: LATEST NATIONAL STOCK NUMBER AND PART NUMBER ASSIGNMENTS ARE INCLUDED AT END OF INDEX

Stock Number	Figure No.	Item No.	Stock Number	Figure No.	Item No.
5970-00-955-2054	D-12	8	5950-00-957-7014	D-2	57
6625-00-955-5538	D-2	36	5355-00-957-8560	D-2	102
6625-00-955-9468	D-7	2	6625-00-957-8563	D-2	107
6625-00-955-9469	D-10	7	6625-00-958-3297	D-2	91
6625-00-955-9471	D-12	11	5910-00-960-3791	D-10	1
6625-00-955-9472	D-12	1	5910-00-960-3810	D-2	44
6625-00-955-9473	D-10	28	5940-00-964-7446	D-11	10
5950-00-955-9524	D-11	1	5910-00-983-6866	D-3	8
6625-00-956-9779	D-2	106	5905-00-985-5383	D-6	8
6625-00-957-0529	D-11	22	5940-00-990-1858	D-2	118
6625-00-957-3611	D-2	1	5355-00-990-4260	D-16	7
5950-00-957-7012	D-2	58			

PART NUMBER	FSCM	FIG. NO.	ITEM NO.	PART NUMBER	FSCM	FIG. NO.	ITEM NO.
AT564( )/U	80056	D-1	5	MS15795-804	96906	D-2	48
A2770	99850	D-2	52	MS15795-804	96906	D-7	4
A2774	99850	D-2	82	MS15795-804	96906	D-9	48
BB65203V2SZ7	80058	D-4	17	MS15795-805	96906	D-2	62
BOW479S10	73287	D-2	29	MS15795-805	96906	D-11	3
CB11RD511K	81349	D-13	1	MS15795-805	96906	D-12	5
CB21RD511J	81349	D-13	4	MS15795-807	96906	D-2	39
CC20UJ070C	81349	D-7	7	MS15795-808	96906	D-16	18
CC20UJ620G	81349	D-11	21	MS18064-8	96906	D-9	70
CC20UK020C	81349	D-11	25	MS21318-8	96906	D-9	10
CD307A	80058	D-1	3	MS27035-625B	96906	D-2	118
				MS3057-4-B	96906	D-22	2
CG4090	80058	D-1	6	MS3057-4-B	96906	D-21	3
CK61BX471K	81349	D-3	8	MS3102R10SL3P	96906	D-2	94
CK62AW472M	81349	D-3	14	MS3108B10SL3S	81349	D-22	3
CK63AW103M	81349	D-3	15	MS35168-88	96906	D-23	2
CK63AW103M	81349	D-8	5	MS35333-103	96906	D-5	10
CL440-2C	46384	D-15	8	MS35335-80	96906	D-9	19
CL632-2C	46384	D-2	78	MS35335-85	96906	D-2	19
CL632-2C	46384	D-9	7	MS35335-85	96906	D-7	3
CL832-2C	46384	D-15	3	MS35335-85	96906	D-9	37
				MS35335-85	96906	D-10	21
CM15C220K	81349	D-11	24	MS35335-85	96906	D-11	12
CM15C470JN3	81349	D-5	23	MS35335-85	96906	D-12	3
CM15C680JN3	81349	D-5	14	MS35335-86	96906	D-2	17
				MS35335-86	96906	D-9	4
CM15F221JN3	81349	D-4	6	MS35335-86	96906	D-10	20
CM15F511J	81349	D-11	6	MS35335-86	96906	D-12	6
CM15F511JN3	81349	D-4	13	MS35335-87	96906	D-9	32
CM20FD102JN3	81349	D-4	14	MS35335-88	96906	D-1	15
CM20FD182JN3	81349	D-4	5	MS35335-88	96906	D-2	8
CM20FD561JN3	81349	D-3	13	MS35335-88	96906	D-10	31
CM29FD681JN3	81349	D-4	23	MS35430-1	96906	D-24	9
				MS35649-26	96906	D-5	11
CR130U1000KC	81349	D-4	19				
CR130U2500KC	81349	D-4	4				
CS13BC101M	81349	D-5	16				
CS13BC227M	81349	D-3	2				
CS13BC227M	81349	D-4	22				
CX12005USM159	80058	D-1	4				
CX7782USM159	80058	D-1	4				
C1632-2C	46384	D-15	7	MS35650-104	96906	D-2	7
DMB346026	80063	D-16	12	MS51957-1	96906	D-1	10
DM15C050K	72136	D-2	46	MS51957-13	96906	D-2	18
DM15C050K	72136	D-11	26	MS51957-13	96906	D-9	35
FR149AUSM159	80058	D-1	9	MS51957-13	96906	D-10	33
FR149BUSM159	80058	D-1	9	MS51957-14	96906	D-2	49
FR149USM159	80058	D-1	9	MS51957-14	96906	D-9	49
HP7N	09922	D-2	67	MS51957-15	96906	D-10	22
				MS51957-15		D-12	2
H216U	80058	D-1	1	MS51957-16	96906	D-9	81
JJ026	81349	D-24	3	MS51957-17	96906	D-4	29
JJ034	81349	D-2	101	MS51957-17	96906	D-10	25
				MS51957-27	96906	D-2	69
				MS51957-27	96906	D-9	27
MS05335-87	96906	D-2	15	MS51957-27	96906	D-11	2
MS15579-4	96906	D-2	54	MS51957-27	96906	D-12	4
MS15795-705	96906	D-10	19	MS51957-28	96906	D-2	2
MS15795-705	96906	D-15	2	MS51957-29	96906	D-2	21
MS15795-802	96906	D-5	9	MS51957-29	96906	D-9	3
MS15795-803	96906	D-4	28	MS51957-3	96906	D-9	77

PART NUMBER	FSCM	FIG. NO.	ITEM NO.
MS51957-30	96906	D-2	16
MS51957-30	96906	D-10	18
MS51957-31	96906	D-1	16
MS51957-43	96906	D-2	95
MS51957-45	96906	D-2	14
MS51957-45	96906	D-9	33
MS51957-47	96906	D-2	40
MS51957-48	96906	D-2	66
MS51957-50	96906	D-10	11
MS51957-64	96906	D-10	32
MS51958-63	96906	D-1	14
MS51959-15	96906	D-2	97
MS51959-20	96906	D-9	54
MS51959-27	96906	D-2	24
MS51959-27	96906	D-9	17
MS51959-29	96906	D-2	119
MS51963-20	96906	D-10	2
MS51963-21	96906	D-2	34
MS51963-21	96906	D-9	44
MS51963-21	96906	D-10	24
MS51963-21	96906	D-16	8
MS51963-34	96906	D-2	110
MS51963-35	96906	D-9	30
MS51963-87	96906	D-10	10
MS90078-18	96906	D-2	99
M229	94312	D-11	5
PJ0558	81349	D-24	5
RC20GF101J	81349	D-4	8
RC20GF101J	81349	D-6	3
RC20GF102J	81349	D-8	4
RC20GF103J	81349	D-3	4
RC20GF103J	81349	D-4	33
RC20GF122J	81349	D-4	15
RC20GF123J	81349	D-4	7
RC20GF153J	81349	D-3	3
RC20GF182J	81349	D-8	11
RC20GF221J	81349	D-5	24
RC20GF221J	81349	D-11	29
RC20GF222J	81349	D-5	4
RC20GF222J	81349	D-11	8
RC20GF223J	81349	D-9	63
RC20GF271J	81349	D-8	2
RC20GF271J	81349	D-11	20
RC20GF272J	81349	D-8	15
RC20GF273J	81349	D-3	11
RC20GF331J	81349	D-8	13
RC20GF392J	81349	D-3	5
RC20GF392J	81349	D-4	24
RC20GF393J	81349	D-5	6
RC20GF470J	81349	D-3	9
RC20GF471J	81349	D-6	6
RC20GF471J	81349	D-8	6
RC20GF472J	81349	D-4	11
RC20GF472J	81349	D-5	13
RC20GF472J	81349	D-11	28
RC20GF511J	81349	D-3	10
RC20GF512J	81349	D-4	20
RC20GF560J	81349	D-4	21
RC20GF562J	81349	D-3	12
RC20GF562J	81349	D-1	15
RC20GF562J	81349	D-1	23
RC20GF681J	81349	D-4	16
RC20GF682J	81349	D-8	12
RC20GF682J	81349	D-11	15
RC20GF820J	81349	D-11	18
RC20GF821J	81349	D-4	10
RC20GF822J	81349	D-8	14
RC20GF912J	81349	D-6	10
RC32GF101J	81349	D-6	9
RG58CU	81349	D-17	3
RG58CU	81349	D-23	1
RN7C9881D	81349	D-6	8
RV4NAYSD502A	81349	D-2	83
RV5LAYSB102B	81349	D-2	59
SCB34065	80063	D-23	3
SCB34065	80063	D-24	2
SCB7674	80063	D-24	4
SE35	61957	D-16	9
SMA346013	80063	D-2	80
SMA346014	80063	D-2	20
SMB165914	80063	D-22	1
SMB283925	80063	D-17	4
SMB283983	80063	D-17	2
SMB345802	80063	D-2	55
SMB345803	80063	D-2	47
SMB345804	80063	D-4	3
SMB345808	80063	D-10	9
SMB345809	80063	D-14	4
SMB345810	80063	D-14	2
SMB345813	80063	D-10	3
SMB345814	80063	D-10	27
SMB345815	80063	D-10	30
SMB345816	80063	D-10	26
SMB345817	80063	D-10	13
SMB345818	80063	D-10	12
SMB345819	80063	D-10	14
SMB345822	80063	D-13	5
SMB345829	80063	D-12	10
SMB345836	80063	D-10	23
SMB345837	80063	D-10	6
SMB345842	80063	D-9	68
SMB345843	80063	D-9	76
SMB345644	80063	D-9	74
SMB345846	80063	D-9	71
SMB345847	80063	D-9	72
SMB345848	80063	D-9	84
SMB345849	80063	D-9	85
SMB345850	80063	D-9	83
SMB345852	80063	D-9	31
SMB345853	80063	D-9	51
SMB345854	80063	D-9	39
SMB345855-1	80063	D-9	52
SMB345855-2	80063	D-9	60
SMB345856	80063	D-9	57
SMB345857	80063	D-9	34
SMB345860	80063	D-9	23
SMB345867	80063	D-9	22
SMB345862	80063	D-9	24
SMB345863	80063	D-9	9
SMB345864	80063	D-9	8
SMB345865	80063	D-9	13
SMB345866	80063	D-9	46
SMB345861	80063	D-9	45
SMB345878	80063	D-2	104
SMB345879	80063	D-2	102
SMB345870	80063	D-9	5
SMB345872	80063	D-9	41
SMB345873	80063	D-9	43
SMB345877	80063	D-9	53
SMB345818	80063	D-9	75
SMB345819	80063	D-9	21
SMB345880	80063	D-9	12
SMB345881	80063	D-9	82
SMB345882	80063	D-2	125
SMB345883	80063	D-2	118
SMB345884	80063	D-16	7
SMB345885	80063	D-16	6
SMB345886	80063	D-21	1
SMB345890	80063	D-4	27
SMB345891	80063	D-2	37
SMB345894	80063	D-2	56
SMB345905	80063	D-2	12
SMB345906	80063	D-2	23
SMB345910	80063	D-2	88
SMB345911	80063	D-15	1
SMB345912	80063	D-2	68
SMB345913	80063	D-15	5
SMB345915	80063	D-2	122
SMB345918	80063	D-2	108
SMB345919	80063	D-2	22
SMB345921	80063	D-2	30
SMB345923	80063	D-2	109
SMB345925	80063	D-2	123
SMB345927	80063	D-2	85
SMB345928	80063	D-2	28
SMB345930	80063	D-2	87
SMB345931	80063	D-2	17

PART NUMBER	FSCM	FIG. NO.	ITEM NO.
SMB345932	80063	D-2	65
SMB345933	80063	D-5	8
SMB345938	80063	D-2	33
SMB345951	80063	D-16	4
SMB345953	80063	D-16	5
SMB345954	80063	D-16	14
SMB345960	80063	D-19	3
SMB345968	80063	D-1	17
SMB345970	80063	D-5	19
SMB345974	80063	D-20	1
SMB345975	80063	D-20	3
SMB345977	80063	D-9	26
SMB345978	80063	D-10	8
SMB345983	80063	D-9	78
SMB345987	80063	D-8	7
SMB345996	80063	D-2	43
SMB345998	80063	D-2	98
SMB345599	80063	D-2	92
SMB346001	80063	D-2	100
SMB346004	80063	D-2	107
SMB346007	80063	D-5	17
SMB346009	80063	D-2	121
SMB346010	80063	D-2	27
SMB346015	80063	D-2	90
SMB346017	80063	D-2	73
SMB346018	80063	D-2	72
SMB346019	80063	D-2	75
SMB346020	80063	D-9	2
SMB346021	80063	D-2	74
SMB346022	80063	D-2	71
SMB346031	80063	D-12	11
SMB346032	80063	D-12	12
SMB346036	80063	D-13	2
SMB346038	80063	D-2	58
SMB346039	80063	D-2	57
SMB346086	80063	D-2	76
SMB346043	80063	D-9	62
SMB346044	80063	D-9	47
SMB346047	80063	D-15	4
SMB346048	80063	D-2	89
SMB346050	80063	D-12	1
SMB346051	80063	D-19	4
SMB346098	80063	D-2	41
SMB346053	80063	D-9	11
SMB346055	80063	D-14	3
SMB346056	80063	D-10	7
SMB346060	80063	D-9	6
SMB346066	80063	D-11	22
SMB346067	80063	D-2	106
SMB346068	80063	D-2	105
SMB346070	80063	D-5	7
SMB346071	80063	D-2	32
SMB346073	80063	D-10	28
SMB346074	80063	D-9	59
SMB346080	80063	D-9	40
SMB346089	80063	D-9	61
SMB346090	80063	D-18	2
SMB352019	80063	D-2	103
SMB352030	80063	D-9	69
SMB546107	80063	D-2	13
SMC146485-2	80063	D-22	4
SMC283978	80063	D-17	5
SMC345823	80063	D-12	8
SMC345840-1	80063	D-9	80
SMC345840-2	80063	D-9	29
SMC345841	80063	D-9	67
SMC345871	80063	D-9	1
SMC345876	80063	D-9	58
SMC345914	80063	D-2	3
SMC345924	80063	D-2	113
SMC345926	80063	D-2	86
SMC345952	80063	D-16	3
SMC345972	80063	D-1	12
SMC345989	80063	D-10	1
SMC345990	80063	D-2	44
SMC346003	80063	D-2	91
SMC346005	80063	D-1	18
SMC346011	80063	D-4	26
SMC346012	80063	D-2	35
SMC346024	80063	D-16	2
SMC346029	80063	D-16	1
SMC346033	80063	D-9	42
SMC346034	80063	D-9	28
SMC346035	80063	D-9	79
SMC346040	80063	D-9	15
SMC346042	80063	D-9	65
SMC346045	80063	D-2	79
SMC346046	80063	D-2	64
SMC346049	80063	D-11	19
SMC346054	80063	D-11	4
SMC346058	80063	D-10	15
SMC346061	80063	D-2	112
SMC346062	80063	D-2	114
SMC346064	80063	D-11	1
SMC346075	80063	D-9	66
SMC346096	80063	D-1	8
SMC346104	80063	D-2	4
SMC346105-1	80063	D-21	9
SMC352027	80063	D-2	26
SMC352036	80063	D-2	81
SMC352038	80063	D-7	1
SMC352040	80063	D-2	51
SMD345807	80063	D-10	16
SMD345851	80063	D-9	38
SMD3445901	80063	D-15	6
SMD345922	80063	D-2	93
SMD345966	80063	D-1	13
SMD346028	80063	D-16	10
SMD346030	80063	D-2	1
SMD346059	80063	D-2	111
SMD346065	80063	D-2	9
SMD346069	80063	D-10	17
SMD346076	80063	D-19	1
SMD346077	80063	D-2	70
SMD346077-3	80063	D-10	4
SMD346066	80063	D-2	36
SMD346086-5	80063	D-9	25
SMD346088	80063	D-20	2
SMD346091	80063	D-18	1
SMD346092	80063	D-1	2
SMD346093	80063	D-2	96
SMD346097	80063	D-1	11
SMD346096	80063	D-7	2
SMD346106	80063	D-2	45
SMD352031	80063	D-4	1
SMD352032	80063	D-2	60
SMD352033	80063	D-5	1
SMD352034	80063	D-2	11
SMD352035	80063	D-3	1
SMD352037	80063	D-8	1
SMD352039	80063	D-6	1
TS0205001	81349	D-4	2
TYPE2CRES062DLAX3-8LG	73957	D-9	16
TYPE4CRES062DLAX3-8LG	73957	D-9	20
UG-898/U	80058	D-17	1
UG-890/U	80058	D-17	1
UP131M	80058	D-22	5
VC11G	73899	D-7	6
XA510	76665	D-2	120
WA510	76665	D-19	5
1-16X5-8MEDDUTY	00287	D-14	1
1-4-28NF2	99813	D-2	117
1N538	81349	D-6	4
1N734A	81349	D-6	7
1N752A	81349	D-6	5
1N82A6	81349	D-5	2
1N914	81349	D-5	20
1070	70485	D-11	7
1214-05	78189	D-2	124
14800	08145	D-11	14
1481A	08145	D-11	10
17624-4	11711	D-5	21
17624-8	11711	D-5	3
17624-8	11711	D-11	17
2N2553	81349	D-6	2

PART NUMBER	FSCM	FIG. NO.	ITEM NO.	PART NUMBER	FSCM	FIG. NO.	ITEM NO.
2N3282	81349	D-11	16	3650-1	71279	D-12	7
2N501A	81349	D-4	12				
2N501A	81349	D-8	16	4040-4	72968	D-11	11
2N502A	81349	D-5	5	41C172	93561	D-4	25
2N526	81349	D-3	7	5C02347D8500B3	93561	D-8	3
2N526	81349	D-4	31	5HKS20	93561	D-5	22
20C20	93561	D-5	18	5133-12SM1	79136	D-2	8
20C202	93561	D-4	9	5133-18M1	79136	D-9	56
20C202	93561	D-8	10	5133-25M1	79136	D-10	5
2045-1	71279	D-2	61	5133-31C	79136	D-9	14
2104-04-00	76665	D-2	115	5133-31C	79136	D-10	29
2104-06-00	76665	D-2	50	5133-37SM1	79136	D-9	50
2901	70485	D-2	10	79-012-062-0312	79963	D-9	55
3488INDHCRESMS	97852	D-13	3	9-4	79963	D-9	55
3-8-32NEF21-2	99813	D-23	42	914-2	86579	D-19	2
32561	00779	D-21	4				

LATEST NATIONAL STOCK NUMBER ASSIGNMENTS

Stock Number	Figure No.	Item No.	Stock Number	Figure No.	Item No.
5305-00-054-6657	D-2	63	5961-00-519-6977	D-6	4
			5910-00-583-0283	D-2	46
5940-00-156-7344	D-2	50	5910-00-583-0283	D-11	26
5905-00-171-2004	D-9	63	5310-00-595-6772	D-16	13
5330-00-171-9984	D-19	2	5910-00-713-2025	D-7	6
5935-00-577-2281	D-17	1	5910-00-717-0169	D-4	32
5910-00-189-4248	D-3	6			
5910-00-189-4248	D-5	12	5935-00-843-7362	D-22	5
5905-00-190-8880	D-4	15	5961-00-892-0727	D-8	8
5905-00-195-6791	D-4	16	5961-00-912-4907	D-5	2
5940-00-258-1813	D-11	11	5365-00-954-5166	D-9	14
5905-00-279-3513	D-5	24	5365-00-954-5166	D-10	29
5905-00-279-3513	D-11	29	5910-00-957-9272	D-4	9
5910-00-435-6776	D-5	22	5910-00-957-9272	D-8	10
5961-00-469-9931	D-6	5			

LATEST PART NUMBER ASSIGNMENTS

PART NUMBER	FSCM	FIG. NO.	ITEM NO.	PART NUMBER	FSCM	FIG. NO.	ITEM NO.
CM15F101G03	81349	D-4	32	M39003-01-2977	81349	D-5	12
MS51957-33	96906	D-2	63	JAN2N700A	81349	D-8	8
M39003-01-2977	81349	D-3	6				

ADDITIONAL LATEST NATIONAL STOCK NUMBER ASSIGNMENTS

Stock Number	Figure No.	Item No.	Stock Number	Figure No.	Item No.
5940-00-050-2308	D-11	27	5355-00-952-3898	D-9	34
5305-00-054-6652	D-11	2	5305-00-975-2069	D-9	70
5305-00-054-6670	D-9	33	5910-00-984-7787	D-11	13
5305-00-054-6670	D-2	14			
5305-00-054-6673	D-2	66			
5905-00-111-4742	D-4	18			
3310-00-516-5330	D-10	8			
6145-00-542-6092	D-17	3			
6145-00-542-6092	D-23	1			
6240-00-577-8456	D-9	64			
6145-00-583-3142	D-24	1			
5310-00-655-9677	D-15	3			
5961-00-682-2587	D-8	9			
5365-00-715-1152	D-9	73			
5305-00-724-5834	D-10	10			
5910-00-733-5689	D-8	3			
5910-00-917-5362	D-2	38			
5935-00-930-7461	D-1	7			
5310-00-934-9748	D-2	31			
5310-00-934-9748	D-4	30			
5310-00-934-9748	D-7	5			
5310-00-934-9748	D-9	36			
5310-00-934-9748	D-11	9			
5310-00-934-9759	D-12	9			
5310-00-934-9761	D-2	25			
5310-00-934-9761	D-9	18			
5310-00-934-9762	D-2	6			

ADDITIONAL LATEST PART NUMBER ASSIGNMENTS

PART NUMBER	FSCM	FIG. NO.	ITEM NO.
CE44C222E	81349	D-2	38
CM15FD121GP3	81349	D-	13
COS2-22	81349	D-24	1
JAN1N662	81349	D-8	9
MS535431-3	96906	D-11	27
MS35649-244	96906	D-2	31
MS35649-244	96906	D-4	30
MS35649-244	96906	D-7	5
MS35649-244	96906	D-9	36
MS35649-244	96906	D-1l	9
MS35649-264	96906	D-2	25
MS35649-264	96906	D-9	18
MS35649-284	96906	D-12	9
MS35649-286	96906	D-2	6
ME2E	08804	D-9	64
RCR20G391JS	81349	D-4	18
UG641AU	80058	D-1	7
5100-37MF	79136	D-9	73

NOTE: SEE PAGE D-71 FOR ADDITIONAL LATEST NATIONAL STOCK NUMBER AND PART NUMBER ASSIGNMENTS.

ADDITIONAL LATEST NATIONAL STOCK NUMBER ASSIGNMENTS

STOCK NUMBER	FIG. NO.	ITEM NO.
5935-00-259-7410	D-21	2
5910-00-681-3001	D-2	5
5910-00-681-3001	D-5	25
6250-00-698-3132	D-2	53
5935-00-843-7362	D-21	5

ADDITIONAL LATEST PART NUMBER ASSIGNMENTS

PART NUMBER	FSCM	FIG. NO.	ITEM NO.
MS24663	96906	D-21	5
MS3108B10SL3S	96906	D-21	2
SMC747144-5	80063	D-2	5
SMC747144-5	80063	D-5	25
18-74	95263	D2	53

INDEX

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USAERDAA (1)
USAERDAW (1)
MAAG (1)
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5-25
5-26
5-52
5-145
5-146
5-155
5-156
6-100
6-200
6-201
6-300
6-302
6-401
6-615
6-616
7
7-15
7-16
7-35
7-36
7-100
8-137
11-16
11-35
11-36
11-38
11-39
11-85
11-86
11-87
11-97
11-98
11-116
11-117
11-215
11-216
11-302
11-500 (AA-AC)
17
17-51
17-52
17-100
29-1
29-15
29-16
29-17
29-21
29-25
29-26
29-27
29-35
29-36
29-37
29-51
29-55
29-56
29-65
29-75
29-76
29-79
29-105
29-109
29-134
29-136
32-52
32-56
32-67
32-78
37
37-100
44-8
55-27
57
57-100

NG: State AG (3)
USAR: None
For explanation of abbreviations used, see AR310-50

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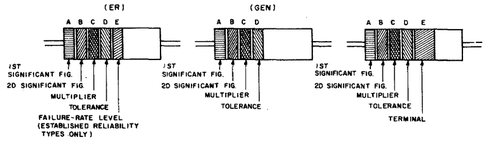


COLOR CODE MARKING FOR COMPOSITION TYPE RESISTORS.

COLOR-CODE MARKING FOR FILM-TYPE RESISTORS.

TABLE I
COLOR CODE FOR COMPOSITION TYPE AND FILM TYPE RESISTORS.

BAND A		BAND B		BAND C		BAND D		BAND E		
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)	COLOR	FAILURE RATE LEVEL	TERM.
BLACK	0	[illegible]	0	[illegible]	1			BROWN	M=1.0	
BROWN	1	BROWN	1	[illegible]	10			RED	P=0.1	
RED	2	RED	2	[illegible]	100			ORANGE	R=0.01	
ORANGE	3	ORANGE	3	[illegible]	1,000			YELLOW	S=0.001	
YELLOW	4	YELLOW	4	[illegible]	10,000	SILVER	±10 (COMP. TYPE ONLY)	WHITE		SOLDERABLE
GREEN	5	GREEN	5	GREEN	100,000	GOLD	±5			
BLUE	6	BLUE	6	BLUE	1,000,000	RED	±2 (NOT APPLICABLE TO ESTABLISHED RELIABILITY)			
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7							
GRAY	8	GRAY	8	SILVER	0.01					
WHITE	9	WHITE	9	GOLD	0.1					

BAND A — THE FIRST SIGNIFICANT FIGURE OF THE RESISTANCE VALUE (BANDS A THRU D SHALL BE OF EQUAL WIDTH.)

BAND B — THE SECOND SIGNIFICANT FIGURE OF THE RESISTANCE VALUE.

BAND C — THE MULTIPLIER (THE MULTIPLIER IS THE FACTOR BY WHICH THE TWO SIGNIFICANT FIGURES ARE MULTIPLIED TO YIELD THE NOMINAL RESISTANCE VALUE.)

BAND D — THE RESISTANCE TOLERANCE.

BAND E — WHEN USED ON COMPOSITION RESISTORS, BAND E INDICATES ESTABLISHED RELIABILITY FAILURE — RATE LEVEL (PERCENT FAILURE PER 1,000 HOURS). ON FILM RESISTORS, THIS BAND SHALL BE APPROXIMATELY 1-1/2 TIMES THE WIDTH OF OTHER BANDS, AND INDICATES TYPE OF TERMINAL.

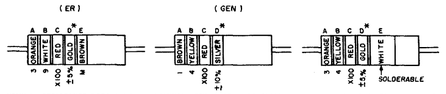
RESISTANCES IDENTIFIED BY NUMBERS AND LETTERS (THESE ARE NOT COLOR CODED.)

SOME RESISTORS ARE IDENTIFIED BY THREE OR FOUR DIGIT ALPHA NUMERIC DESIGNATORS. THE LETTER R IS USED IN PLACE OF A DECIMAL POINT WHEN FRACTIONAL VALUES OF AN OHM ARE EXPRESSED. FOR EXAMPLE:

2R7 = 2.7 OHMS 10R0 = 10.0 OHMS

FOR WIRE-WOUND-TYPE RESISTORS COLOR CODING IS NOT USED, IDENTIFICATION MARKING IS SPECIFIED IN EACH OF THE APPLICABLE SPECIFICATIONS.

EXAMPLES OF COLOR CODING



NOMINAL RESISTANCE 3,900 OHMS
RESISTANCE TOLERANCE ±5%
FAILURE RATE LEVEL M

NOMINAL RESISTANCE 1,400 OHMS
RESISTANCE TOLERANCE ±10%

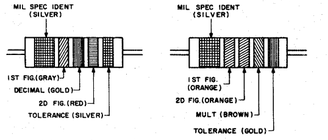
NOMINAL RESISTANCE 3,400 OHMS
RESISTANCE TOLERANCE ±5%
TERMINAL SOLDERABLE

COMPOSITION-TYPE RESISTORS

FILM-TYPE RESISTORS

* IF BAND D IS OMITTED, THE RESISTOR TOLERANCE IS ±20% AND THE RESISTOR IS NOT MIL-STD.

A. COLOR CODE MARKING FOR MILITARY STANDARD RESISTORS.



(A) 8.2UH ± 10% (B) 330UH ± 5%

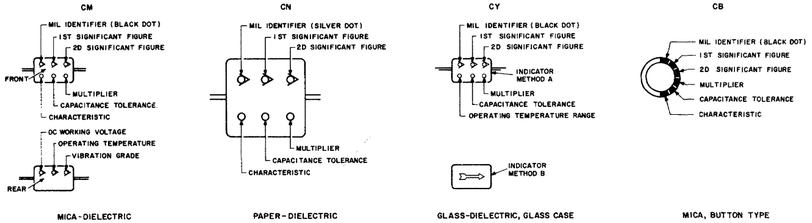
COLOR CODING FOR TUBULAR ENCAPSULATED R.F. CHOKES. AT A, AN EXAMPLE OF OF THE CODING FOR AN 8.2UH CHOKE IS GIVEN. AT B, THE COLOR BANDS FOR A 330 UH INDUCTOR ARE ILLUSTRATED.

TABLE 2
COLOR CODING FOR TUBULAR ENCAPSULATED R.F. CHOKES.

COLOR	SIGNIFICANT FIGURE	MULTIPLIER	INDUCTANCE TOLERANCE (PERCENT)
BLACK	0	1	
BROWN	1	10	1
RED	2	100	2
ORANGE	3	1,000	3
YELLOW	4		
GREEN	5		
BLUE	6		
VIOLET	7		
GRAY	8		
WHITE	9		
NONE			20
SILVER			10
GOLD	DECIMAL POINT		5

MULTIPLIER IS THE FACTOR BY WHICH THE TWO COLOR FIGURES ARE MULTIPLIED TO OBTAIN THE INDUCTANCE VALUE OF THE CHOKE COIL.

CAPACITORS, FIXED, VARIOUS-DIELECTRICS, STYLES CM, CN, CY, AND CB.



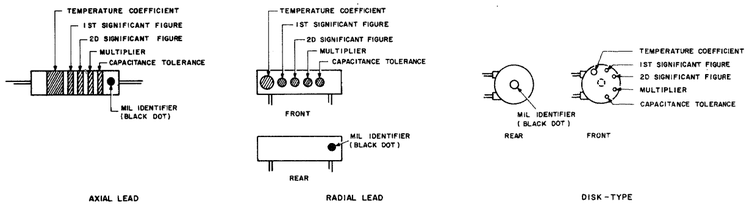


TABLE 3 — FOR USE WITH STYLES CM, CN, CY AND CB.

COLOR	MIL ID	1ST SIG FIG.	2D SIG FIG.	MULTIPLIER	CAPACITANCE TOLERANCE			CHARACTERISTIC			DC WORKING VOLTAGE	OPERATING TEMP. RANGE	VIBRATION GRADE
					CM	CN	CY	CB	CM	CN	CB	CM	CY, CM	CM
BLACK	CM, CY, CB	0	0	1			±20%	±20%		A			-55°TO+70°C	10-55HZ
BROWN		1	1	10					B	E	B			
RED		2	2	100	±2%		±2%	±2%	C				-55°TO+80°C	
ORANGE		3	3	1,000		±30%			D		D	300		
YELLOW		4	4	10,000					E				-55°TO+125°C	10-2,000HZ
GREEN		5	5		±5%				F			500		
BLUE		6	6										-55°TO+150°C	
PURPLE (VIOLET)		7	7											
GRAY		8	8											
WHITE		9	9											
GOLD				0.1			±5%	±5%						
SILVER	CN			0.01	±10%	±10%	±10%	±10%						

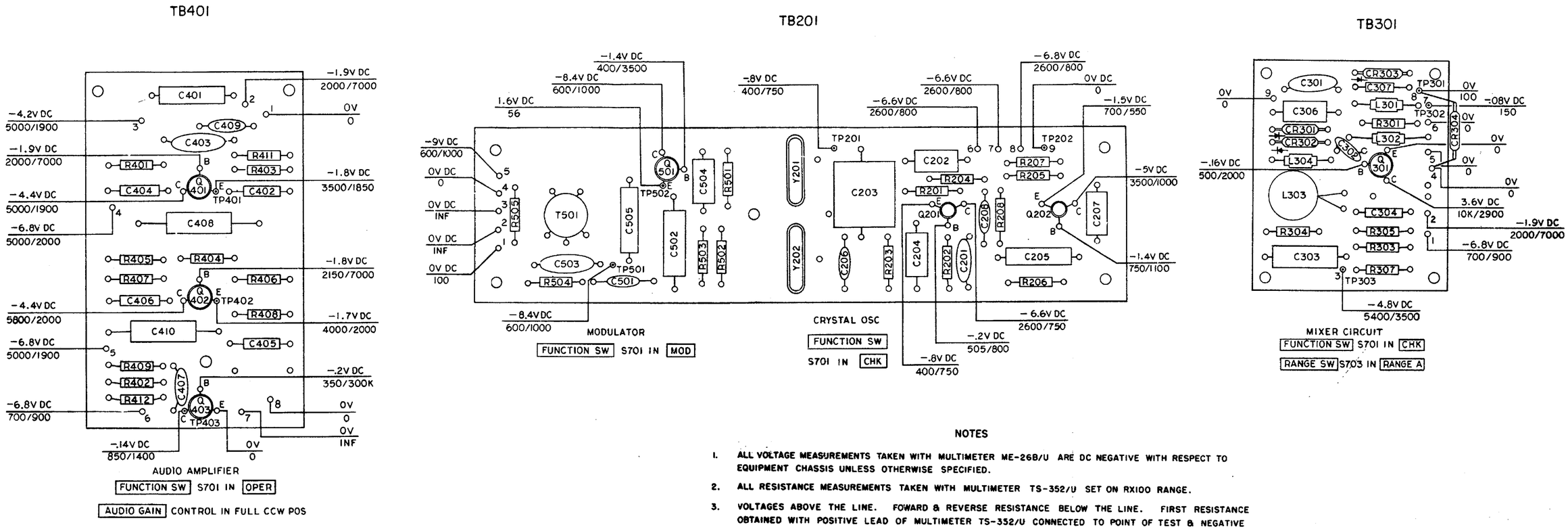
TABLE 4 — TEMPERATURE COMPENSATING, STYLE CC.

COLOR	TEMPERATURE COEFFICIENT[4]	1ST SIG FIG.	2D SIG FIG.	MULTIPLIER[1]	CAPACITANCE TOLERANCE		MIL ID
					CAPACITANCES OVER 10 UUF	CAPACITANCES 10 UUF OR LESS	
BLACK	0	0	0	1		±2.0 UUF	CC
BROWN	−30	1	1	10	±1%		
RED	−80	2	2	100	±2%	±0.25 UUF	
ORANGE	−150	3	3	1,000			
YELLOW	−220	4	4				
GREEN	−330	5	5		±5%	±0.5 UUF	
BLUE	−470	6	6				
PURPLE (VIOLET)	−750	7	7				
GRAY		8	8	0.01*			
WHITE		9	9	0.1*	±10%		
GOLD	+100			0.1		±1.0 UUF	
SILVER				0.01			

1. THE MULTIPLIER IS THE NUMBER BY WHICH THE TWO SIGNIFICANT (SIG) FIGURES ARE MULTIPLIED TO OBTAIN THE CAPACITANCE IN UUF.
2. LETTERS INDICATE THE CHARACTERISTICS DESIGNATED IN APPLICABLE SPECIFICATIONS: MIL-C-5, MIL-C-250, MIL-C-11272B, AND MIL-C-10950C RESPECTIVELY.
3. LETTERS INDICATE THE TEMPERATURE RANGE AND VOLTAGE-TEMPERATURE LIMITS DESIGNATED IN MIL-C-11015D.
4. TEMPERATURE COEFFICIENT IN PARTS PER MILLION PER DEGREE CENTIGRADE.

* OPTIONAL CODING WHERE METALLIC PIGMENTS ARE UNDESIRABLE.

Figure FO-1. Color code markings for MIL-STD resistors, inductors, and capacitors.



NOTES

1. ALL VOLTAGE MEASUREMENTS TAKEN WITH MULTIMETER ME-26B/U ARE DC NEGATIVE WITH RESPECT TO EQUIPMENT CHASSIS UNLESS OTHERWISE SPECIFIED.
2. ALL RESISTANCE MEASUREMENTS TAKEN WITH MULTIMETER TS-352/U SET ON RX100 RANGE.
3. VOLTAGES ABOVE THE LINE. FOWARD & REVERSE RESISTANCE BELOW THE LINE. FIRST RESISTANCE OBTAINED WITH POSITIVE LEAD OF MULTIMETER TS-352/U CONNECTED TO POINT OF TEST & NEGATIVE TEST LEAD TO CHASSIS. SECOND RESISTANCE OBTAINED WITH MULTIMETER NEGATIVE TEST LEAD CONNECTED TO POINT OF TEST & POSITIVE TEST LEAD TO CHASSIS.
4. VOLTAGE MEASUREMENTS TAKEN WITH EQUIPMENT OPERATING ON 115V AC 60 CPS POWER. RESISTANCE MEASUREMENTS TAKEN WITH AC POWER DISCONNECTED & FUNCTION SWITCH OFF.

Figure FO-2 (1). FR-149/USM-159, voltage and resistance diagram (sheet 1 of 2).

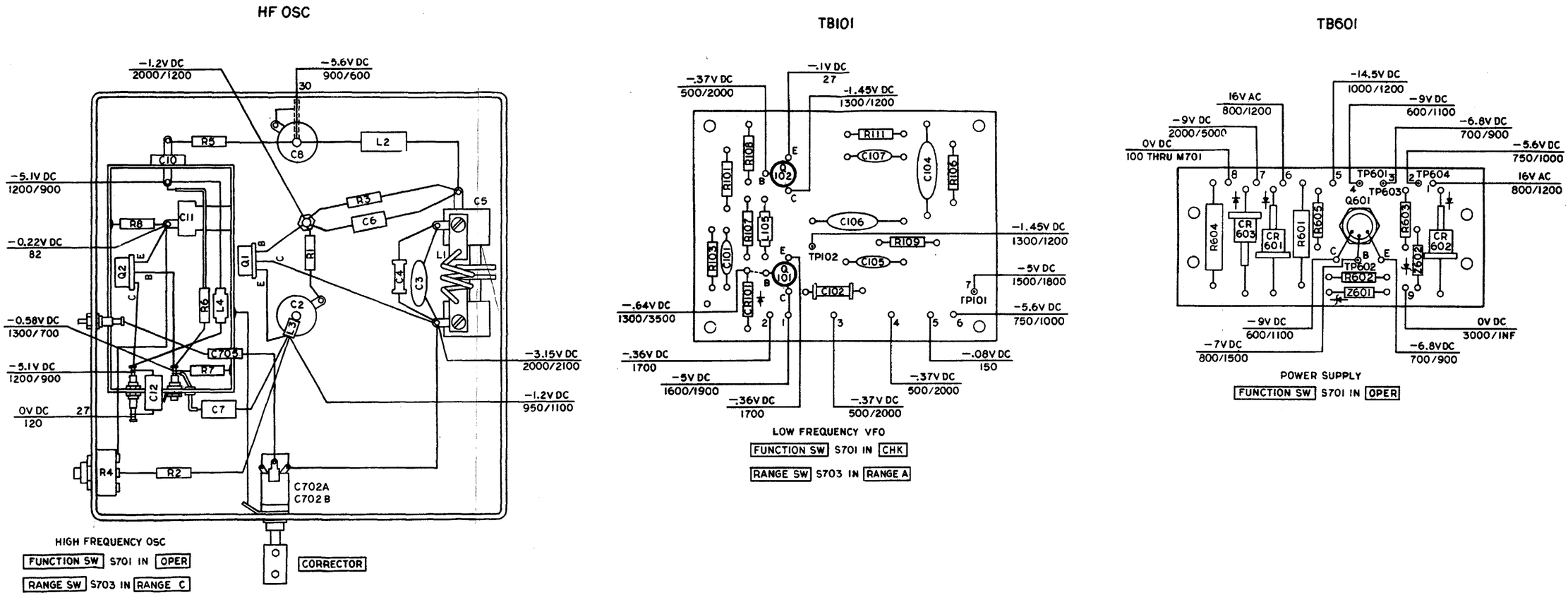
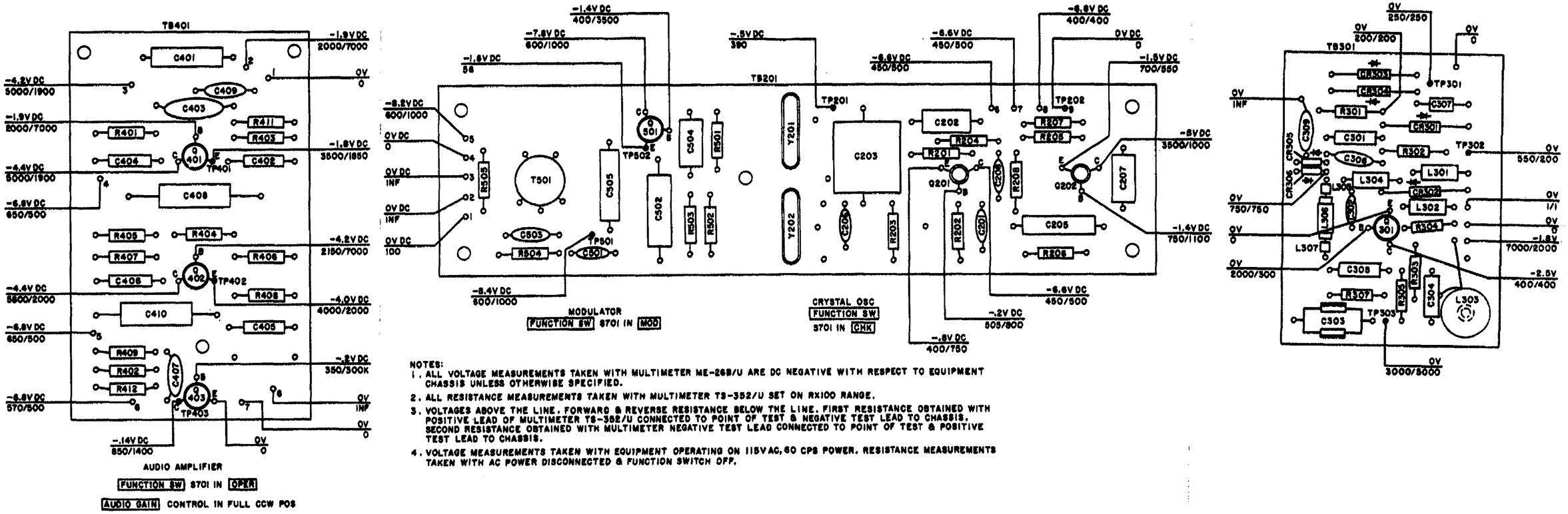


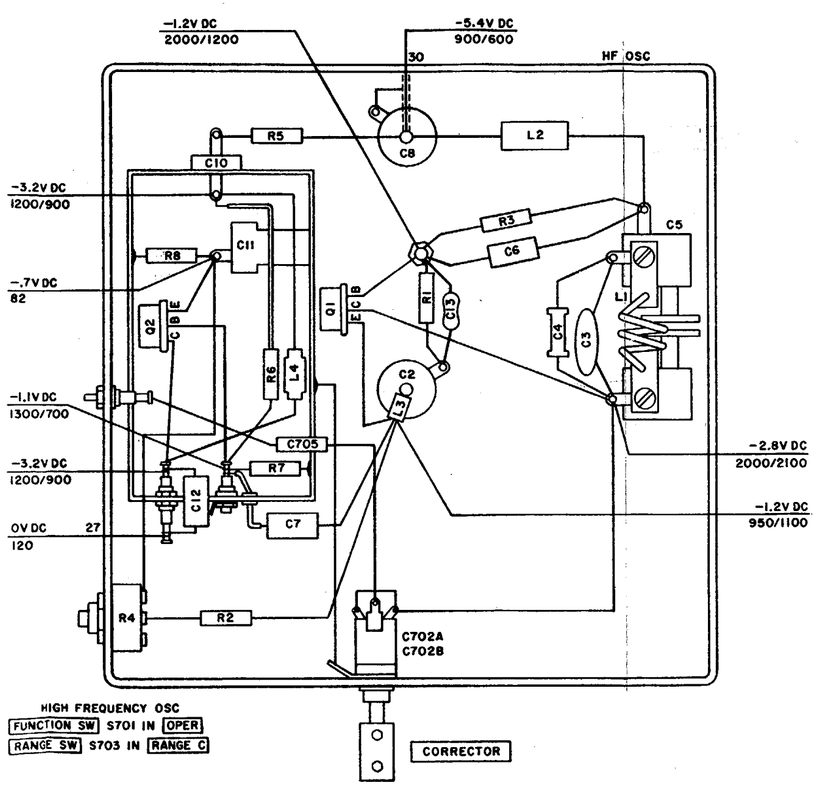
Figure FO-2 (2). FR-149/USM-159, voltage and resistance diagram (sheet 2 of 2).

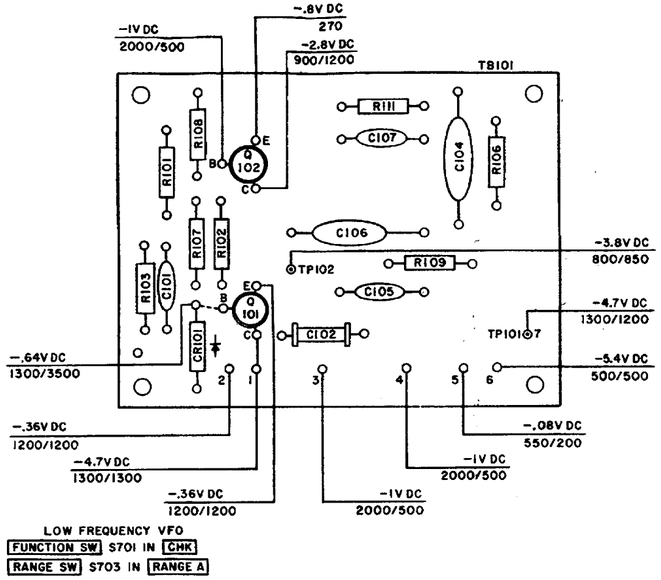


NOTES:

1. ALL VOLTAGE MEASUREMENTS TAKEN WITH MULTIMETER ME-26B/U ARE DC NEGATIVE WITH RESPECT TO EQUIPMENT CHASSIS UNLESS OTHERWISE SPECIFIED.
2. ALL RESISTANCE MEASUREMENTS TAKEN WITH MULTIMETER TS-352/U SET ON RX100 RANGE.
3. VOLTAGES ABOVE THE LINE, FORWARD & REVERSE RESISTANCE BELOW THE LINE. FIRST RESISTANCE OBTAINED WITH POSITIVE LEAD OF MULTIMETER TS-352/U CONNECTED TO POINT OF TEST & NEGATIVE TEST LEAD TO CHASSIS. SECOND RESISTANCE OBTAINED WITH MULTIMETER NEGATIVE TEST LEAD CONNECTED TO POINT OF TEST & POSITIVE TEST LEAD TO CHASSIS.
4. VOLTAGE MEASUREMENTS TAKEN WITH EQUIPMENT OPERATING ON 115VAC, 60 CPS POWER. RESISTANCE MEASUREMENTS TAKEN WITH AC POWER DISCONNECTED & FUNCTION SWITCH OFF.

Figure FO-3 (1). FR-149A/USM-159 and FR-149B/USM-159, voltage and resistance diagram (sheet 1 of 2).





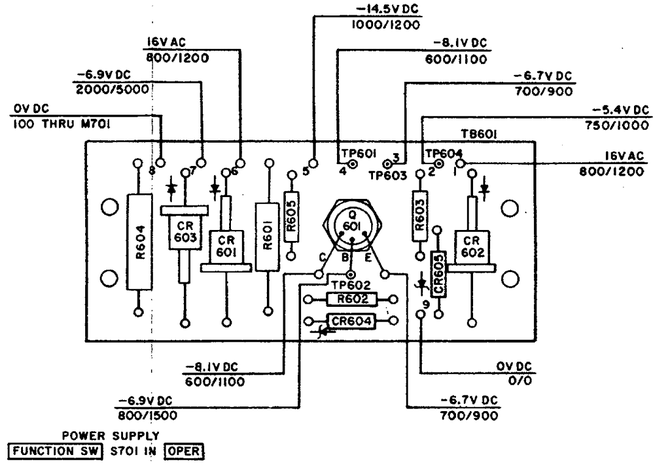
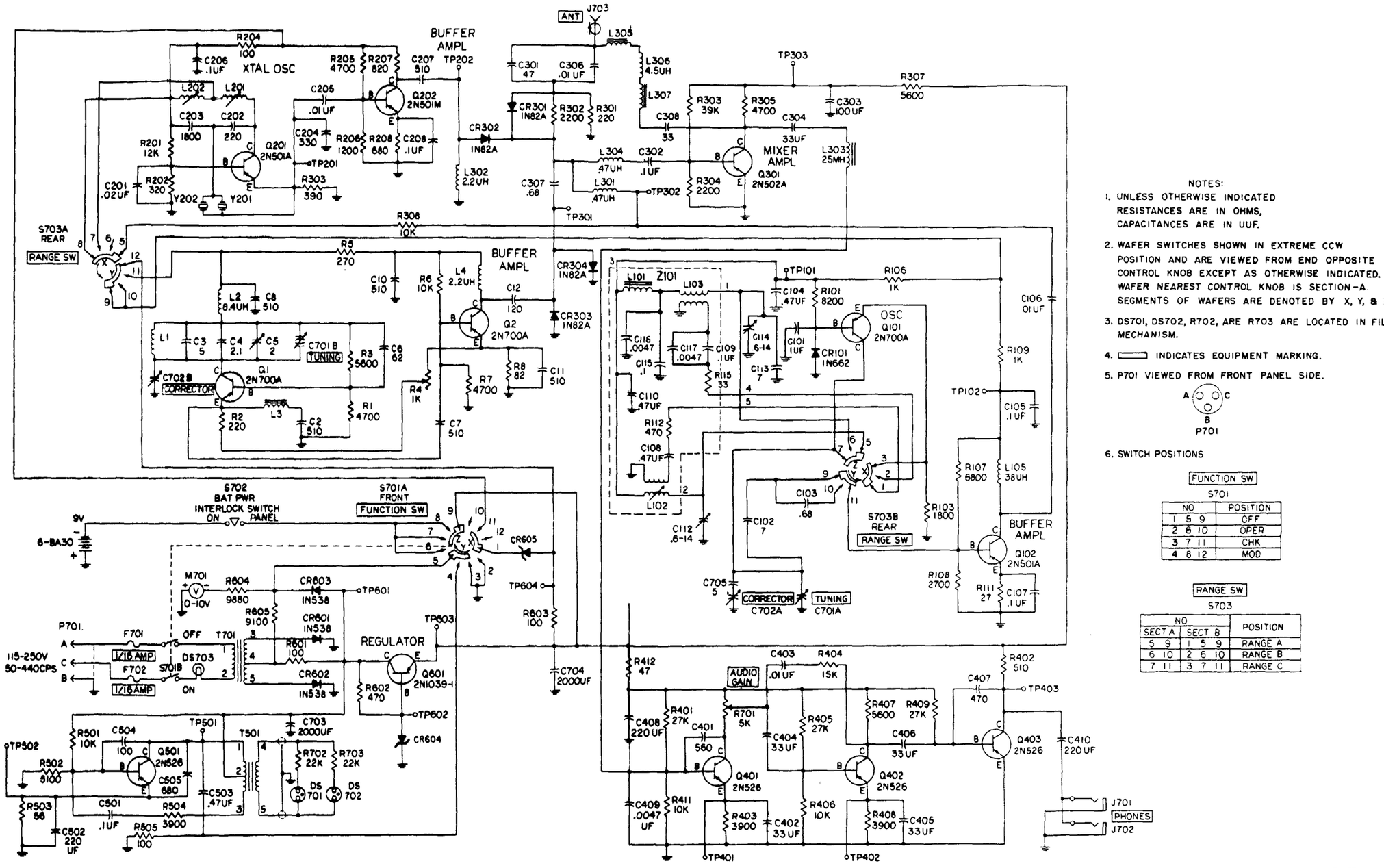


Figure FO-3 (2). FR-149A/USM-159 and FR-149B/USM-159, voltage and resistance diagram (sheet 2 of 2).



NOTES:

1. UNLESS OTHERWISE INDICATED RESISTANCES ARE IN OHMS, CAPACITANCES ARE IN UUF.
2. WAFER SWITCHES SHOWN IN EXTREME CCW POSITION AND ARE VIEWED FROM END OPPOSITE CONTROL KNOB EXCEPT AS OTHERWISE INDICATED. WAFER NEAREST CONTROL KNOB IS SECTION-A. SEGMENTS OF WAFERS ARE DENOTED BY X, Y, & Z.
3. DS701, DS702, R702, ARE R703 ARE LOCATED IN FILM MECHANISM.
4. ▭ INDICATES EQUIPMENT MARKING.
5. P701 VIEWED FROM FRONT PANEL SIDE.

6. SWITCH POSITIONS

FUNCTION SW
S701

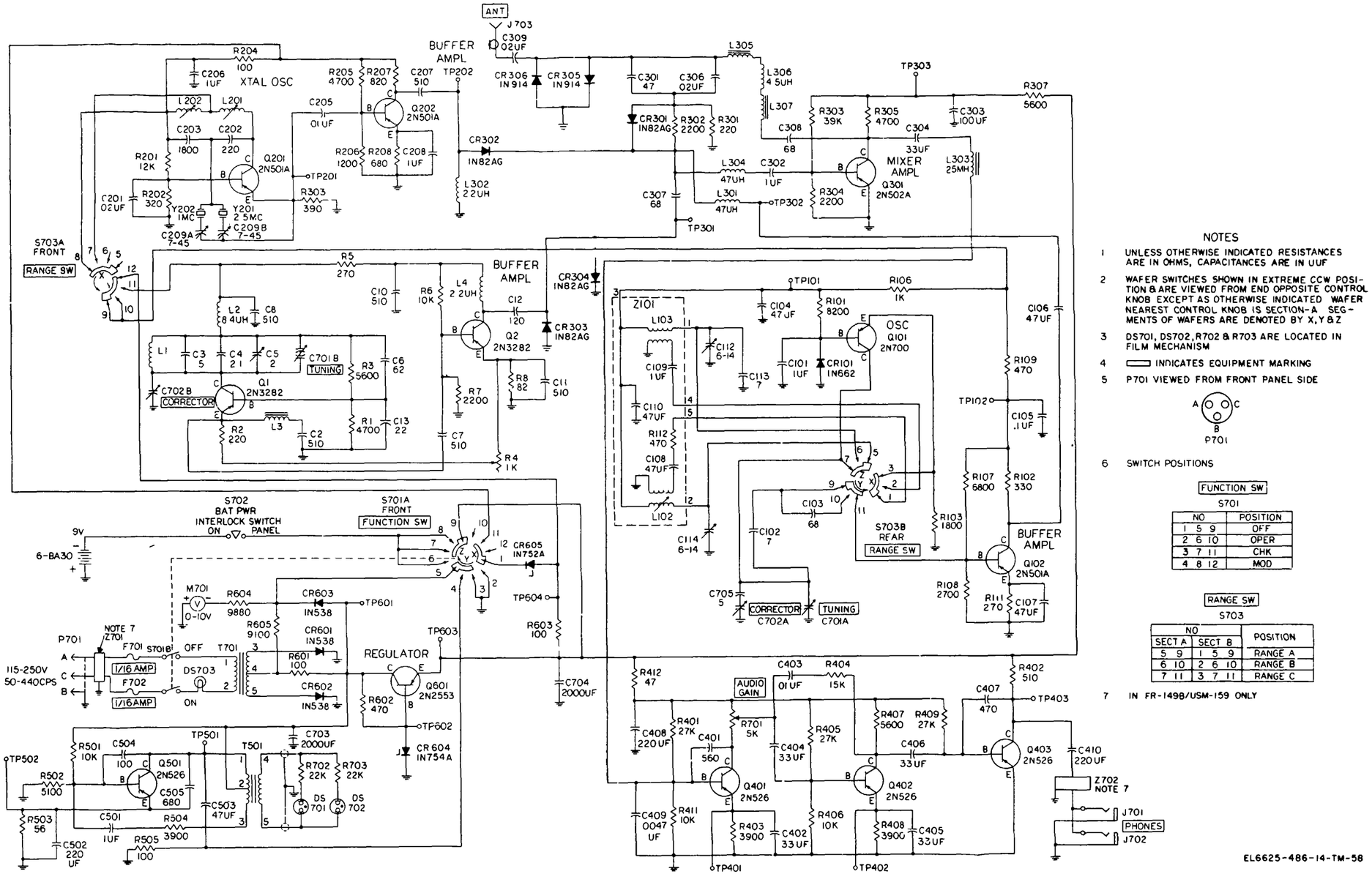
NO	POSITION
1 5 9	OFF
2 6 10	OPER
3 7 11	CHK
4 8 12	MOD

RANGE SW
S703

NO		POSITION
SECT A	SECT B	
5 9	1 5 9	RANGE A
6 10	2 6 10	RANGE B
7 11	3 7 11	RANGE C

EL6625-486-14-TM-57

Figure FO-4. Frequency Meter FR-149/USM-159, schematic diagram.



NOTES

1. UNLESS OTHERWISE INDICATED RESISTANCES ARE IN OHMS, CAPACITANCES ARE IN UUF
2. WAFER SWITCHES SHOWN IN EXTREME CCW POSITION & ARE VIEWED FROM END OPPOSITE CONTROL KNOB EXCEPT AS OTHERWISE INDICATED WAFER NEAREST CONTROL KNOB IS SECTION-A SEGMENTS OF WAFERS ARE DENOTED BY X, Y & Z
3. DS701, DS702, R702 & R703 ARE LOCATED IN FILM MECHANISM
4. ▭ INDICATES EQUIPMENT MARKING
5. P701 VIEWED FROM FRONT PANEL SIDE

6. SWITCH POSITIONS

FUNCTION SW
S701

NO	POSITION
1 5 9	OFF
2 6 10	OPER
3 7 11	CHK
4 8 12	MOD

RANGE SW
S703

NO		POSITION
SECT A	SECT B	
5 9	1 5 9	RANGE A
6 10	2 6 10	RANGE B
7 11	3 7 11	RANGE C

7. IN FR-149B/USM-159 ONLY

Figure FO-5. Frequency Meters FR-149A/USM-159 and FR-149B/USM-159, schematic diagram.

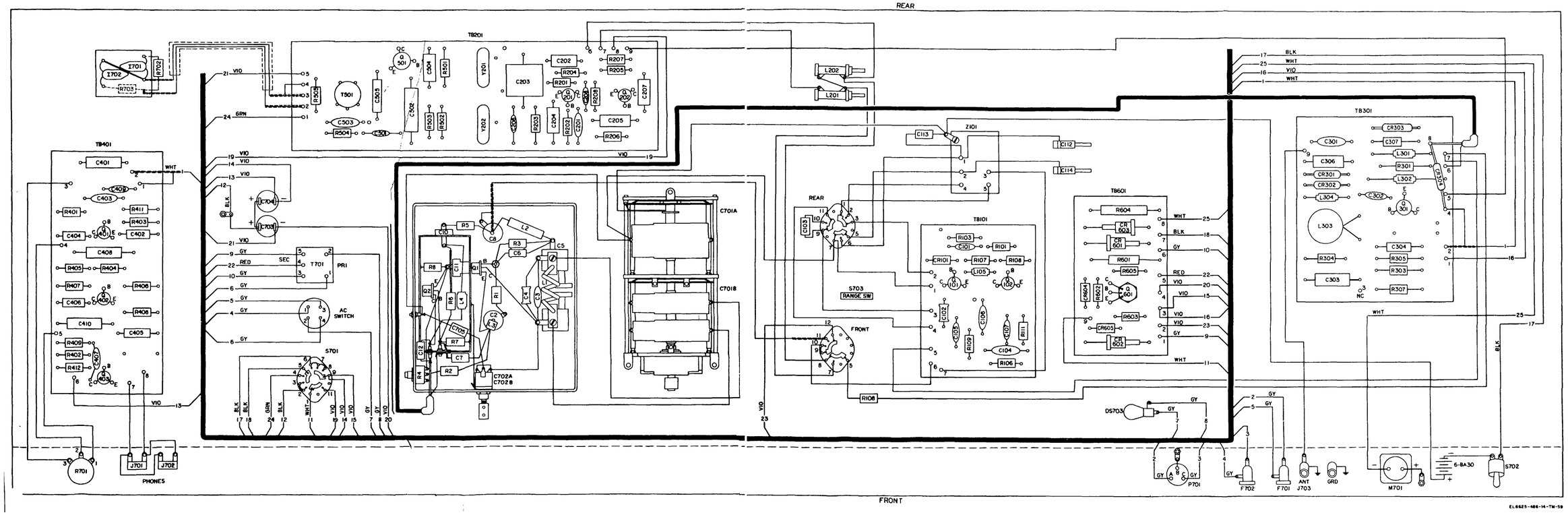


Figure FO-6. Frequency Meter FR-149/USM-159, wiring diagram.

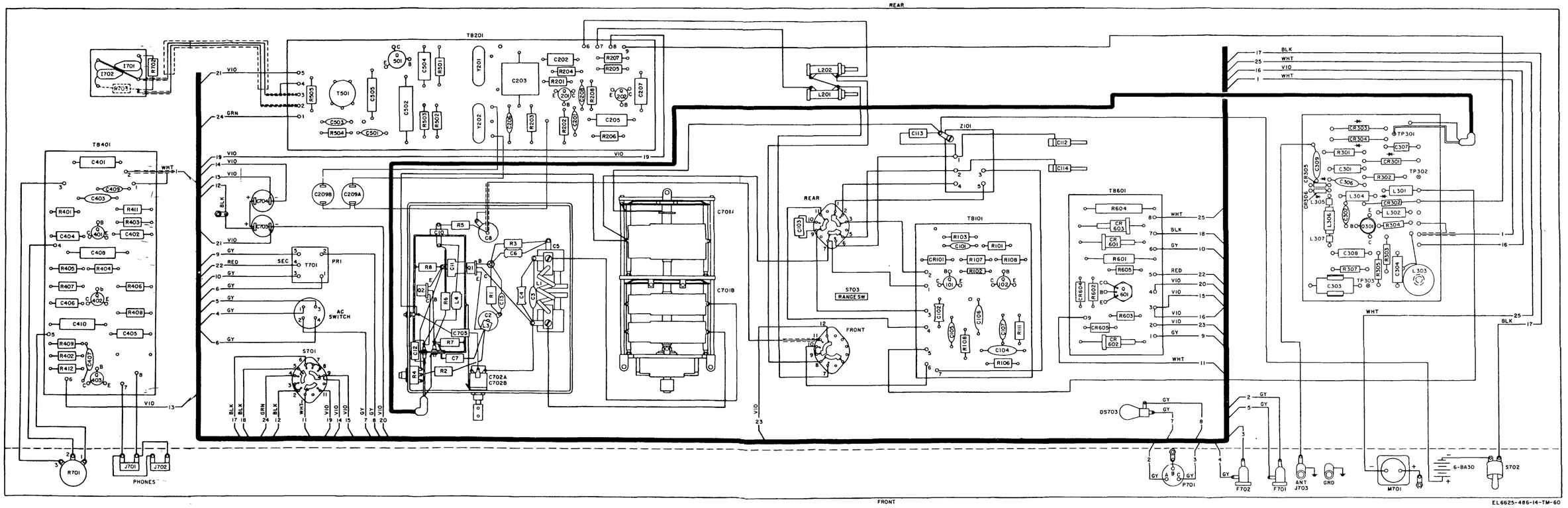


Figure FO-7. Frequency Meters FR-149A/USM-159 and FR-149B/USM-159, wiring diagram.

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The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
1 decimeter = 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 meters = 32.8 feet
1 hectometer = 10 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = .035 ounce
1 decagram = 10 grams = .35 ounce
1 hectogram = 10 decagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3.38 fl. ounces
1 liter = 10 deciliters = 33.81 fl. ounces
1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

To change	*To*	*Multiply by*	*To change*	*To*	*Multiply by*
inches	centimeters	2.540	ounce-inches	Newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29,573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	Newton-meters	1.356	metric tons	short tons	1.102
pound-inches	Newton-meters	.11296			

Temperature (Exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

PIN: 020784-000