MOBILE RADIO

DESCRIPTION AND MAINTENANCE

66—88 MHz, 25-WATT MASTR® II TRANSMITTER

TABLE OF CONTENTS

DESCRIPTION

MASTR® II transmitters are crystal controlled, phase modulated transmitters designed for one through eight frequency operation in the 66-88 MHz frequency band. This solid state, high reliability transmitter uses two integrated circuits, ICOMS and discrete components to provide 25 watts of transmitted RF power. The transmitter consists of:

- Exciter Board; with audio IC, divide by 2 IC, ICOMS, amplifier, and multiplier stages.
- Power Amplifier Assembly; with amplifier, PA final, power control and low pass filter assembly.

Figure 1 is a block diagram of the MASTR II transmitter showing the exciter and PA board.

The exciter uses six transistors and one integrated circuit to drive the PA assembly. The exciter can be equipped with up to eight Integrated Circuit Oscillator Modules (ICOMs). The ICOM crystal frequency ranges from approximately 11.0 to 14.7 megahertz, and the crystal frequency is multiplied 6 times.

The power amplifier assembly utilizes two transistor stages (amplifier and power amplifier) to provide rated output power, a low pass filter and a power control circuit to adjust the output power level for desired output from 8 to 25 watts.

MAINTENANCE

The PA operates from a floating DC source to permit operation in negative or positive ground vehicles.

NOTE

In positive ground vehicles, A- is hot with respect to vehicle ground. Shorting the printed wiring board ground patterns to the radio case may cause one of the line fuses to blow.

MOBILE DISASSEMBLY

- To service the transmitter from the top:
  1. Pull the locking handle down, then pry up the cover at the front notch and lift off the cover.
- To service the transmitter from the bottom:
  1. Pull the locking handle down and pull the radio out of the mounting frame.
  2. Remove the top cover, then loosen the two bottom cover retaining screws and remove the bottom cover (see Figure 2).
  3. To gain access to the bottom of the exciter board, remove the six screws (A) holding the exciter board

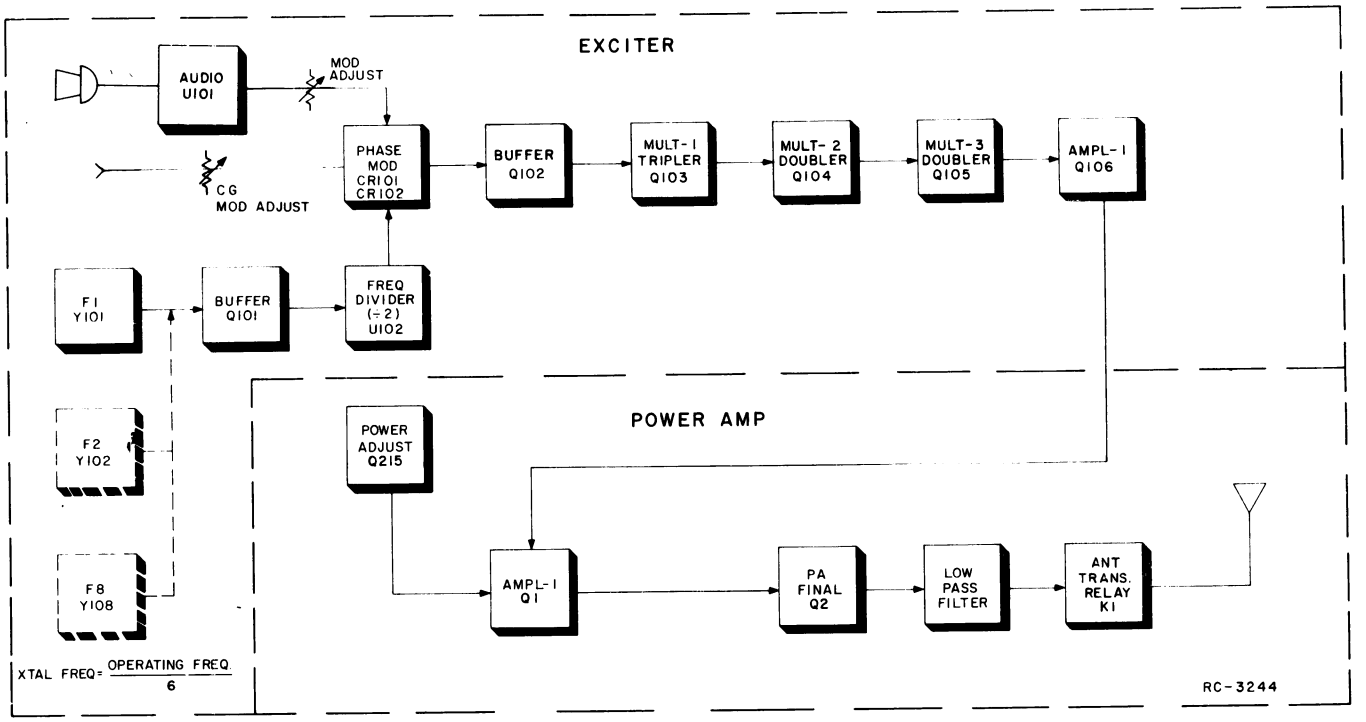


Figure 1 - Transmitter Block Diagram

and its bottom cover to the module mounting frame, and remove the bottom cover.

> **NOTE**
>
> Be careful not to bend the three pins on the exciter board bottom cover during removal or installation of the cover.

STATION DISASSEMBLY

For a more complete mechanical parts breakdown refer to the station manual. To service the transmitter exciter from the front:

1. Turn the two latching knobs (A) counterclockwise to unlatch the Radio Panel Front Door. Refer to Figure 3.
2. Swing the Radio Panel Front Door down as shown.
3. Remove covers.

To service the transmitter Power Amplifier from the rear:

1. Remove the top two screws (B) on the Intermittent or Continuous Duty Power Amplifier. Refer to Figure 4.
2. Swing the Power Amplifier down as shown. Remove the top cover of the Power Amplifier.

> **NOTE**
>
> If the heatsink blower option is present, this blower must be removed before the Power Amplifier can be lowered.

EXCITER DISASSEMBLY

- To remove the exciter board: (see Figure 2)
  1. Unplug the exciter/PA cable (B).
  2. Remove the six screws (A) holding the exciter board and its bottom cover to the module mounting frame.
  3. Press straight down on the plug-in exciter from the top to avoid bending the pins when unplugging the board from the system board jack.

PA DISASSEMBLY

- To remove the PA assembly: (see Figure 2)
  1. Remove the PA top cover and unplug the exciter/PA cable (B), the antenna, receiver and PTT cables (C).
  2. Remove the four side-rail screws (D), and unsolder the power cables from the bottom of the PA assembly if desired.

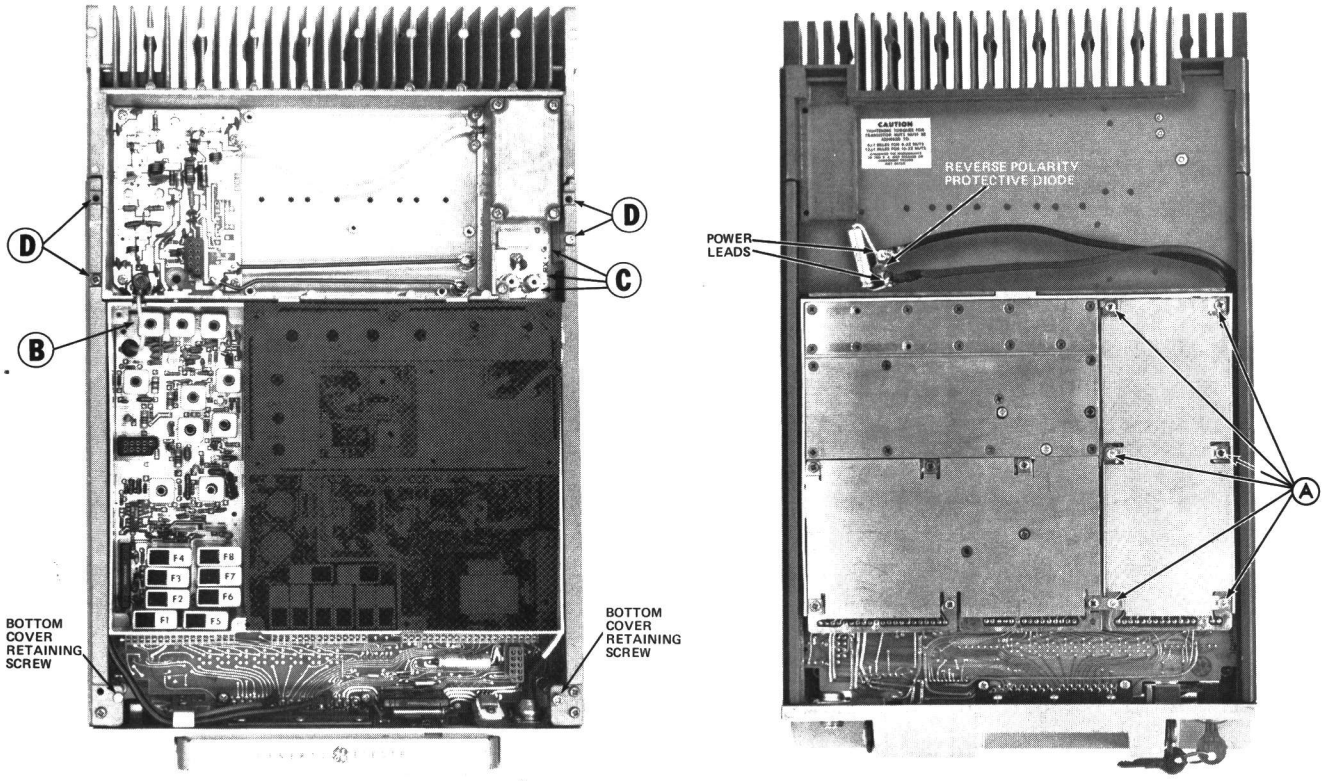


Figure 2 - Disassembly Procedure

- To remove PA module: (see PA assembly Outline Diagram - LBI30619)

  1. Remove the PA top cover and unplug the exciter/PA cable.

  2. Unsolder power feed cables W214 from G1 and W215 from E1.

  3. Unsolder 50-ohm cable W217 from W2 and disconnect G213 (ground).

NOTE

The center conductor of W217 must be soldered to W2 in the area indicated. The ground braid at G213 is connected to vehicle ground by the board mounting screw. The ground braid of W217 must not touch ground (A-) on the PA module.

  4. Remove Q215 retaining screw, nut and washer from heat sink assembly.

  5. Remove Q1, Q2 and Q3 transistor mounting screws (2 each), and nuts and washers on bottom of the PA assembly.

  6. Remove the four remaining PA board mounting screws, and lift the board out.

- To remove Low Pass Filter/Antenna Switch module: (see PA assembly Outline Diagram - LBI30619)

  1. Remove the PA top cover.

  2. Remove antenna and receiver plugs, and disconnect PTT cables.

  3. Unsolder 50-ohm cable W217 from W1 and disconnect G214 (ground).

  4. Remove the six mounting screws, lift off the filter casting, and lift the board out.

PA TRANSISTOR REPLACEMENT

WARNING

The RF Power Transistors used in the transmitter contain Beryllium Oxide, a TOXIC substance. If the ceramic or other encapsulation is opened, crushed, broken or abraded, the dust may be hazardous if inhaled. Use care in replacing transistors of this type.

To replace the PA RF transistor:

(1) Unsolder one lead at a time with a 50-Watt soldering iron. Use a scribe

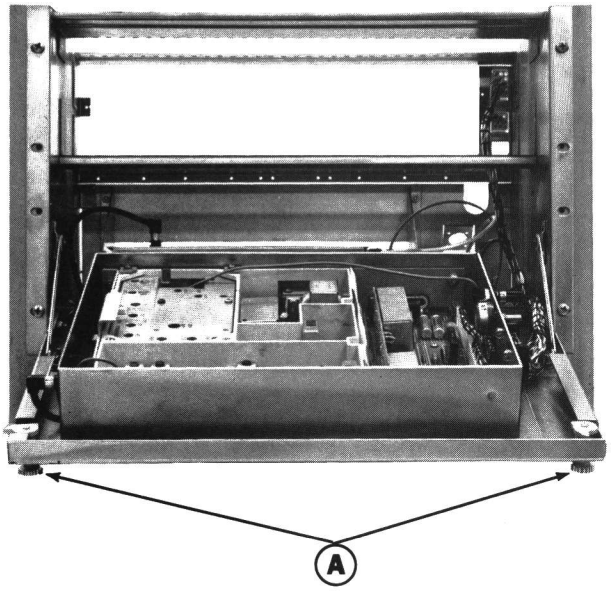


Figure 3 - Access to Exciter Front View

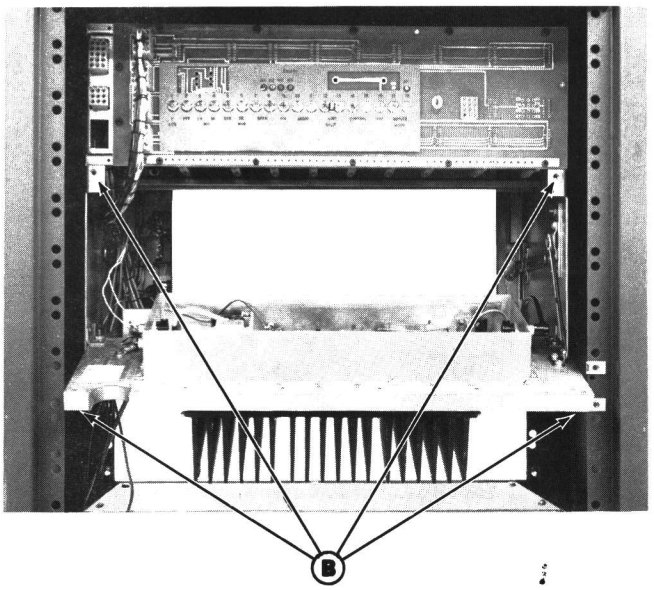


Figure 4 - Access to Power Amplifier Rear View

or Xacto® knife to hold the lead away from the printed circuit board until the solder cools.

(2) Turn the PA board over.

(3) Lift out the transistor, and remove the old solder from the printed circuit board with a de-soldering tool such as a SOLDA PULLT®. Special care should be taken to prevent damage to the printed circuit board runs because part of the matching network is included in the base and collector runs.

(4) Trim the new transistor leads to the lead length of the removed transistor. The letter "C" on the top of the transistor indicates the collector. (See Figure 5 for transistor lead identication).

(5) Apply a coat of silicon grease between the mounting surfaces of Q1 and Q2 and the heat sink. Replace the PA board and loosely insert the four hold-down screws. Place the transistor in the mounting hole. Align the leads as shown in the Outline Diagram. Then hold the body of the transistor and replace the transistor mounting hardware, using moderate torque (6 inch-pounds). A torque wrench must be used for these adjustments sinch transistor damage can result if too little or too much torque is used. Tighten the PA board hold down screws.

(6) Solder the leads to the printed circuit pattern. Start at the inner edge of mounting hole and solder the remaining length of transistor lead to the board. Use care not to use excessive heat that causes the printed wire board runs to lift up from the board. Check for shorts and solder bridges before applying power.

CAUTION

Failure to solder the transistor leads as directed may result in the generation of RF loops that could damage the transistor or may cause low power output.

TROUBLESHOOTING

A Troubleshooting Procedure, including QUICK CHECKS, permits rapid fault location in the exciter and power amplifier.

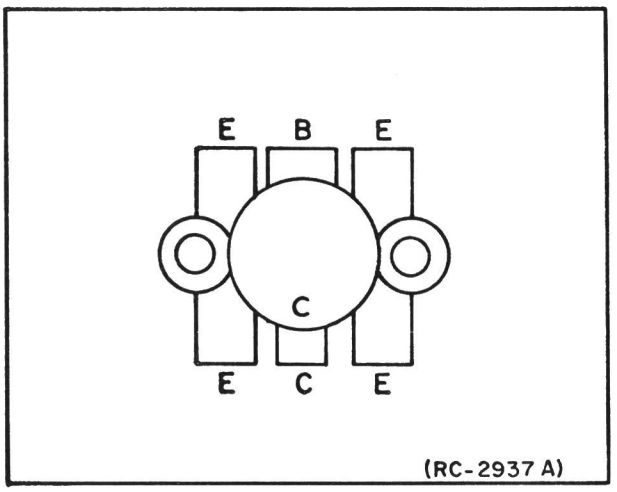


Figure 5 - PA Transistor Lead Identification for Q201 and Q202

CAUTION

Before bench testing the radio, be sure of the output voltage characteristics of your bench power supply.

To protect the transmitter power output transistors from possible instant destruction, the following input voltages must not be exceeded:

Transmitter unkeyed: 20 Volts
Transmitter keyed (50 ohm resistive load): 18 Volts
Transmitter keyed (no load or non-resistive load): 16 Volts

These voltages are specified at the normal vehicle battery terminals of the radio and take the voltage drop of standard cables into account. The voltage limits shown for a non-optimum load is for "worst case" conditions. For antenna mismatches likely to be encountered in practice, the actual limit will approach the 18 Volt figure.

Routine transmitter tests should be performed at EIA Standard Test Voltages (13.8 VDC for loads of 0 to 6 amperes: Input voltages must not exceed the limits shown, even for transient peaks of short duration.

Many commonly used bench power supplies cannot meet these requirements for load regulation and transient voltage suppression. Bench supplies which employ "brute force" regulation and filtering (such as Lapp Model 73) may be unable when operated in parallel with a 12-Volt automotive storage battery.

TEST EQUIPMENT

1. An audio oscillator (GE Model 4EX6A10)
2. A deviation monitor
3. A Multimeter and AC voltmeter
4. GE Test Set Models 4EX3A11 or 4EX8K12
5. Wattmeter, 50 ohm
6. Frequency Counter
7. Oscilloscope

MODULATION LEVEL ADJUSTMENT

MOD ADJUST Control R106 has been adjust to the proper setting before shipment and should not normally require readjustment. This setting permits approximately 75% modulation for the average voice level.

NOTE

The Channel Guard Deviation Adjustment should be repeated every time the Tone Frequency is changed.

MOBILE SET UP

1. Connect the audio oscillator and the AC meter across audio input terminals J10 (Green-H1) and J11 (Black-Lo) on GE Test Set, and connect red Test Set plug to the System red metering plug. Connect black plug to Exciter metering jack. If not using GE Test Set, connect audio oscillator and meter across PRO2-6 (Mike High) through a 0.5 microfarad (or larger) DC blocking capacitor, and PRO2-5 (Mike-Low) on the System Board.
2. Adjust the audio oscillator for 1-Volt RMS at 1000 Hz.

STATION SET UP

1. Connect the audio oscillator and the meter across audio input terminals J10 (Green-H1) and J11 (Black-Lo) on GE Test Set, and connect red Test Set plug to the System red metering plug. Connect black plug to Exciter Metering jack. Set the Pre-amp levels as outlined in the combination Manual.
2. Set the audio generator frequency to 1 kHz.
   A. In all station combinations except Local Control Intermittent Duty combinations, set the audio generator output to 35 millivolts RMS.
   B. In Local Control Intermittent Duty station combinations, set the audio generator output to 1.0 volts RMS.

DEVIATION ADJUSTMENT (MOBILE AND STATION)

For transmitters without Channel Guard, set MOD ADJUST R105 for a 4.5-kHz swing with the deviation polarity which gives the highest reading as indicated on the frequency modulation monitor.

NOTE

If the deviation reading plus (+) or minus (-) differs more than 0.2 kHz, recheck Step 1 as shown in the Transmitter Alignment Chart.

For transmitters with Channel Guard, set CHANNEL Guard MOD ADJUST R105 for zero tone deviation. Next, with the 1-Volt signal at 1000 Hz applied, set MOD ADJUST R105 for 3.75 kHz deviation. Then remove the signal from the audio oscillator and set Channel Guard MOD ADJUST R105 for 0.75 kHz tone deviation.

For multi-frequency transmitters, set the deviation as described in Steps 3 or 4 on the channel producing the largest amount of deviation.

PA POWER INPUT

For FCC purposes, the PA power input can be determined by measuring the PA supply voltage and PA current, and using the following formula:

$$P_i = \text{PA voltage} \times \text{PA current}$$

where:

P_i is the DC power input in watts, to the final transistor power amp.

PA voltage is measured with Test Set Model 4EX3A11 in Position G on the 15-Volt range (read as 15-full scale), and with the polarity switch in the (-) position. With Test Set Model 4EX8K12, use the 8+ position and the 1-Volt range (read as 15 Volts full scale), with the HIGH SENSITIVITY button pressed and the polarity switch in the (-) position.

PA current is measured with the Test Set in Position G in the Test 1 position, and with the HIGH SENSITIVITY button pressed (10 amperes full scale).

Example:

P_i = 13.2 Volts x 4.2 amperes = 56 watts

ICOM FREQUENCY ADJUSTMENT

First, check the frequency to determine if any adjustment is required. The frequency should be set with a frequency meter or counter with an absolute accuracy that is 5 to 10 times better than the tolerance to be maintained, and with the entire radio as near as possible to an ambient temperature of 26.5°C (79.8°F).

MASTR II ICOMs should be reset only when the frequency shows deviations in excess of the following limits:

A. ±0.5 PPM, when the radio is at 26.5°C (79.8°F).

B. ±2 PPM at any other temperature within the range of -5°C to +55°C (+23°F to +131°F).

C. ±2 PPM or ± 5 PPM at any temperature within the ranges of -40°C to -5°C (-40°F to +23°F) or +55°C to +70°C (+131°F to +158°F).

If an adjustment in required, pry up the cover on the top of the ICOM to expose the trimmer, and use one pf the following procedures:

If the radio is at an ambient temperature of 26.5°C (79.8°F), set the oscillator for the correct operating frequency.

If the radio is not at an ambient temperature of 26.5°C, setting errors can be minimized as follows:

A. To hold setting error to ±0.6 PPM (which is considered reasonable for 5 PPM ICOMS):
   1. Maintain the radio at 26.5°C (±5°C) and set the oscillator to desired frequency, or-
   2. Maintain the radio at 26.5°C (±10°C) and offset the oscillator, as a function of actual temperature, by the amount shown in Figure 6.

B. To hold setting error to ±0.35 PPM (which is considered reasonable for 2 PPM ICOMs): Maintain unit at 26.5°C (±5°C) and offset the oscillator, as a function of actual temperature, by the amount shown in Figure 6.

For example: Assume the ambient temperature of the radio is 18.5°C (65.4°F). At that temperature, the curve shows a correction factor of 0.3 PPM. (At 66 MHz, 1 PPM is 66 Hz. At 88 MHz, 1 PPM is 88 Hz).

With an operating frequency of 70 MHz, set the oscillator for a reading of 21 Hz (0.3 x 70 Hz) higher than the licensed operating frequency. If a negative correction factor is obtained (at temperatures above 26.5°C), set the oscillator for the indicated PPM lower than the licensed operating frequency.

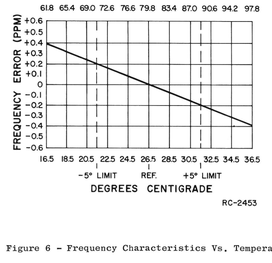
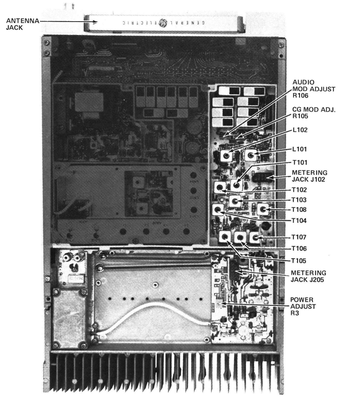


Figure 6 - Frequency Characteristics Vs. Temperature



66 — 88 MHZ

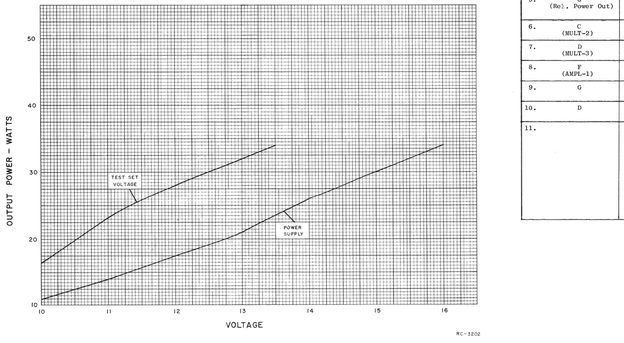


Figure 7 - Power Output Setting Chart

TRANSMITTER ALIGNMENT

PRELIMINARY CHECKS AND ADJUSTMENTS

1. Install ICOMS on Exciter Board (crystal frequency - operating frequency ÷ 6.)
2. For a large change in frequency or a badly mis-aligned transmitter, preset slugs for L101, L102, T101 and T102 to the bottom of the coil form. Preset slugs for T103 thru T108 to top of coil form.

NOTE

The tuning frequency for multi-frequency transmitters is determined by the operating frequency and the frequency spread between transmitters.

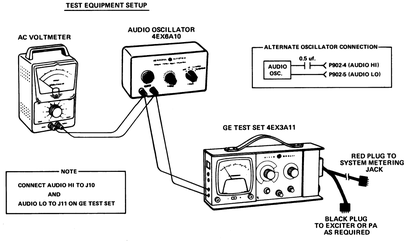
3. For multi-frequency transmitters with a frequency spread less than 0.5 MHz tune the transmitter to the lowest frequency.

   For frequency spread exceeding 0.5 MHz but less than 1.0 MHz tune the transmitter using a center frequency tune up ICOM. These limits can be extended to 1.5 MHz with 1 dB degradation.

4. Connect the red plug on the GE Test Set to the system metering jac, and the black plug to the Exciter metering jack. Set the polarity to +, and set the range to the Test 1 position (1-Volt position for 4EX8K12) for all adjustments.
   NOTE: With the Test Set connected to the PA metering jack, the voltage reading at position "G" with the HIGH SENSITIVITY button pressed may be converted to PA collector current by reading the current as 10 amperes full scale.
5. Rotate Power Adjust potentiometer R3 on PA Board all the way counterclockwise.
6. All adjustments are made with the transmitter keyed.

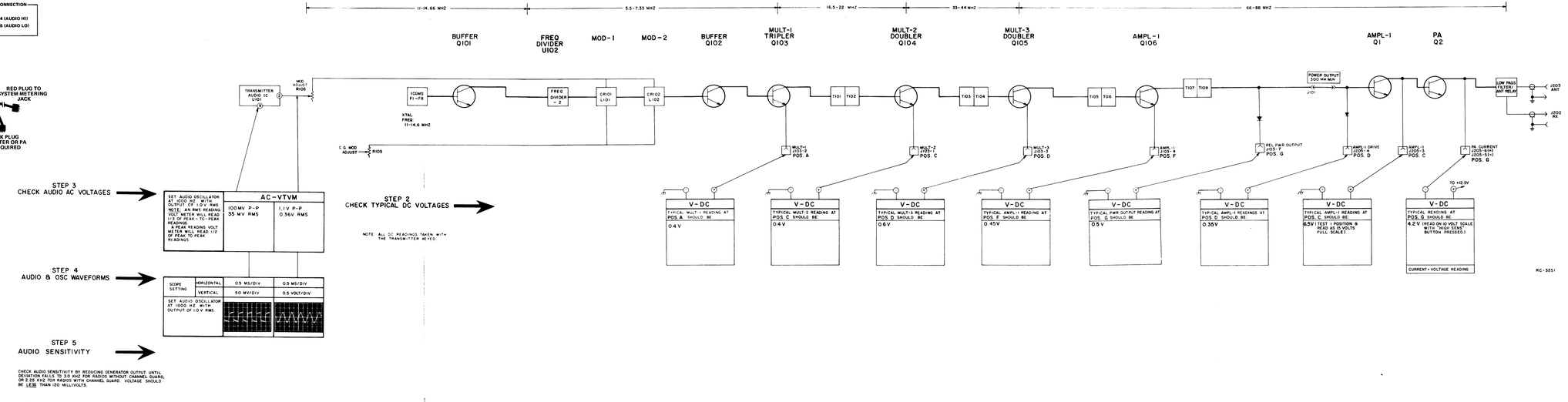
ALIGNMENT PROCEDURE

STEP	METER POSITION	TUNING CONTROL	METER READING	PROCEDURE
1.	A (MULT-1)	L101, L102 & T101	See Procedure	Press HIGH SENSITIVITY button and tune L101 then L102 for maximum meter reading. Then tune T101 for a dip in meter reading.
2.	C (MULT-2)	T102, T101 & T103	See Procedure	Tune T102 (green) for maximum meter reading and re-adjust T101 for maximum meter reading. Then tune T103 (Red) for a dip in meter reading.
3.	D (MULT-3)	T104, T103 & T105	See Procedure	Tune T104 (Blue) for maximum meter reading and re-adjust T103 (Red) for maximum meter reading. Then tune T105 for a dip in meter reading.
4.	F (AMPL-1)	T106, T105 & T107	See Procedure	Tune T106 (Green) for maximum meter reading, and then re-adjust T105 for maximum meter reading. Then tune T107 for dip.
5.	G (Rel. Power Out)	T107, T106 & T108	Maximum	Tune T107 and then T106 for maximum meter reading. Retune T107 for maximum meter reading, then tune T108 for maximum meter reading or power out.
6.	C (MULT-2)	T102 & T103	Maximum	Tune for maximum meter reading.
7.	D (MULT-3)	T103 & T104	Maximum	Tune T103 and T104 for maximum meter reading.
8.	F (AMPL-1)	T105 & T106	Maximum	Tune T105 and T106 for maximum meter reading.
9.	G	T107 & T108	Maximum	Tune T107 and T108 for maximum power output.
10.	D	T107 & T108	Maximum	Connect the black metering plug to the PA metering jack and tune T107 and T108 for maximum meter reading.
11.		R3	See Procedure	With the battery voltage at 13.8 Volts or the PA collector voltage at 13.2 Volts, set Power Adjust potentiometer R3 on the PA board for the desired power output from 8 to 25 watts as read on the wattmeter connected to antenna jack J2. If the battery voltage is not at 13.8 Volts or the collector voltage at 13.2 Volts and full rated output is desired (25 watts at 13.8 Volts), set R3 for the output power according to the battery voltage or collector voltage shown in Figure 5. NOTE The PA collector voltage is measured as described in the PA POWER INPUT section.



STEP 1 - QUICK CHECKS

METER POSITION OR TEST SET	PROBABLE DEFECTIVE STAGE		
	HIGH METER READING	LOW METER READING	ZERO METER READING
	EXCITER BOARD		
A (MULT-1)	Q104, Q105, T104	Q104, Q105, CR101, CR205, L101, L202, D102, VR101, Q103	Q105, Q104, T101, Q102, T102, Q103 VR101
C (MULT-2)	Q106, T102	T101, T102, T103, Q106, R130	T101, T102, T103, Q106, R130
D (MULT-3)	Q107	T103, T104, T105, Q107, R131	T103, T104, Q107 R131
E (AMPL-1)	Q108	T105, T106, Q108 C147, C148, R134	T105, T106, Q108 L107, L105
G (POWER OUT)	W216	CR103, R137, R136, T107, T108	Q108, CR103, R136 C147, C152, T107, T108
	POWER AMPLIFIER		
"D" (AMPL-1 DRIVE)	R8	Q108, C147, C152, CR1, Low Output from Exciter	No output from Exciter, CR1, C26, R7, R8
"C" (AMPL-1 POWER CONTROL VOLTAGE)	Q215, R3	Q215, R3	Q215, R3
"G" (PA CURRENT)	Q2	Q1, Q2	Q2, Q1, Q215, R3



STEP 2
CHECK TYPICAL DC VOLTAGES

NOTE ALL DC READINGS TAKEN WITH THE TRANSMITTER KEYED

STEP 3
CHECK AUDIO AC VOLTAGES

SET AUDIO OSCILLATOR AT 1000 HZ WITH OUTPUT OF 1.0 V RMS. NOTE: METER WILL READ 1/3 OF PEAK - TO - PEAK READING. A PEAK READING VOLT METER WILL READ 1/2 OF PEAK - TO - PEAK READING.	AC-VTVM	
	100 MV P-P 35 MV RMS	1.1 V P-P 0.36V RMS

STEP 4
AUDIO & OSC WAVEFORMS

SCOPE SETTING	HORIZONTAL	0.5 MS/DIV	0.5 MS/DIV
	VERTICAL	50 MV/DIV	0.5 VOLT/DIV
SET AUDIO OSCILLATOR AT 1000 HZ WITH OUTPUT OF 1.0 V RMS.			

STEP 5
AUDIO SENSITIVITY

CHECK AUDIO SENSITIVITY BY REDUCING GENERATOR OUTPUT UNTIL DEVIATION FALLS TO 3.0 KHZ FOR RADIOS WITHOUT CHANNEL GUARD, OR 2.25 KHZ FOR RADIOS WITH CHANNEL GUARD. VOLTAGE SHOULD BE LESS THAN 120 MILLIVOLTS.

TROUBLESHOOTING PROCEDURE

66—88 MHz, 25-WATT MASTR II TRANSMITTER