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**DESCRIPTION**

MASTR® II transmitters are crystal-controlled, phase modulated transmitters designed for one through eight-frequency operation in the 138 to 174 megahertz frequency band. The solid state transmitter utilizes both integrated circuits (ICs) and discrete components, and consists of the following assemblies:

- Exciter Board; with audio, modulator, amplifier and multiplier stages.
- Power Amplifier Assembly; with amplifiers, driver, PA, power control, low pass filter, and antenna switch.

Figure 1 is a block diagram of the 138-174 MHz MASTR II transmitter, showing the Exciter board and Power Amplifier Assembly.

The exciter uses nine 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 11.5 to 14.5 megahertz, and the crystal frequency is multiplied 12 times.

The PA assembly uses three RF power transistors to provide 65 Watts output power. The output power is adjustable over a range

of 13 to 65 Watts. A directional coupler, transistor and power control IC are used in the power control circuit.

**MAINTENANCE**

The PA assembly is insulated from vehicle ground to permit operation in positive or negative ground vehicles.

**NOTE**

In positive ground vehicles, A- is "hot" with respect to vehicle ground. Shorting the transmitter PA printed wiring board ground pattern to the radio case may cause one of the inline fuses to blow.

**MOBILE DISASSEMBLY**

To service the transmitter from the top:

1. Pull the locking handle down, then pry up the top cover at the front notch and lift off the cover.

To service the transmitter from the bottom:

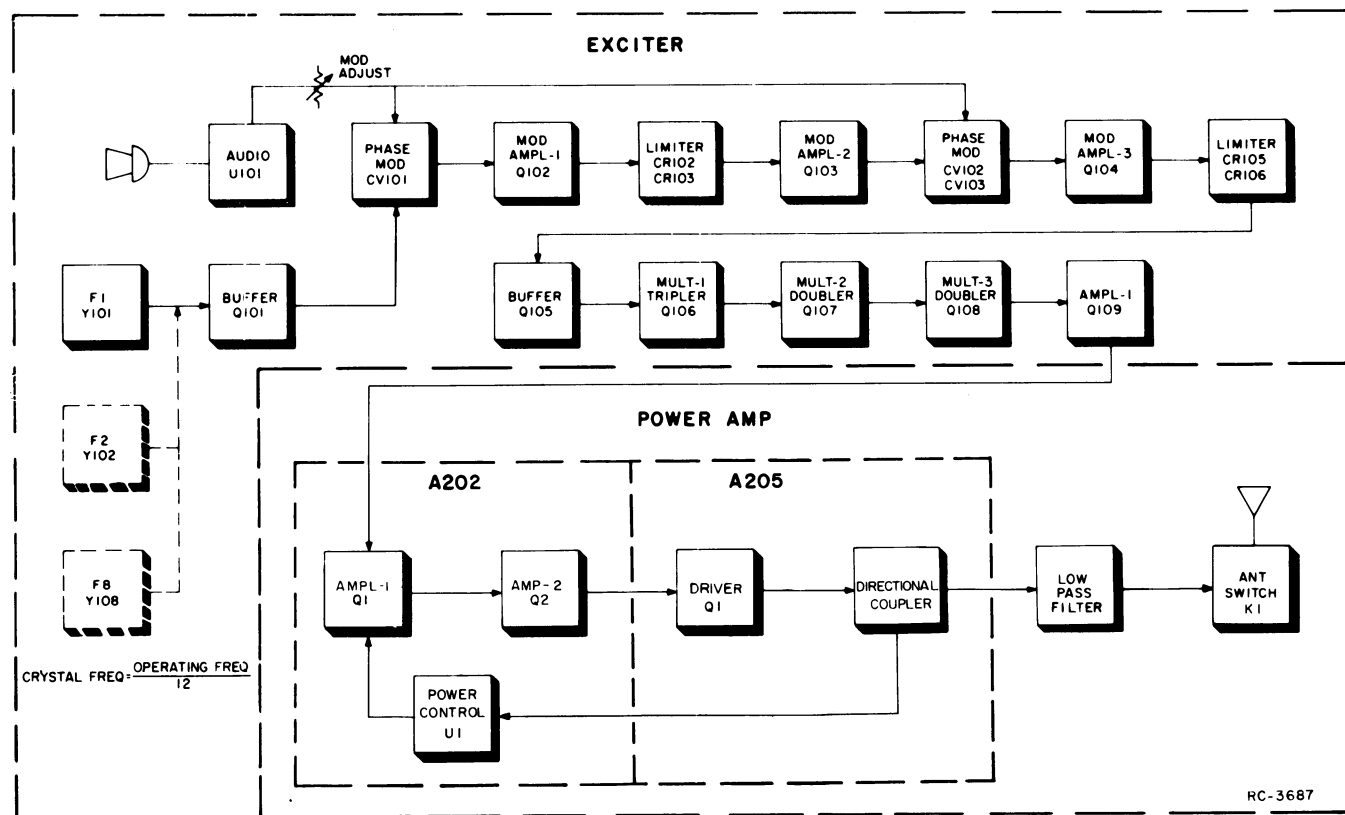


Figure 1 - Transmitter Block Diagram

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 and its bottom cover to the module mounting frame, and remove the bottom cover (See Figure 3).

## STATION DISASSEMBLY

For a more complete mechanical parts breakdown refer to the station combination 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 4.
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 5.
2. Swing the Power Amplifier down as shown. Remove the top cover of the Power Amplifier.

## NOTE

If the heat sink blower option is present, this blower must be removed before the Power Amplifier can be lowered.

## EXCITER DISASSEMBLY

To remove the exciter board from the radio:

1. Unplug the exciter/PA cable (B). (Figure 2).

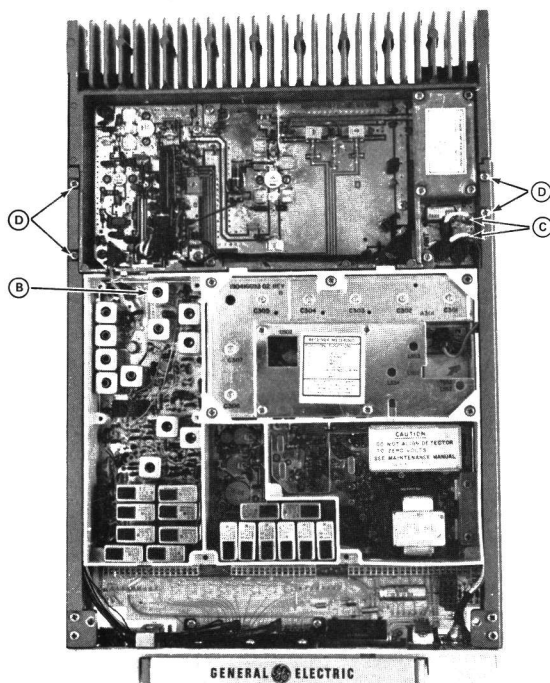


Figure 2 - Disassembly Procedure  
Top View

2. Remove the six screws (A) holding the exciter board and its bottom cover to the module mounting frame. (Figure 3)
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

##### PA Assembly

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.

##### PA Driver Module (A202)

To remove PA Driver module: (See PA Assembly Outline Diagram).

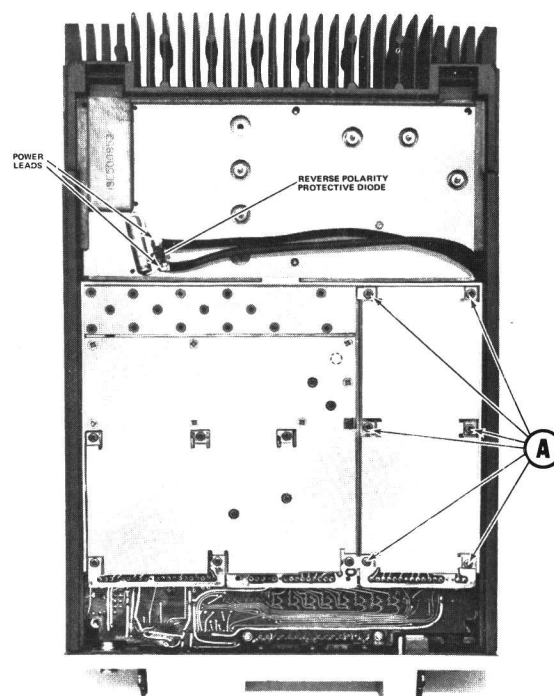


Figure 3 - Disassembly Procedure  
Bottom View

1. Remove the PA top cover and unplug the Exciter/PA cable.
2. Unsolder and remove power feed cables W207/W220 and W206/W221.

#### CAUTION

Extreme care must be taken to prevent damage to the printed circuit runs of the PA module when removing W30.

3. Carefully unsolder and remove straps and jumpers W30, W203, W204, W205 and leads from holes 3, 4 and 5 between the PA Driver module and the PA module. Remove the excess solder from the ground connections with a de-soldering tool such as a SOLDA-PULLT®; then lift the connections from the PA Driver module with a scribe or X-acto® knife.
4. Unsolder thermistor (RT201) leads.
5. Remove Q215 retaining screw, nut and washer from heat sink assembly.
6. Remove A202-Q1 and A202-Q2 transistor mounting screws (2 each), and nuts and washers on bottom of the PA assembly.

3. Hold the nuts on the bottom of the heat sink with a 3/16-inch nutdriver and remove the two retaining screws. 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.

To replace RF PA transistors:

1. Trim the new transistor leads (if required) to the lead length of the removed transistor. The collector lead is identified by the smaller center lead (See Figure 6). The letter "C" on top of each transistor also identifies the collector.

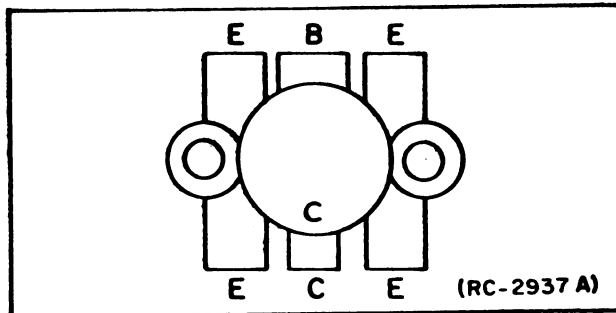


Figure 6 - Lead Identification

2. Apply a coat of silicone grease to the transistor surface and heat sink.

Assemble all hardware loose and align the leads as shown on the Outline Diagram. Then hold the body of the transistor and replace the two retaining screws and hand tighten. Then torque to 6 inch pounds. A torque wrench must be used for this adjustment since transistor damage can result if too little or too much torque is used.

3. 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. Do not use excessive heat which causes the printed wire runs to lift up from the board. Check for shorts and solder bridges with an ohmmeter 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.

#### DIRECTIONAL COUPLER ADJUSTMENT

The directional coupler adjustment (A205-R2, Forward Power and A205-R3, Reflected Power) controls are preset at the factory and normally do not require readjustment. Should it become necessary to replace A205-CR1, CR2 or the PA transistors, it may be desirable to reset A205-R2 and A205-R3. The following procedure applies.

1. Connect a 50 ohm wattmeter capable of measuring 150 watts to the antenna jack.

#### CAUTION

ADJUSTING DIRECTIONAL COUPLER POTENTIOMETERS A205-R2 and R3 may destroy them and require their replacement.

2. Turn power adjust potentiometer A202-R8 and forward power sensor potentiometer A205-R2 fully clockwise. Set reflected power sensor potentiometer A205-R3 fully counterclockwise.
3. Key transmitter on each channel and determine which channel produces the highest output.
4. With the channel producing the highest output selected, adjust forward power sensor A205-R2 to 10% above rated output power.
5. Set power adjust potentiometer for rated output power and unkey transmitter.
6. Remove wattmeter and double terminate the antenna jack with two paralleled 50 ohm wattmeters. Connect the wattmeters directly to antenna jack using the connectors and adaptors as required.
7. Set reflected power sensor potentiometer A205-R3 fully clockwise.
8. Key transmitter on each channel and determine which channel produces the lowest output.

9. If PA provides 80% or more of rated power on all channels; no further adjustment is required. If less than 80% of rated power is present on any channel, set frequency selector to the channel with lowest output and adjust A205-R3 to provide 80% of rated output power.
10. Re-cement forward and reflected power potentiometers A205-R2 and R3 using RTV.

## TROUBLESHOOTING

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

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MOBILE RADIO DEPARTMENT  
GENERAL ELECTRIC COMPANY • LYNCHBURG, VIRGINIA 24502

GENERAL  ELECTRIC

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): 15.5 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 (13.6 VDC for loads of 6 to 16 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 usable when operated in parallel with a 12-Volt automotive storage battery.

TEST EQUIPMENT

1. An audio oscillator
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 adjusted properly 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 each time the Tone Frequency is changed.

MOBILE SET UP

1. Connect the audio oscillator and the AC meter across audio input terminals J10 (Green-Hi) and J11 (Black-Lo) on GE Test Set, and connect red Test Set plug to the red System metering plug. Connect black plug to Exciter Metering jack. If not using GE Test Set, connect audio oscillator and meter across P902-6 (Mike High) through a 0.5 microfarad (or larger) DC blocking capacitor, and P902-5 (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-Hi) and J11 (Black-Lo) on GE Test Set, and connect red Test Set plug to the red System 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 30 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 using the deviation polarity that provides the highest reading as indicated on the frequency modulation monitor.

NOTE

If the deviation reading plug (+) or minus (-) differs more than 0.5 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:

$$P_1 = \text{PA voltage} \times \text{PA current}$$

where:

$P_1$  is the power input in Watts,

PA voltage is measured with Test Set Model 4EX3A11 in Position G on the 15-Volt range (read as 15 Volts full scale), and with the polarity switch in the (-) position. With Test Set Model 4EX8K12, use the B+ 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:  $P_1 = 13.0 \text{ Volts} \times 8.5 \text{ amperes} = 110 \text{ Watts}$

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 deviation in excess of the following limits:

- A.  $\pm 0.5$  PPM, when the radio is at 26.5°C (79.8°F).
- B.  $\pm 2$  PPM at any other temperature within the range of -5°C to +55°C (23°F to +131°F).
- C. The specification limit ( $\pm 2$  PPM or  $\pm 5$  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 is required, use one of 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 the setting error to  $\pm 0.6$  PPM (which is considered reasonable for 5 PPM ICOMs):

1. Maintain the radio at 26.5°C ( $\pm 5^\circ\text{C}$ ) and set the oscillator to desired frequency, or-

2. Maintain the radio at 26.5°C ( $\pm 10^\circ\text{C}$ ) and offset the oscillator, as a function of actual temperature, by the amount shown in Figure 7.
- B. To hold setting error to  $\pm 0.35$  PPM (which is considered reasonable for 2 PPM ICOMs): Maintain unit at 26.5°C ( $\pm 5^\circ\text{C}$ ) and offset the oscillator as a function of actual temperature, by the amount shown in Figure 7.

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 138 MHz, 1 PPM is 138 Hz. At 174 MHz, 1 PPM is 174 Hz).

With an operating frequency of 150 MHz, set the oscillator for a reading of 45 Hz (0.3 x 150 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.

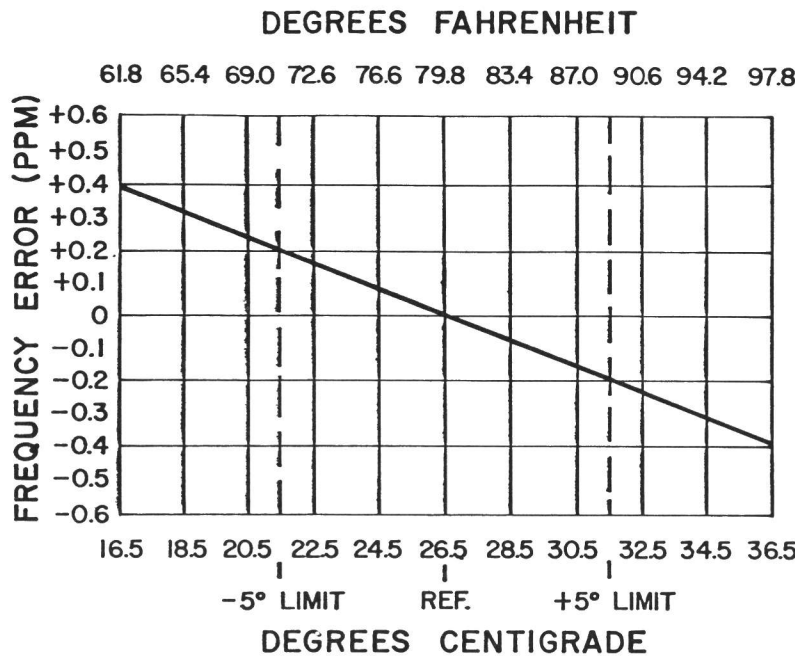


Figure 7 - Frequency Characteristics Vs. Temperature

TRANSMITTER ALIGNMENT

PRELIMINARY CHECKS AND ADJUSTMENTS

1. Place ICOMs on Exciter Board (crystal frequency = operating frequency  $\div$  12).
2. For a large change in frequency or a badly mis-aligned transmitter, pre-set all slugs to top of coil form. NOTE: If Exciter 19D416859 is provided, pre-set T104 and T105 only, to bottom of coil form.
3. For multi-frequency transmitters with a frequency spacing less than .900 MHz for frequencies between 138-155 MHz or less than 1.00 MHz for frequencies between 150.8-174 MHz tune the transmitter on the lowest frequency.

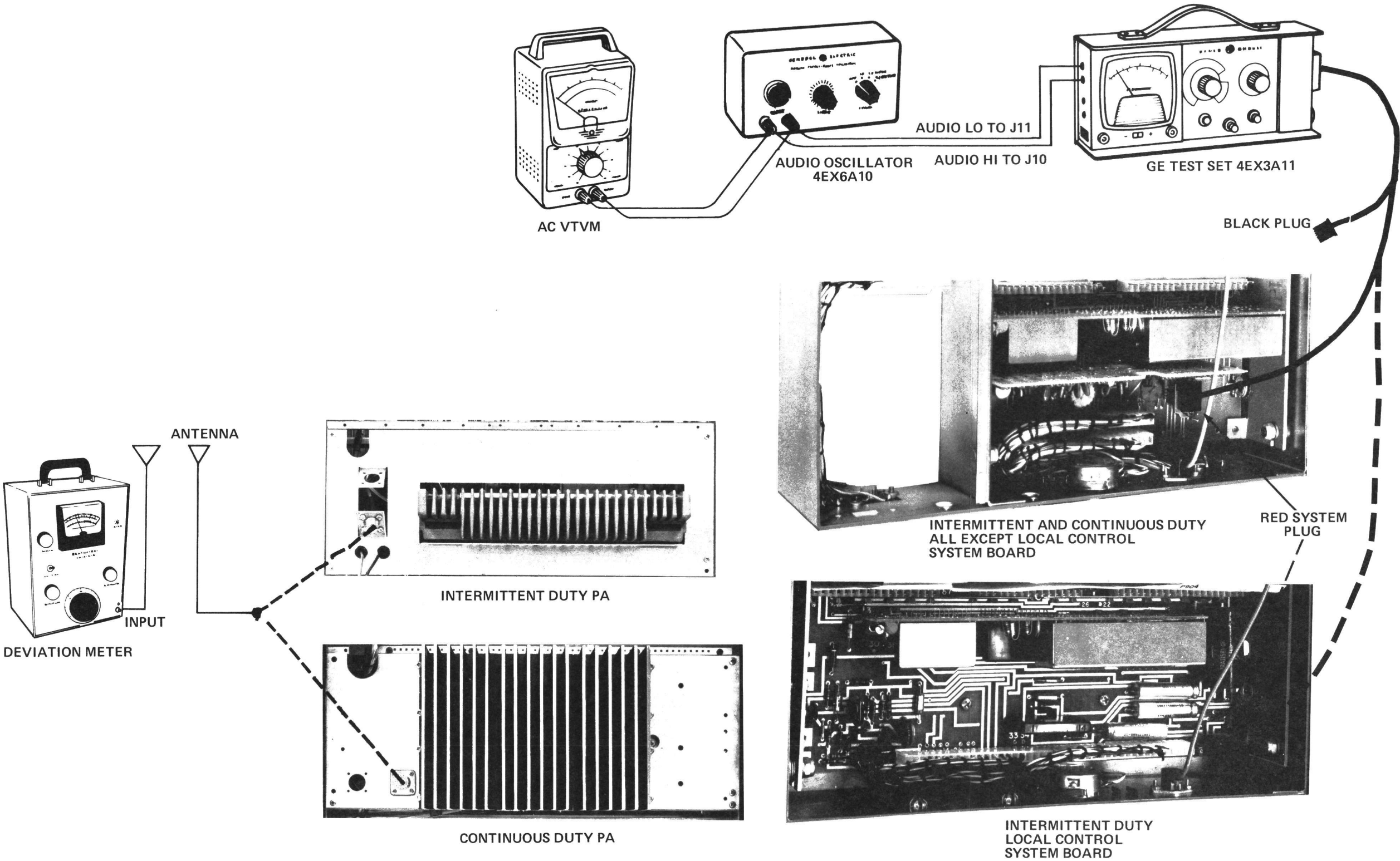
For multi-frequency transmitters with a frequency spacing up to 1.8 MHz for frequencies between 138-155 MHz or 2.0 MHz for frequencies between 150.8-174 MHz, tune the transmitter using a center frequency tune-up ICOM. These limits can be extended to 2.75 MHz and 3.0 MHz respectively with 1 dB degradation in power output.
4. Connect the red plug on the GE Test set to the System Board metering jack, 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 (J205), 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. Connect 50 ohm Wattmeter to antenna jack.
6. All adjustments are made with the transmitter keyed. Unkey the transmitter between steps to avoid unnecessary heating.

STEP	METER POSITION		TUNING CONTROL	METER READING	PROCEDURE
	GE TEST SET	INTERNAL METERING			
1.	A (MOD-1)	1 (MOD-1)	T101	Maximum	Tune T101 for maximum meter reading on the lowest frequency.
2.	B (MOD-2)	2 (MOD-2)	T102 & T103	Maximum	Tune T102 and then T103 for the maximum meter reading on the lowest frequency.
3.	C (MULT-1)	3 (MULT-1)	T104	Minimum	Tune T104 for a dip in meter reading.
4.	D (MULT-2)	4 (MULT-2)	T105, T104 & T106	See Procedure	Tune T105 for maximum meter reading and re-adjust T104 for maximum meter reading. Then tune T106 for a dip in meter reading.
5.	F (MULT-3)	5 (MULT-3)	T107, T106, T108 & T109	See Procedure	Tune T107 for maximum meter reading and re-adjust T106 for maximum meter reading. Then tune T108 for a dip in meter reading and T109 for maximum meter reading.
6.	G (AMPL-1)	6 (AMPL-1)	T110, T108 & T109	Maximum	Tune T110 for maximum meter reading, and then re-adjust T108 and T109 for maximum meter reading.
7.	D (AMPL-1 DRIVE on PA)	8 (AMPL-1 DRIVE on PA)	T11 & T112	Maximum	Move the black metering plug to the Power Amplifier metering jack (J205) and tune T11 and then T112 for maximum meter reading.
8.	G (AMPL-1)	6 (AMPL-1 on EXCITER)	T108, T109 & T110	Maximum	Move the black metering plug back to the Exciter metering jack and re-adjust T108, T109 and T110 for maximum meter reading.
9.	D (AMPL-1 DRIVE on PA)	8 (AMPL-1 DRIVE on PA)	T111 & T112	Maximum	Move the black metering plug back to the Power Amplifier metering jack (J205) and re-adjust T111 and T112 for maximum meter reading.
10.			A201-R8		Set Power Adjust potentiometer A201-R8 on the driver board for the desired power output.
ADDITIONAL STEPS FOR TRANSMITTERS USING CENTER FREQUENCY TUNE-UP ICOM					
11.	D (MULT-2)	4 (MOD-2 on EXCITER)	T105	See Procedure	Move the black metering plug to the exciter metering jack and re-adjust T105 for equal drive on the highest and lowest frequency.
12.	G (AMPL-1)	6 (AMPL-1 on EXCITER)	T110 & T108	Maximum	Re-adjust T110 and then T108 for maximum meter reading on the lowest frequency.

ALIGNMENT PROCEDURE

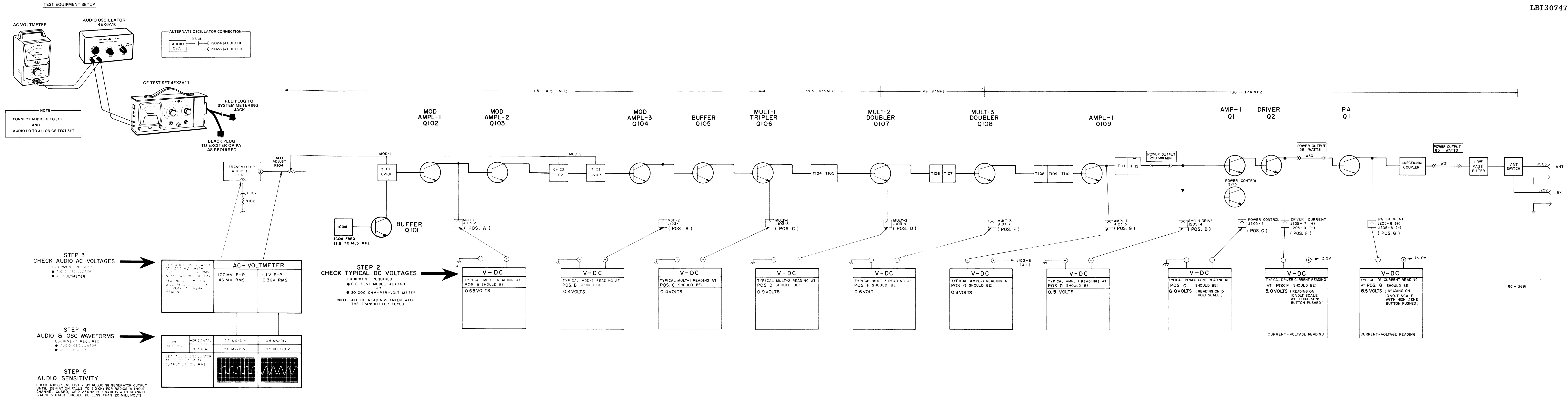
138—174 MHz, 65 WATT TRANSMITTER





STEP 1 - QUICK CHECKS

METER POSITION GE TEST SET	PROBABLE DEFECTIVE STAGE		
	HIGH METER READING	LOW METER READING	ZERO METER READING
EXCITER			
A (MOD-1)	Q102, 10-Volt Regulator	Q102, CV101, T101, 10-Volt Regulator	ICOM, Q101, Q102, CR101, 10-Volt regulator or Channel Selector switch ground.
B (MOD-2)	Q104, 10-Volt Regulator	Q103, T102, T103, CV102, CV103, Q104	Q103, T102, CV102, T103, CV103, CR104, Q104
C (MULT-1)	Q105, Q106, T104	Q105, Q106	Q105, Q106, T104
D (MULT-2)	Q107, T106	T104, T105, Q107	T104, T105, Q107, T106
F (MULT-3)	Q108, T108	T106, T107, Q108	T106, T107, Q108, T108
G (AMPL-1)	Q109, C157	T108, T109, T110, Q109	T108, T109, T110, Q109, L106
POWER AMPLIFIER			
"D" (AMPL-1 DRIVE)		Low Output from Exciter	No output from Exciter, A202-CR1
"C" (AMPL-1 POWER CONTROL VOLTAGE)	Q215	Q215, U1	No Exciter output, Q215, A202-Q1, A202-Q2, A202-CR1, U1
"F" (DRIVER CURRENT)	A202-Q2	Low Output from A202-Q1	A202-Q1, P2, Check Pos. C
"G" (PA CURRENT)	A205-Q1	A202-Q1, Q2 A205-Q1	Q215, A202-Q1, Q2 A205-Q1



TROUBLESHOOTING PROCEDURE

138-174 MHz, 65 WATT TRANSMITTER