MOBILE RADIO

LBI30757B
(DF3156)
(DF3171, IMTS)

DESCRIPTION AND MAINTENANCE

138—174 MHz, 40 WATT MASTR® II TRANSMITTER (WITH PHASE LOCK LOOP EXCITER)

TABLE OF CONTENTS

ILLUSTRATIONS

DESCRIPTION

MASTR® II 40 Watt transmitters with phase lock loop exciters are crystal controlled, frequency modulated transmitters designed for wide spaced multi-frequency operation in the 138-174 MHz frequency band. The solid state transmitter utilizes both integrated circuits (ICs) and discrete components, and consists of the following assemblies:

- Exciter Board; with audio, FM ICOMS, Phase Lock Loop, Lock Detector, 10 Volt DC Switch and amplifier stages.
- Power Amplifier Assembly; with amplifiers, driver, PA, power control, low pass filter and antenna switch.

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

The exciter contains the FM oscillators, audio IC, harmonic amplifier IC, bandpass filter, phase lock loop, RF amplifiers, lock detector, 10 Volt switch and exciter output control circuitry to provide 250 milliwatts of RF power to the power amplifier. The phase lock loop permits wide spaced transmitter operation with up to 24 MHz frequency separation.

The PA assembly uses three RF power transistors to provide 40 Watts output power. The output power is adjustable over a range of 10 to 40 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:

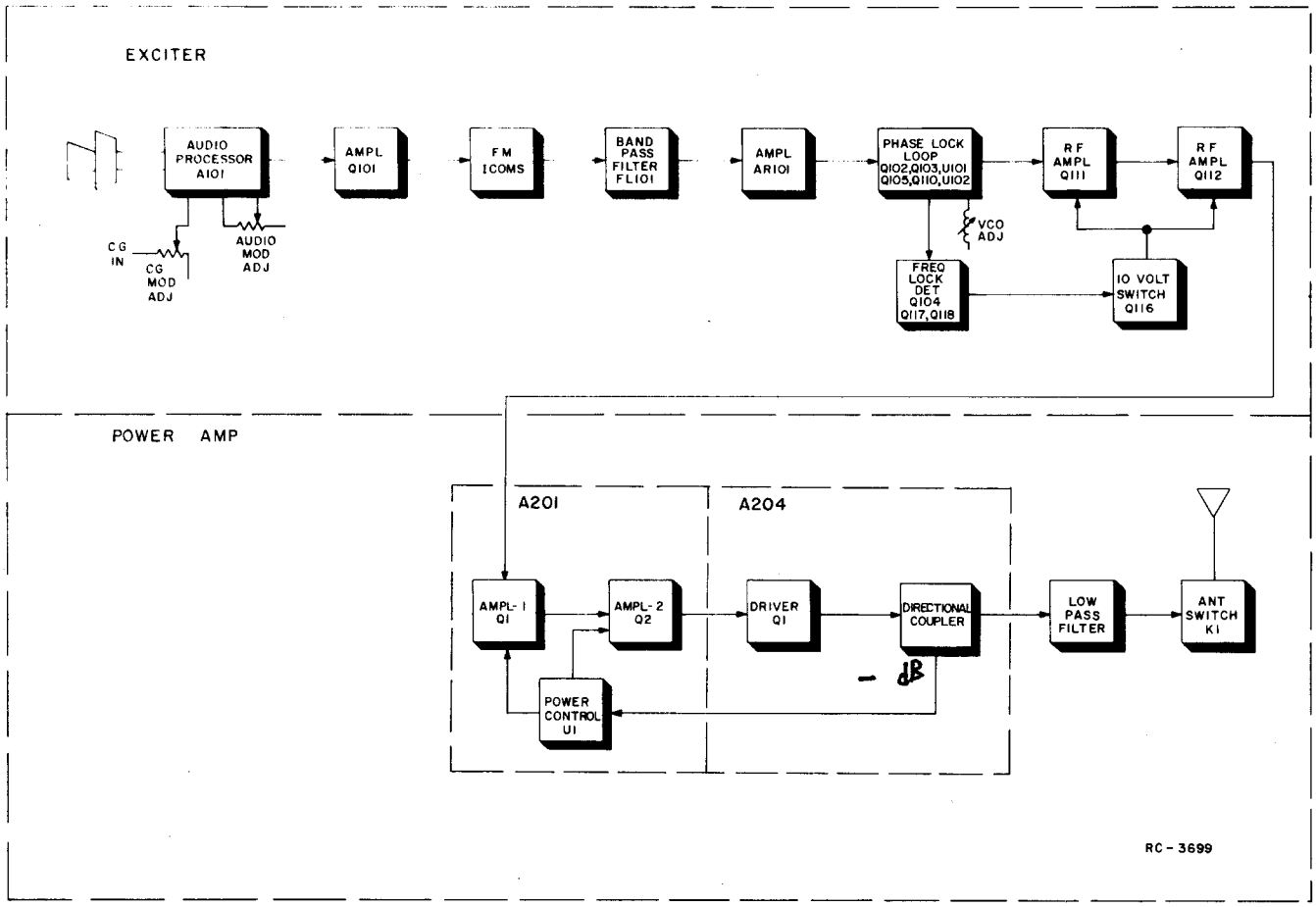

Figure 1 - Transmitter Block Diagram

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 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.

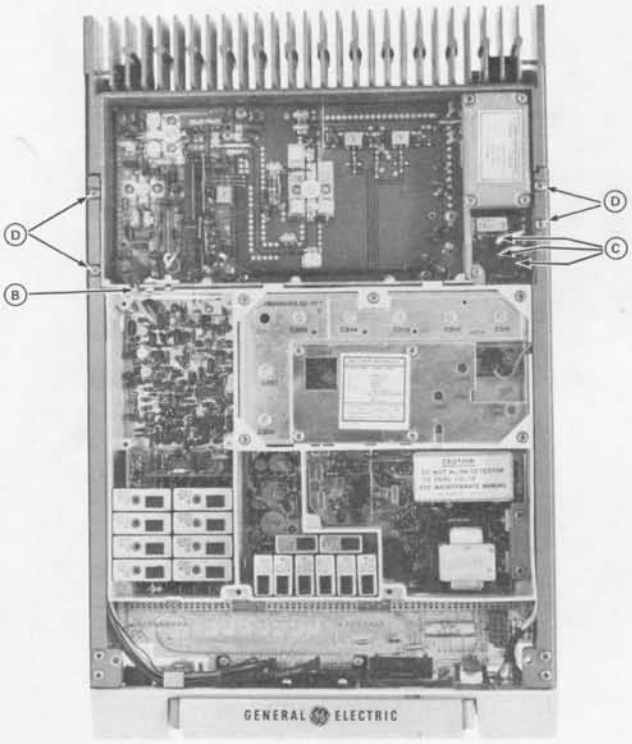

Figure 2 - Disassembly Procedure
Top View

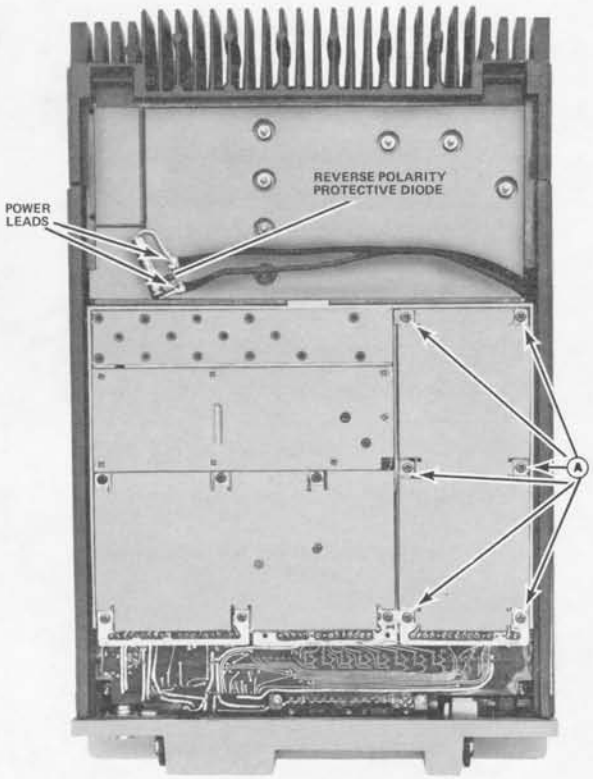

Figure 3 - Disassembly Procedure
Bottom View

EXCITER DISASSEMBLY

To remove the exciter board from the radio:

1. Unplug the exciter/PA cable (B). (Figure 2).
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 (A201)

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

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 cables W30, W204 and W205 and leads connected to A201-H3, H4 and H5 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.

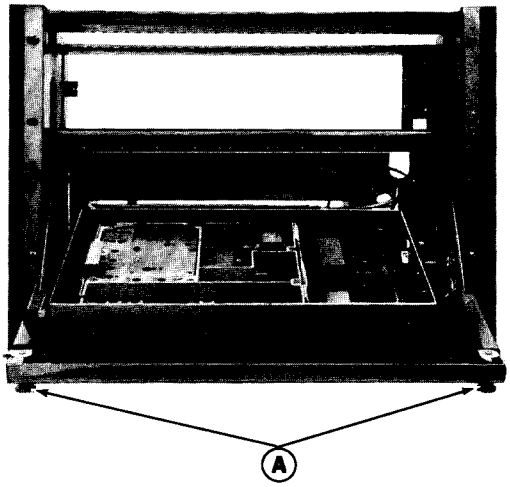

Figure 4 - Access to Exciter Front View

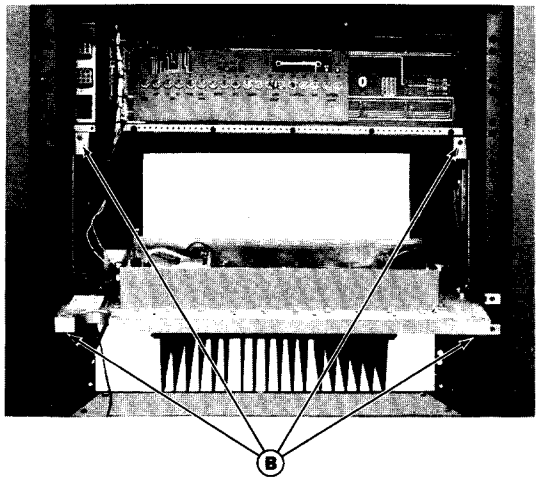

Figure 5 - Access to Power Amplifier Rear View

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

6. Remove A201-Q1 and A201-Q2 transistor mounting screws (2 each), and nuts and washers on bottom of the PA assembly.

7. Remove the four PA Driver board mounting screws (including the one securing W204) and lift the board out.

PA Module (A204)

To remove PA module: (See PA assembly Outline Diagram).

1. Remove the PA top cover.

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 on the PA module and the Low Pass Filter module when unsoldering W30 and W31.

3. Carefully unsolder and remove strap W30, W203, W204 and W205 between the PA Driver module and the PA module. Remove the excess solder from the ground connections with a desoldering tool such as a SOLDAPULLT®; then lift the connections from the PA Driver module with a scribe or X-acto® knife.

4. Carefully unsolder and remove strap W31 between the PA module and the Low Pass Filter module.

5. Unsolder leads connected to holes H3, H4, H5 on PA Module A204. Unsolder L201 at C298-1.

6. Remove A204-Q1 transistor mounting screws (2 each), and nuts and washers on bottom of the PA assembly.

7. Remove the six PA board mounting screws, and lift the board out.

To remove Low Pass Filter/Antenna Switch module:

1. Remove the PA top cover.

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

3. Carefully unsolder and remove strap W31 between the PA module and the Low Pass Filter module.

4. Remove the seven 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.

Good RF insulation & heat sink

To remove RF PA transistors:

1. With a 50 Watt soldering iron and a de-soldering tool such as the SOLDA-PULLT®, remove the excess solder from the leads. Use a scribe or X-acto® knife to hold the leads away from the printed circuit board until the solder cools.

2. Turn the PA Assembly over.

3. Hold the nuts on the bottom of the heat sink with a 3/16 inch nut-driver 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.

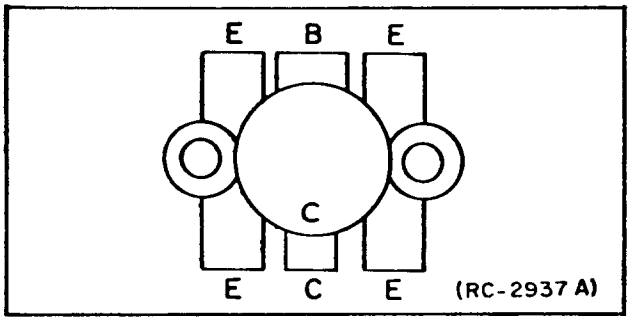

Figure 6 - Lead Identification

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 ohmeter 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 (A204-R2, Forward Power and A204-R3, Reflected Power) controls are preset at the factory and normally do not require readjustment. Should it become necessary to replace A204-CR1, CR2 or the PA transistors, it may be desirable to reset A204-R2 and A204-R3. The following procedure applies.

1. Connect a 50 ohm directional wattmeter capable of measuring 100 watts to the antenna jack. Terminate in a 50 ohm load capable of dissipating 100 watts.

CAUTION

ADJUSTING DIRECTIONAL COUPLER POTENTIOMETERS A204-R2 and R3 may destroy them and require their replacement.

2. Turn power adjust potentiometer A201-R8 and forward power sensor potentiometer A204-R2 fully clockwise. Set reflected power sensor potentiometer A204-R3 full 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 A204-R2 to 10% above rated output power.

5. Set power adjust potentiometer for rated output power and unkey transmitter.

6. Terminate the wattmeter with two 50 ohm loads (or wattmeters) connected in parallel, each capable of dissipating 75 watts.

7. Set reflected power sensor potentiometer A204-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 as indicated on the wattmeter on all channels, no further adjustment is required.

   If less than 80% of rated power is present on any channel, set the frequency selector to the channel with lowest output and adjust A204-R3 to provide 80% of rated output power.

10. Re-cement forward and reflected power potentiometers A204-R2 and R3 using RTV.

LOCK DETECTOR DC THRESHOLD ADJUSTMENT

NOTE

The gain of the differential amplifier is preset at the factory and normally does not require field adjustment. However, if U101, Q102 or Q103 have been replaced readjustment may be necessary.

1. Set channel selector to an unused channel. (One without a crystal.)
2. Using a DC voltmeter monitor the collector of Q102 (top of R129).
3. Key transmitter by pressing PTT switch and adjust R171 for 1.8 ±0.1 VDC as indicated on voltmeter.

TROUBLESHOOTING

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

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WORLD HEADQUARTERS • LYNCHBURG, VIRGINIA 24502 U.S.A.

GENERAL ELECTRIC*
U.S.A.

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. 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 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-Hi) 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 P902-6 (Mike High) through a 0.5 micrcfarad (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 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 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)

1. For transmitters without Channel Guard, set MOD ADJUST R104 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 (-) iiffers more than 0.5 kHz, recheck Step 1 as shown in the Transmitter Alignment Chart.

2. For transmitters with Channel Guard, set CHANNEL Guard MOD ADJUST R103 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 R103 for 0.75 kHz tone deviation.
3. For multi-frequency transmitters, set the deviation as described in Steps 1 or 2 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 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 (30 amperes full scale).

Example:

P_i = 13.2 Volts x 5.5 amperes = 72.5 watts

FM ICOM FREQUENCY ADJUSTMENT

NOTE

Always verify correct adjustment of FM ICOMS before setting modulation levels.

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 FM ICOMs should be reset only when the frequency shows deviation 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. The specification limit (±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 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 ±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 7.

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 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.

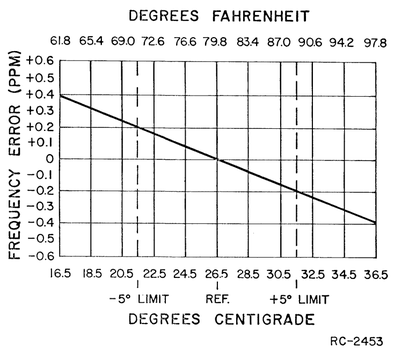
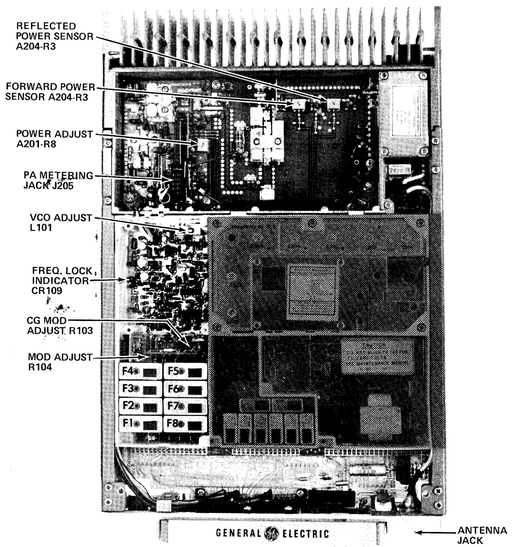


Figure 7 - Frequency Characteristics Vs. Temperature



TRANSMITTER ALIGNMENT

TEST EQUIPMENT REQUIRED

1. GE Test Set Model 4EX3A11 or Test Kit 4EX8K12.
2. A 50 ohm wattmeter connected to antenna jack J906.
3. A frequency counter.
4. AC Voltmeter (minimum input impedance is 10 megaohms).

NOTE

Set range switch on Test Set to Test 1 Position. With the Test set connected to the PA metering jack, the voltage reading at position "P" with the HIGH SENSITIVITY button pressed may be converted to driver collector current by reading the current as 10 amperes full scale. 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.

VCO AND POWER ADJUSTMENTS

NOTE

Before adjusting the VCO, be sure all FM-ICOMS are installed on the exciter in the proper location and are on frequency. (Crystal frequency = Operating frequency ÷ 12). See FM ICOM FREQUENCY ADJUSTMENT.

1. Key the transmitter on the highest frequency and record the DC voltage at TP101.
   - If the voltage at TP101 is less than +5 VDC, adjust L101 for a meter reading of +5 VDC. Go to step 2.
   - If the DC voltage at TP101 cannot be adjusted to +5 VDC, adjust L101 for maximum meter reading. Key remaining frequencies and verify that "lock" indicator comes on for each frequency and that rated power is available. For this group of frequencies this is the optimum performance setting for L101. Proceed to step 3.
2. Key the transmitter on the lowest frequency and record the DC voltage at TP101. Using the voltages recorded in steps 1 and 2, apply the following formula to calculate the optimum voltage setting for L101. Re-key the transmitter on the lowest frequency and adjust L101 to obtain the calculated voltage at TP101.

$$\text{Voltage at TP101} = 5 - \frac{HF-LF}{2}$$

where

HF = Voltage at highest frequency

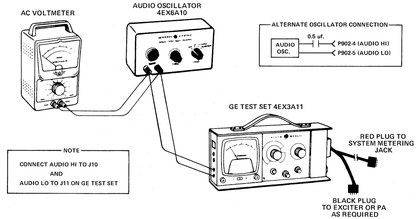
LF = Voltage at lowest frequency

3. Check the VCO voltage at TP101 for all remaining frequencies. Voltages should fall within the range obtained for the high and low frequency but never below 3.4 or above 6.4 VDC. The "lock" indicator CR109 should be on for each frequency. Verify that rated power is available.
4. Power Adjustment

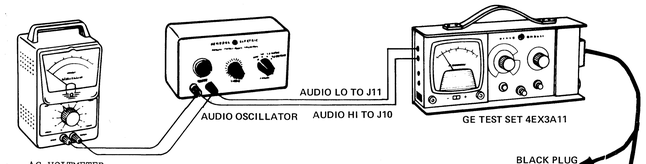
   Set Power Adjust potentiometer A201-R8 for the desired power output (from 10 to 40 Watts).

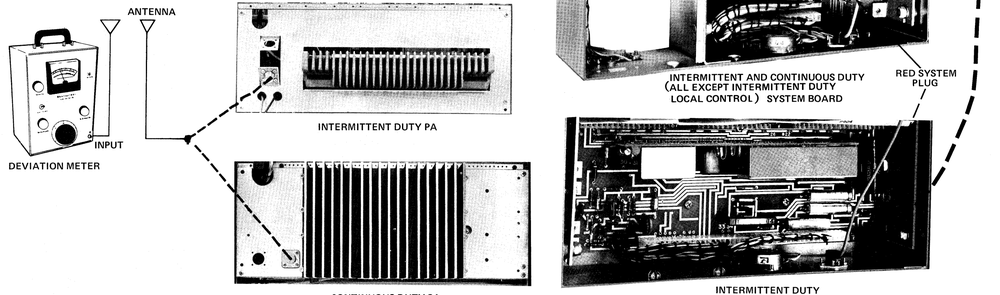
MOBILE METERING

TEST EQUIPMENT SETUP



STATION METERING





STEP 1 - QUICK CHECKS

TEST POINT	EXCITER METER READING	PROBABLE DEFECTIVE STAGE
	NOTE: When using a digital voltmeter bypass the input leads using a 150 pf capacitor (nominal). When checking DC lead at TP101, be sure to use a VTVM with 10 megohm input impedence.	
TP101	+3.4 - 6.4 VDC (Stable)	Check VCO Adjustment See Alignment Procedure
P902-12	+10 VDC (Tx Keyed)	External to exciter
Q113C	+10 VDC (Tx Keyed)	Q113, Q114, 10 V Regulator
Q113E	+ 5 VDC (Tx Keyed)	Q115, Q114, Q113
XY101-6	+6.1 VDC	R152, R153
XY101-4	+5 VDC	FM-ICOM 5C or 2C
	POWER AMPLIFIER	

METER POSITION GE TEST SET	TEST POINT	NORMAL METER READING	PROBABLE DEFECTIVE STAGE: HIGH METER READING	LOW METER READING	ZERO METER READING
"D" (AMPL-1 DRIVE)	J205-4	0.7 VDC		Low Output from Exciter	No output from Exciter, A201-CR1
"C" (AMPL-1 POWER CONTROL VOLTAGE)	J205-3	7.5 VDC (Test 1 position Read as 15 volts full scale)	Q215, U1	Q215, U1	No output from Exciter Q215, A201-CR1, A201-Q1, Q2, U1
"F" (DRIVER CURRENT)	J205-7 (+) J205-9 (-)	1.5 VDC (Note 1, 2 Read as 10 volts full scale)	A201-Q2	A201-Q1 Output from A201-Q2	A201-Q1, Q2 A204-Q1
"G" (PA CURRENT)	J205-6 (+) J205-5 (-)	5.0 VDC (Note 1, 2	A204-Q1	A201-Q1, Q2 A204-Q1	A201-Q1, Q2 A204-Q1 Q215

NOTES

1. Current = voltage reading x 30
2. High Sens button depressed

STEP 2 - EXCITER SYMPTOM CHECKS

SYMPTOM	PROCEDURE	PROBABLE DEFECTIVE STAGE
Low or no power OUTPUT Lock Indicator On Lock Indicator Out	NOTE: Check all DC voltages. With test set on position D, monitor exciter output power. Verify voltage at TP101 is within range of 3.4 - 6.4 VDC and stable (no ac component). Output power should be 250 milliwatts.	Q111, Q112, Q116, Q117, Q118, Q104
No power output on some channels	Substitute ICOMS, check for misadjustment of L101.	FM-ICOM
Output frequency unstable, lock indicator on	Check operation of lock detector circuit. Check for misadjustment of L101. Further trouble indicated. Refer to Phase Lock Loop Troublenshooting Procedure.	CR107, CR108, Q104, Q117, Q118, Q116
No Output Power, voltage at TP101 is above 7.0 VDC	Check for presence of FM ICOM and VCO INPUTS to U101. U101-4 - 100 millivolts PP minimum at U101-4 (3rd harmonic of FM ICOM). U101-8 - 800 millivolts PP minimum at 1/4 of operating frequency.	FM ICOM Q101, AR101, FL101 U102, Q109, Q110, Q107, Q108
No output power, voltage at TP101 within limit but unstable	Refer to Step 4 Phase Lock Loop Trouble Analysis for detailed procedure.	
Lock indicator does not come on	Monitor TP101 with a VTVM and tune L101 over entire frequency range. LED should be on between +3.4 VDC and 6.4 VDC.	CR102
Intermittent operation at low temperatures		CR105 and CR106 (Use exact replacements) RT102

TROUBLESHOOTING PROCEDURE

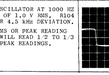
138—174 MHz, 40 WATT TRANSMITTER

STEP 3 - AUDIO AC VOLTAGES

TEST EQUIPMENT REQUIRED

- Audio Oscillator
- AC Voltmeter
- Oscillascope

1. Connect audio oscillator output through a 0.5 pf to P902-6. Connect Audio oscillator ground to P902-5.

SCOPE SETTING	HORIZONTAL VERTICAL	JUNCTION OF A101 R109 and C120 200 V SEC/DIV 2 VOLTS/DIV	XY101-3 200 V SEC/DIV 2 VOLTS/DIV
SET AUDIO OSCILLATOR AT 1000 HZ WITH OUTPUT OF 1.0 V RMS. R104 ADJUSTED FOR 4.5 kHz DEVIATION. NOTE: AN RMS OR PEAK READING VOLT METER WILL READ 1.2 TO 1.3 OF PEAK-TO-PEAK READINGS.			

STEP 4 - EXCITER TROUBLESHOOTING PROCEDURE

Equipment Required (or equivalent)

- Oscilloscope - 200 MHz resolution
- Electronic Frequency Counter (Capable of 300 MHz)
- Voltmetr (10 megaohm input impedance)
- 50 ohm wattmeter

Preliminary Procedure

1. Connect wattmeter to J101.
2. All checks assume that transmitter is keyed.
3. Verify accuracy of all DC levels before performing this procedure, DC levels provide a quick indication of defective stage.
4. Force RF Amplifiers on by temporarily soldering a DA jumper wire between Q117C and ground on the solder side of printed wire board.

STEP	TEST POINT	PROCEDURE	PROBABLE DEFECTIVE STAGE
1	U101-4	• Using oscilloscope, observe 100 millivolt PP signal, (DC level 3.2 VDC) at 3 times FM ICOM frequency. If signal is present, proceed to step 4.	
2	J103-1 (FL101)	• Remove bandpass filter FL101 and observe 1 volt PP minimum sawtooth wave form. Select all remaining operating channels. • Verify presence of +8.6 VDC at J103-1. • Replace FL101.	Defective ICOM Q113, Q114 FL101
3	AR101-1	• Verify presence of a 400 millivolt PP (nominal) sine wave (Distorted). • If signal is not present.	AR101 FL101
4	U101-8	• Observe presence of 800 millivolt PP minimum square wave (distorted). If present, proceed to step 9.	
5	R139 J101	• Observe sine wave at VCO frequency. • Observe sine wave at VCO frequency. Power meter should read 250 milliwatts minimum.	Q107, Q108 Q111, Q112
6	Q109B	Observe sine wave at VCO frequency.	Q110
7	U102-14	Observe 800 millivolt PP square wave (distorted) at 1/4 VCO frequency. When using frequency counter, connect a nominal 33 pf capacitor in series with probe.	Q109, U102
8	TP101	Using oscilloscope, monitor TP101 and tune L101 through entire range. Voltage should be stable and be variable from 2.4-6.4 VDC minimum. There should be no AC component. A varying DC voltage indicates that the PLL is hunting and won't lock.	CR102, Q102, Q103 Q107, Q108
9	TP101	Remove bandpass filter FL101. Voltage at TP101 should be 8.0 VDC. Replace bandpass filter FL101.	CR102, Q105, Q106, Q102 or Q103
10	U101-4, 8	Verify that FM ICOM frequency (X3) and divided VCO frequency (÷4) are present.	U101
11	Q103-B	Check for 8.0 VDC ±0.1 (0.2 VAC PP normal).	U101
12	Q102-C	Check for +4.0 VDC (stable with L101 adjusted for +5 VDC at TP101).	Q102
13	Q117-C	NOTE: Remove DA jumper wire soldered between Q117-C and ground. Ground TP101 and check for 0.2 VDC at Q104C, CR109 should be off.	C109, C127 CR107, CR108, Q104
14	Q117C	Check for +10 VDC. Remove ground from TP101.	Q117, Q118
15	Q116C	Check for 9.75 VDC at Q116C. Frequency Lock Indicator CR109 should be on.	Q116
16	J101	Verify a minimum of 250 milliwatts RF power is available for each operating frequency.	