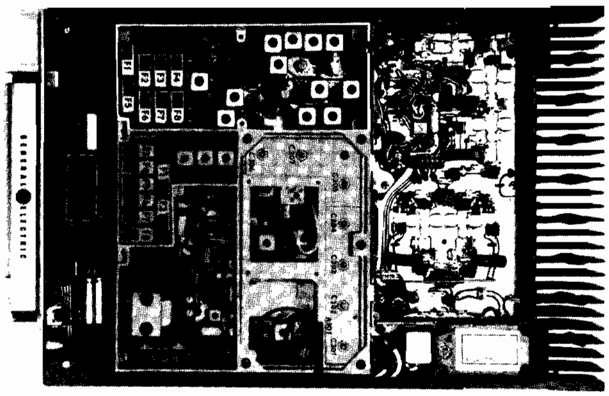
GE MOBILE RADIO

MASTR II MAINTENANCE MANUAL

138-174 MHz, 65-WATT TRANSMITTER

Maintenance Manual LBI-4560B

138-174 MHz EXCITER 19D416859G1-4
65-WATT PA ASSEMBLY 19C320414G2,5



SPECIFICATIONS *

Power Output	65 Watts (Adjustable from 20 to 65 Watts)
Crystal Multiplication Factor	12
Frequency Stability	
5C-ICOM with EC-ICOM	±0.0005% (-40°C to +70°C)
5C-ICOM or EC-ICOM	±0.0002% (0°C to +55°C)
2C-ICOMS	±0.0002% (-40°C to +70°C)
Spurious and Harmonic Emission	At least 85 dB below full rated power output.
Modulation	Adjustable from 0 to ±5 kHz swing with instantaneous modulation limiting.
Modulation Sensitivity	75 to 120 Millivolts
Audio Frequency Characteristics	Within +1 dB to -3 dB of a 6-dB/octave pre-emphasis from 300 to 3000 Hz per EIA standards. Post limiter filter per FCC and EIA.
Distortion	Less than 2% (1000 Hz) Less than 3% (300 to 3000 Hz)
Deviation Symmetry	0.5 kHz maximum

Maximum Frequency Spread: (2 to 8 channels)	Full Specifications	1 dB Degradation
138-155 MHz	1.8 MHz	2.75 MHz
150.8-174 MHz	2.0 MHz	3.0 MHz

Duty Cycle	EIA 20% Intermittent
RF Output Impedance	50 Ohms

* These specifications are intended primarily for the use of the serviceman. Refer to the appropriate Specification Sheet for the complete specifications.

GENERAL ELECTRIC

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ILLUSTRATIONS

WARNING

Although the highest DC voltage in MASTR II Mobile Equipment is supplied by the vehicle battery, high currents may be drawn under short circuit conditions. These currents can possibly heat metal objects such as tools, rings, watchbands, etc., enough to cause burns. Be careful when working near energized 12-Volt circuits! High-level RF energy in the transmitter Power Amplifier assembly can cause RF burns upon contact. Keep away from these circuits when the transmitter is energized!

ADDENDUM TO LBI 4560

This addendum provides additional information required to align MASTR II multi-frequency transmitters using a center frequency tune up ICOM. The center frequency ICOM is used when the frequency spread exceeds the limits specified in step 3 under "PRELIMINARY CHECKS AND ADJUSTMENTS".

Add steps 11 and 12 to the Transmitter Alignment procedure as shown.

ADDITIONAL STEPS FOR TRANSMITTERS USING CENTER FREQUENCY TUNE-UP ICOM				
11.	D (MULT-2)	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)	T110 & T108	Maximum	Re-adjust T110 and then T108 for maximum meter reading on the lowest frequency.

DESCRIPTION

The MASTR II variable power transmitters are crystal-controlled, phase modulated transmitters designed for one through eight-frequency operation in the 138 to 174 megahertz 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 amplifier, driver, PA, power control, filter and antenna switch.

CIRCUIT ANALYSIS

EXCITER

The exciter uses nine transistors and one integrated circuit to drive the PA assembly. The excitercan 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.

Audio, supply voltages and control functions are connected from the system board to the exciter board through P902.

Centralized metering jack J103 is provided for use with GE Test Set Model 4EX3A11 or Test Kit 4EX8K12. The test set meters the modulator, multiplier and amplifier stages, and the regulated 10-Volts.

ICOMS

Three different types of ICOMs are available for use in the exciter. Each of the ICOMs contains a crystal-controlled Colpitts oscillator, and two of the ICOMs contain compensator ICs. The different ICOMs are:

- 5C-ICOM - contains an oscillator and a 5 part-per-million (±0.0005%) compensator IC. Provides compensation for EC-ICOMs.
- EC-ICOM - contains an oscillator only. Requires external compensation from a 5C-ICOM.
- 2C-ICOM - contains an oscillator and a 2 PPM (±0.0002%) compensator IC. Will not provide compensation for an EC-ICOM.

The ICOMs are enclosed in an RF shielded can with the type ICOM (5C-ICOM, EC-ICOM or 2C-ICOM) printed on the top of the can. Access to the oscillator trimmer is obtained by prying up the plastic tab on the top of the can. The tabs can also be used to pull the ICOMs out of the radio.

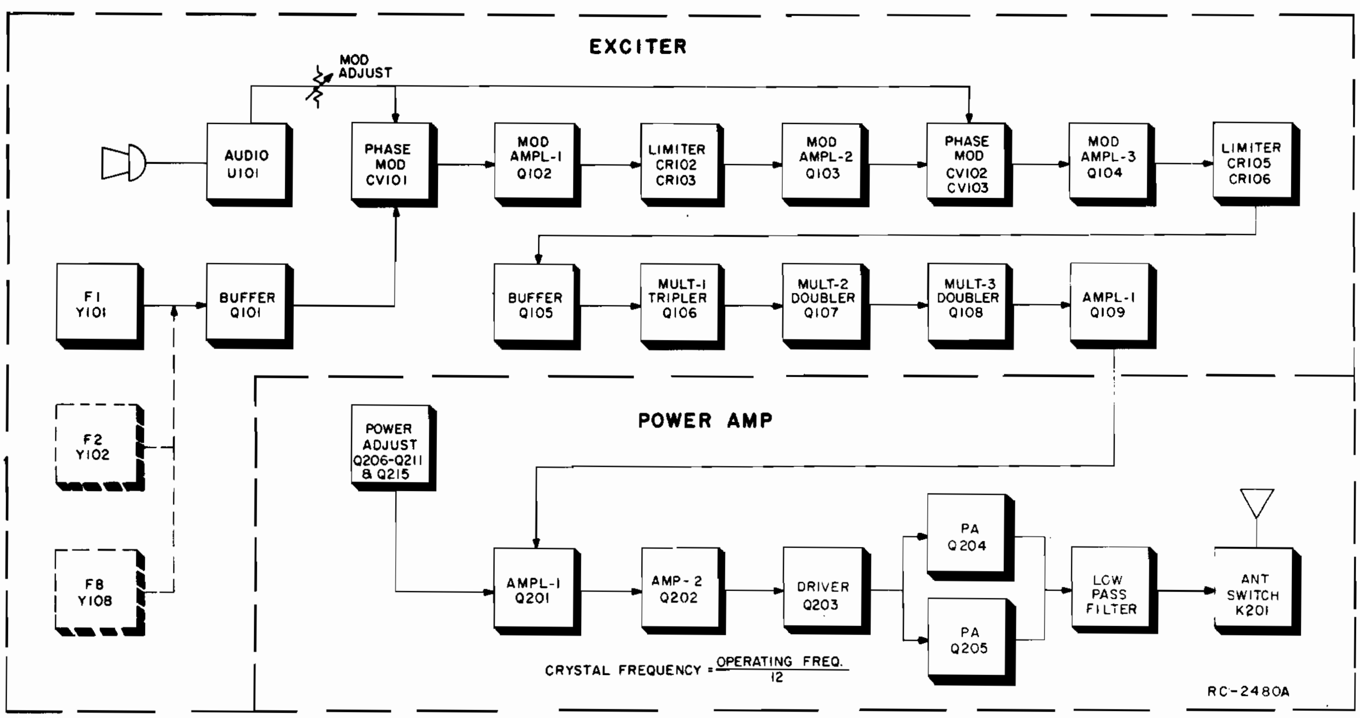


Figure 1 - Transmitter Block Diagram

Frequency selection is accomplished by switching the ICOM keying lead (terminal 6) to A- by means of the frequency selector switch on the control unit. In single-frequency radios, a jumper from H9 to H10 in the control unit connects terminal 6 of the ICOM to A-. The oscillator is turned on by applying a keyed +10 Volts to the external oscillator load resistor.

CAUTION

> All ICOMs are individually compensated at the factory and cannot be repaired in the field. Any attempt to repair or change an ICOM frequency will void the warranty.

In Standard 5 PPM radios using EC-ICOMs, at least one 5C-ICOM must be used. The 5C-ICOM is normally used in the receiver F1 position, but can be used in any transmit or receive position. One 5C-ICOM can provide compensation for up to 15 EC-ICOMs in the transmit and receiver. Should the 5C-ICOM compensator fail in the open mode, the EC-ICOMs will still maintain 2 PPM frequency stability from 0°C to 55°C (+32°F to 131°F) due to the regulated compensation voltage (5 Volts) from the 10-Volt regulator IC. If desired, up to 16 5C-ICOMs may be used in the radio.

The 2C-ICOMs are self-compensated at 2 PPM and will not provide compensation for EC-ICOMs.

Oscillator Circuit

The quartz crystals used in ICOMs exhibit the traditional "S" curve characteristics of output frequency versus operating temperature.

At both the coldest and hottest temperatures, the frequency increases with increasing temperature. In the middle temperature range (approximately 0°C to 55°C), frequency decreases with increasing temperature.

Since the rate of change is nearly linear over the mid-temperature range, the output frequency change can be compensated by choosing a parallel compensation capacitor with a temperature coefficient approximately equal and opposite that of the crystal.

Figure 2 shows the typical performance of an uncompensated crystal as well as the typical performance of a crystal which has been matched with a properly chosen compensation capacitor.

At temperatures above and below the mid-range, additional compensation must be introduced. An externally generated compensation voltage is applied to a varactor (voltage-variable capacitor) which is in parallel with the crystal.

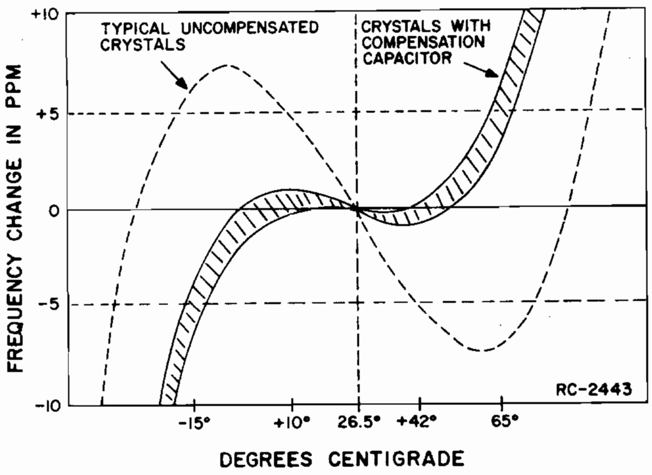


Figure 2 - Typical Crystal Characteristics

A constant bias of 5 Volts (provided from Regulator IC U901 in parallel with the compensator) establishes the varactor capacity at a constant value over the entire mid-temperature range. With no additional compensation, all of the oscillators will provide 2 PPM frequency stability from 0°C to 55°C (+32°F to 131°F).

Compensator Circuits

Both the 5C-ICOMs and 2C-ICOMs are temperature compensated at both ends of the temperature range to provide instant frequency compensation. An equivalent ICOM circuit is shown in Figure 3.

The cold end compensation circuit does not operate at temperatures above 0°C. When the temperature drops below 0°C, the circuit is activated. As the temperature decreases, the equivalent resistance decreases and the compensation voltage increases.

The increase in compensation voltage decreases the capacity of the varactor in the oscillator, increasing the output frequency of the ICOM.

The hot end compensation circuit does not operate at temperatures below +55°C. When the temperature rises above +55°C, the circuit is activated. As the temperature increases, the equivalent resistance decreases and the compensation voltage decreases. The decrease in compensation voltage increases the capacity of the varactor, decreasing the output frequency of the ICOM.

SERVICE NOTE: Proper ICOM operation is dependent on the closely-controlled input voltages from the 10-Volt regulator. Should all of the ICOMs shift off frequency, check the 10-Volt regulator module.

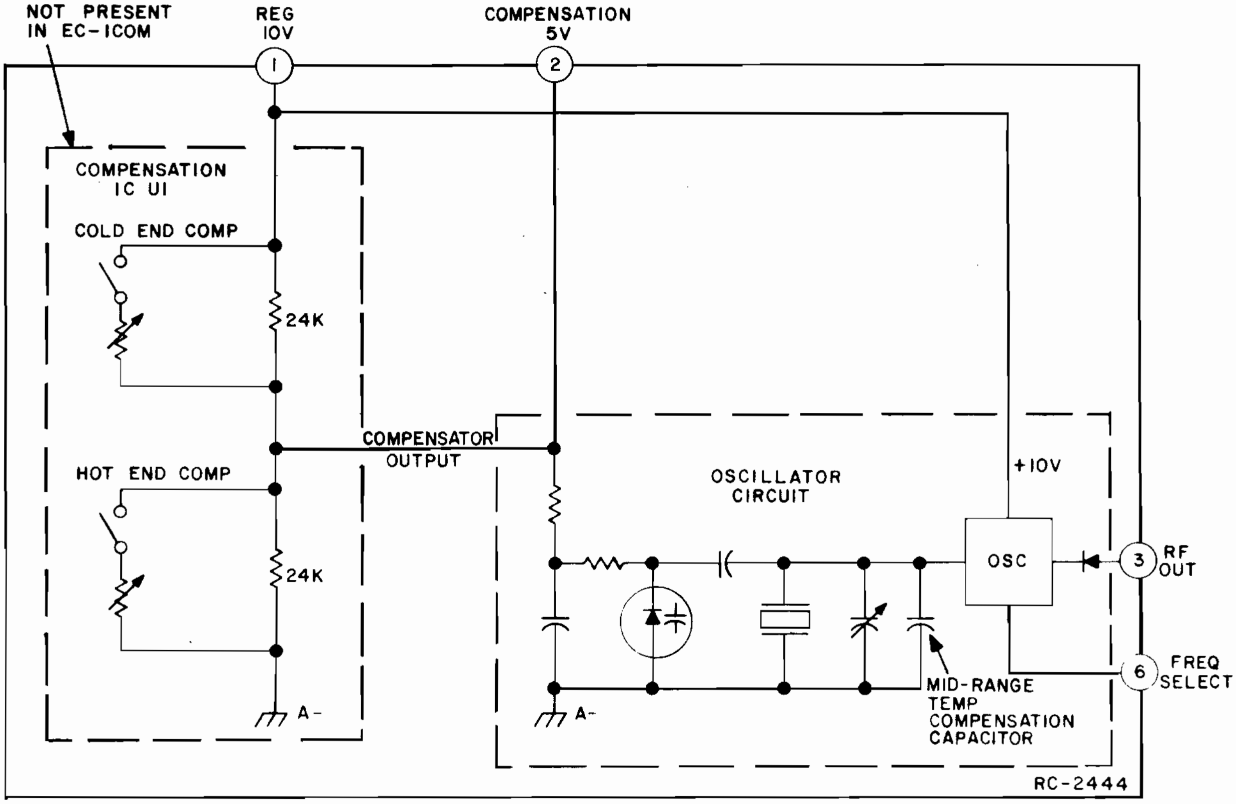


Figure 3 - Equivalent ICOM Circuit

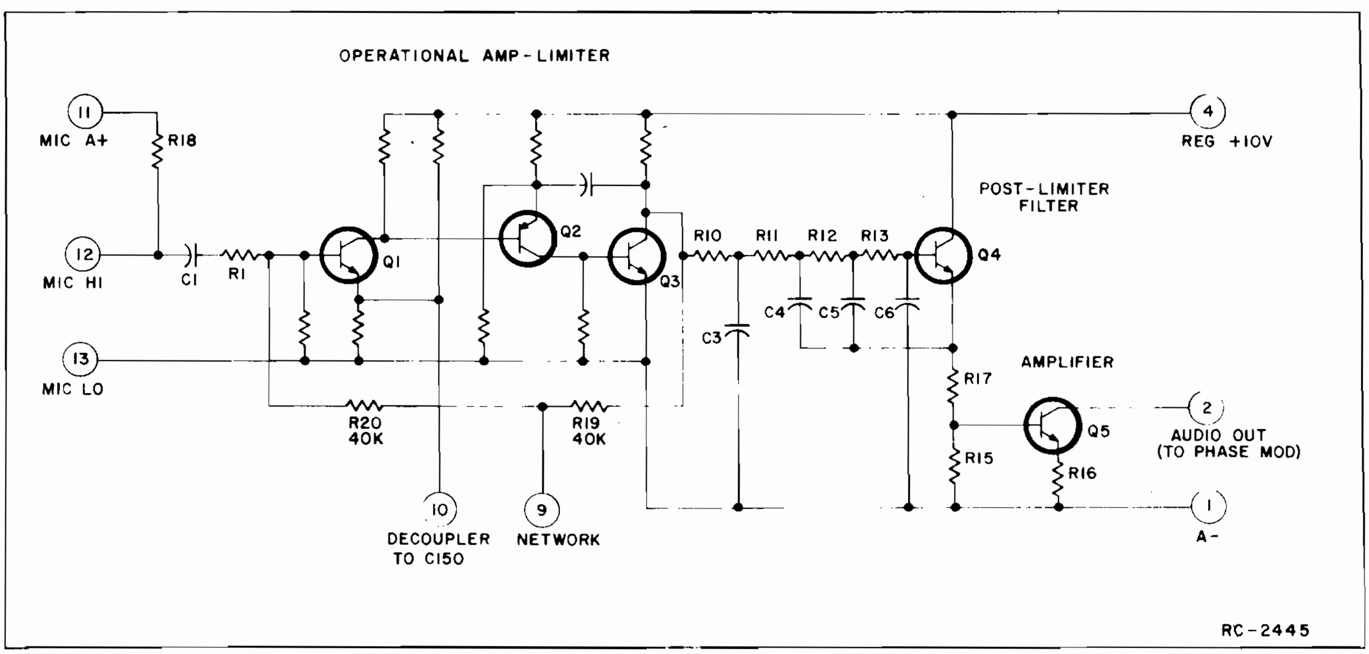


Figure 4 - Simplified Audio IC

AUDIO IC

The transmitter audio circuitry is contained in audio IC U101. A simplified drawing of the audio IC is shown in Figure 4.

Audio from the microphone at pin 12 is coupled through pre-emphasis capacitor C1 to the base of Q1 in the operational amplifier-limiter circuit. Collector voltage for the transistorized microphone preamplifier is supplied from pin 11 through microphone collector load resistor R18 to pin 12.

The operational amplifier-limiter circuit consists of Q1, Q2 and Q3. Q3 provides limiting at high signal levels. The gain of the operational amplifier circuit is fixed by negative feedback through R19, R20 and the resistance in the network (Pin 9).

The output of Q3 is coupled through a de-emphasis network (R10 and C3) to an active post-limiter filter consisting of C4, C5, C6, R11, R12, R13, R15, R17 and Q4.

Following the post-limiter filter is class A amplifier Q5. The output of Q5 is coupled through MOD ADJUST potentiometer R104 and resistors R108 and R125 to the phase modulators.

SERVICE NOTE: If the DC voltages to the Audio IC are correct and no audio output can be obtained, replace U101.

For radios equipped with Channel Guard, tone from the encoder is applied to the phase modulators through CHANNEL GUARD MOD ADJUST potentiometer R105, and resistors R112, R123 and R127. Instructions for setting R105 are contained in the modulation adjustment section of the Transmitter Alignment Procedure.

BUFFER, PHASE MODULATORS & AMPLIFIERS

The output at pin 3 of the selected ICOM is coupled through buffer-amplifier Q101 to the first modulator stage. The first phase modulator is varactor (voltage-variable capacitor) CV101 in series with tunable coil T101. This network appears as a series-resonant circuit to the RF output of the oscillator. An audio signal applied to the modulator circuit through blocking capacitor C107 varies the bias of CV101, resulting in a phase modulated output. A voltage divider network (R110 and R111) provides the proper bias for varactors CV101, CV102 and CV103.

The output of the first modulator is coupled through blocking capacitor C113 to the base of Class A amplifier Q102. The first modulator stage is metered through a metering network consisting of C115, R118 and CR101. Diodes CR102 and CR103 remove any amplitude modulation in the modulator output.

Following Q102 is another Class A amplifier, Q103. The output of Q103 is applied to the second modulator stage. The second modulator consists of two cascaded modulator circuits consisting of CV102, T102, T103 and CV103. Following the second modulator is a Class A amplifier, Q104. The output of the second modulator stage is metered through C123, R132 and CR104 and is applied to the base of buffer Q105. Diodes CR105 and CR106 remove any amplitude modulation in the second modulator output.

BUFFER, MULTIPLIERS & AMPLIFIER

Buffer Q105 is saturated when no RF signal is present. Applying an RF signal to Q105 provides a sawtooth waveform at its collector to drive the class C tripler, Q106. The tripler stage is metered through R138. The output of Q106 is coupled through tuned circuits T104 and T105 to the base of doubler Q107. T104 and T105 are tuned to one-fourth of the operating frequency. The doubler stage is metered through R141.

The output of Q107 is coupled through tuned circuits T106 and T107 to the base of second doubler Q108. T106 and T107 are tuned to one-half the operating frequency. Q108 is metered through R146.

The output of Q108 is coupled through three tuned circuits (T108, T109 and T110) to the base of amplifier Q109. The circuits are tuned to the transmitter operating frequency.

Q109 is a class C amplifier, and is metered through R148. The amplifier collector circuit consists of T111, C154, C155, T112 and C157, and matches the amplifier output to the input of the power amplifier assembly.

POWER AMPLIFIER

The PA assembly uses five RF power transistors and seven transistors in the Power Control circuitry to provide a power output of 65 Watts. The broadband PA has no adjustments other than Power Control potentiometer R222.

Supply voltage for the PA is connected through power leads from the system board to feedthrough capacitors C297 and C298 on the bottom of the PA assembly. C297, C298, C299, L295 and L296 prevent RF from getting on the Power leads. Diode CR295 will cause the main fuse in the fuse assembly to blow if the polarity of the power leads is reversed, providing reverse voltage protection for the radio.

Centralized metering jack J205 is provided for use with GE Test Set Model 4EX3A11 or Test Kit 4EX8K12. The Test Set meters the Ampl-1 drive (exciter output), Ampl-1 power control, Driver and PA current.

RF AMPLIFIERS

The exciter output is coupled through an RF cable to PA input jack J201. The RF is coupled through a matching network to the base of Class C amplifier Q201. The network matches the 50-ohm input to the base of Q201, and consists of T201, C204, C205 and L202. R201, L201 and C206 comprise a stabilizing network in the base circuit of Q201.

Part of the RF input is rectified by CR201 and used to activate the Power Control circuit. Another portion of the rectified RF is applied to voltage dividers R203 and R231 for metering the Ampl-1 drive at J205.

Collector voltage to Q201 (Ampl-1) is controlled by the Power Control circuit, and is applied through a collector stabilizing network (L203, R204 and C209) and collector feed network T202 and C286. The collector voltage of Q201 is metered through R212 at J205.

The output of Q201 is coupled to the base of the second class C amplifier (Q202) through a matching network consisting of T203, C214 and C215. Collector voltage to Q202 is applied through collector stabilizing network Z201 and collector feed network L204 and C218.

The output of Q202 is applied to the base of Class C driver Q203 through a low-pass filter matching network (L216, C219, C221 and C222). Collector voltage to Q203 is coupled through collector stabilizing network Z202 and collector feed network L205 and C226.

Collector current for Q203 is metered across tapped manganin resistor R213 at J205 (Driver Current). The reading is taken on the one-Volt scale with the High Sensitivity button pressed, and read as 10 amperes full scale.

Following Q203 is a matching network (L217, C228, T204 and C229) that matches the output of Q203 to the 50-ohm microstrip impedance (W206) to the input of power divider Z205.

The power amplifier stages consist of two identical paralleled Class C PA circuits (Q204 and Q205). One output of Z205 is applied to the base of Q204 through an impedance matching network (T206, C233 and C237). C234, L207 and R208 are a stabilizing network in the base of Q204.

Supply voltage for Q204 is coupled through collector stabilizing network Z203, and collector feed network L208 and C252.

Collector current for Q204 and Q205 is metered across paralleled tapped manganin resistors R210 and R211. The reading is taken on the one-volt scale with the High Sensitivity button pressed, and read as 30 amperes full scale.

The output of Q204 is coupled through a matching network (L218, C242 and T208), and added to the output of Q205 in power combiner Z206. Following Z206 is impedance matching transformer T210 that matches the combiner output to the 50-ohm microstrip (W207). Capacitors C270 through C287 provides ground isolation for ± ground operation. The PA output is coupled through a low-pass filter to the antenna through antenna switch K201.

WARNING

The stud mount 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.

POWER CONTROL CIRCUIT

When the transmitter is keyed, rectified RF from CR201 is applied to the base of switch Q206, turning it on. Turning on Q206 turns on voltage regulator Q207, supplying a constant voltage to Power Adjust potentiometer R222.

Q210, Q211 and Q215 operate as an amplifier chain to supply voltage to the collector of Q201 (Ampl-1). The setting of R222 determines the voltage applied to the base of Q210. The higher the voltage at the base of Q210, the harder the amplifiers conduct, supplying more collector voltage to Q201. The lower the voltage at the base of Q210, the less collector voltage is supplied to Q201. Reducing the supply voltage to Q201 reduces the drive to Q202 and Q203, thereby reducing the power output of the PA. The power output can be adjusted by R222 from approximately 20 to 65 Watts.

Temperature protection is provided by Q208, Q209, and thermistor RT201 which is mounted in the PA heatsink. Under normal operating conditions, the circuit is inactive (Q208 is on and Q209 is off). When the heatsink temperature reaches approximately 100°C, the resistance of RT201 decreases. This increases the base voltage applied to Q208, turning it off. Turning off Q208 allows Q209 to turn on, decreasing the voltage at Power Adjust potentiometer R222. This reduces the base voltage to Q210 which causes Q211 and Q215 to conduct less, reducing the collector voltage to Q201 (Ampl-1). This reduces the transmitter output power, keeping the heatsink at a maximum of approximately 100°C. When the heatsink temperature decreases below 100°C, the temperature control circuit turns off, allowing the normal transmitter power output.

CARRIER CONTROL TIMER

The Carrier Control Timer option shuts off the transmitter on each transmission after a one-minute timing cycle, and alerts the operator that the transmitter is off by means of an alarm tone in the speaker. The transmitter can be turned on again by releasing and rekeying the push-to-talk switch on the microphone.

The timing cycle (transmitter keyed time) is normally set at the factory for a duration of one minute. A potentiometer permits the timing cycle to be adjusted from approximately 15 seconds to 3 minutes.

MAINTENANCE

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:

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 5).

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.

To remove the exciter board from the radio:

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 (see Figure 6).

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.

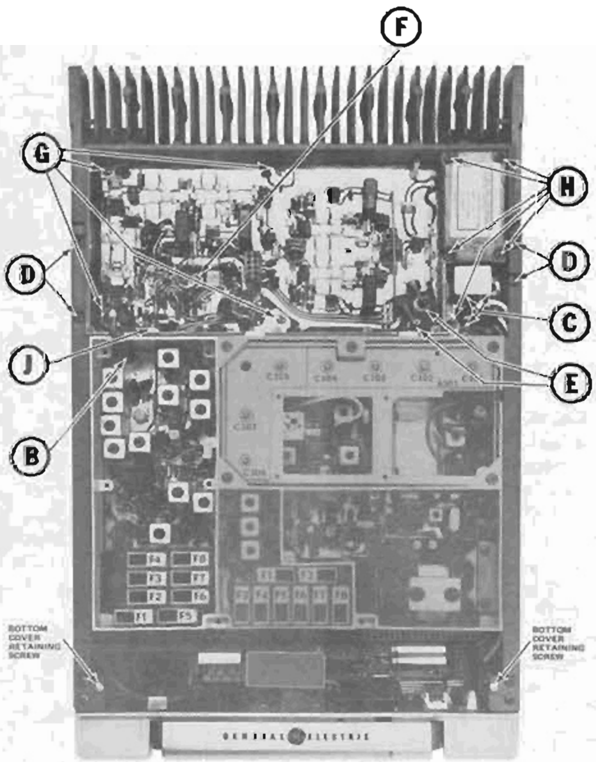


Figure 5 - Disassembly Procedure Top View

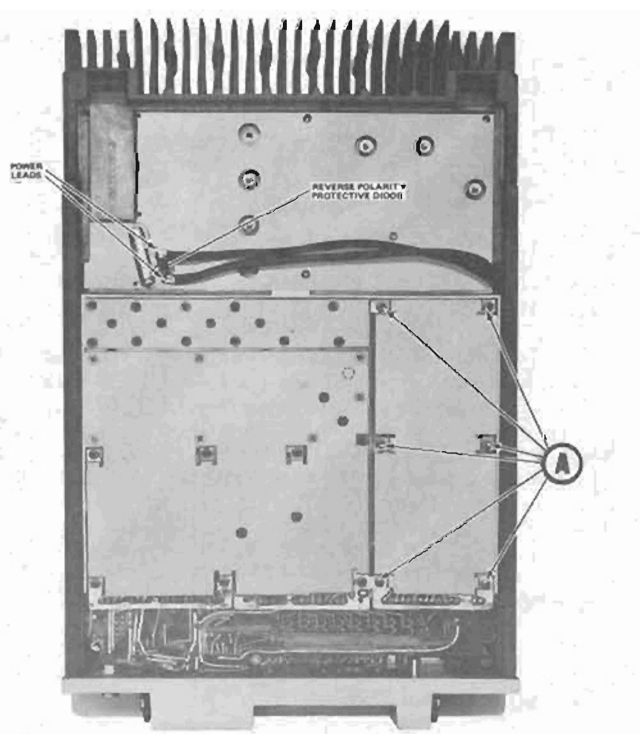


Figure 6 - Disassembly Procedure Bottom View

To remove the PA assembly:

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.

To remove the PA board:

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

2. Unsolder the two feedthrough coils (E) and the thermistor leads (F).

3. Remove the PA transistor hold-down nuts and spring washers on the bottom of the PA assembly.

4. Remove the four PA board mounting screws (G), the five screws in the filter casting (H), and the retaining screw in Q215 (J), and lift the board out.

PA TRANSISTOR REPLACEMENT

WARNING

The stud mounted 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 transistors:

1. Unsolder one lead at a time with a 50-Watt soldering iron. Use a scribe to hold the lead away from the printed circuit board until the solder cools.

2. Turn the transmitter over.

3. Hold the body of the transistor to prevent it from turning. Remove the transistor hold-down nut and spring washer through the hole in the heat-sink with an 11/32-inch nut-driver for Q201, Q202 and Q203. 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 (if required) to the lead length of the removed transistor. Cut the collector lead at a 45° angle for future identification (see Figure 7). The letter "C" on the top of the transistor also indicates the collector.

5. Applying a coating of silicon grease around the transistor mounting surface, and 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 holding-down nut and spring-washer, using moderate torque (8 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.

6. Make sure that the transistor leads are formed as shown in Figure 8 so that the leads can be soldered to the printed circuit pattern, starting from the inner edge of the mounting hole.

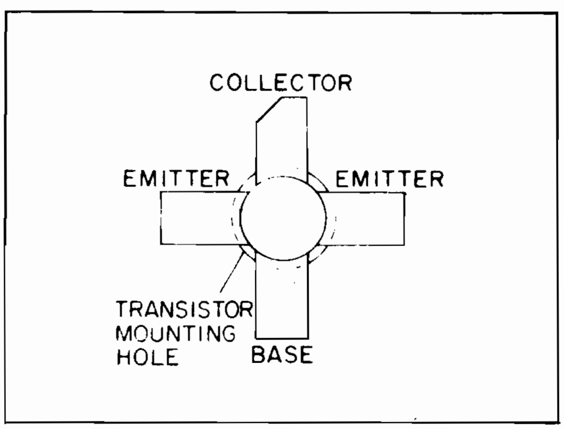


Figure 7 - Lead Identification

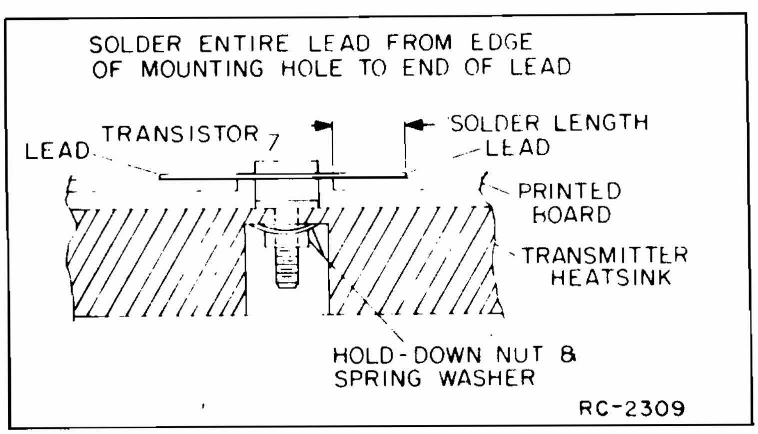


Figure 8 - Lead Forming

7. 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.

MODULATION LEVEL ADJUSTMENT

The MOD ADJUST (R104) was adjusted to the proper setting before shipment and should not normally require readjustment. This setting permits approximately 75% modulation for the average voice level. The audio peaks which would cause overmodulation are clipped by the modulation limiter. The limiter, in conjunction with the de-emphasis network, instantaneously limits the slope of the audio wave to the modulator, thereby preventing overmodulation while preserving intelligibility.

TEST EQUIPMENT

1. An audio oscillator (GE Model 4EX6A10)
2. A frequency modulation monitor
3. An output meter or a VTVM
4. GE Test Set Models 4EX3A11 or 4EX8K12

PROCEDURE

1. Connect the audio oscillator and the meter across audio input terminals J10 (Green-Hi) and J11 (Black-Lo) on GE Test Set, or 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.
3. For transmitters without Channel Guard, set MOD ADJUST R104 for a 4.5-kilohertz swing with the deviation polarity which gives the highest reading as indicated on the frequency modulation monitor.
4. 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 R104 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.
5. 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 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 (30 amperes full scale).

Example:

$$P_i = 12.6 \text{ Volts} \times 5.0 \text{ amperes} = 63 \text{ Watts}$$

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. ±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 an adjustment is required, pry up the cover on the top of the ICOM to expose the trimmer, and 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 ±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 9.

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 9.

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.

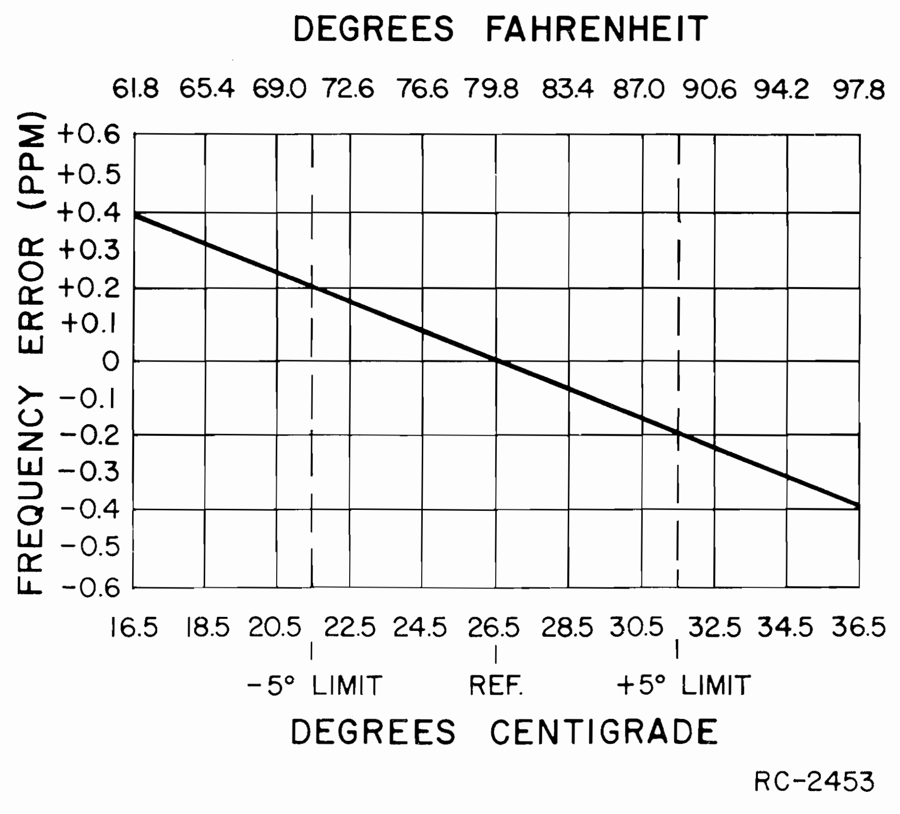
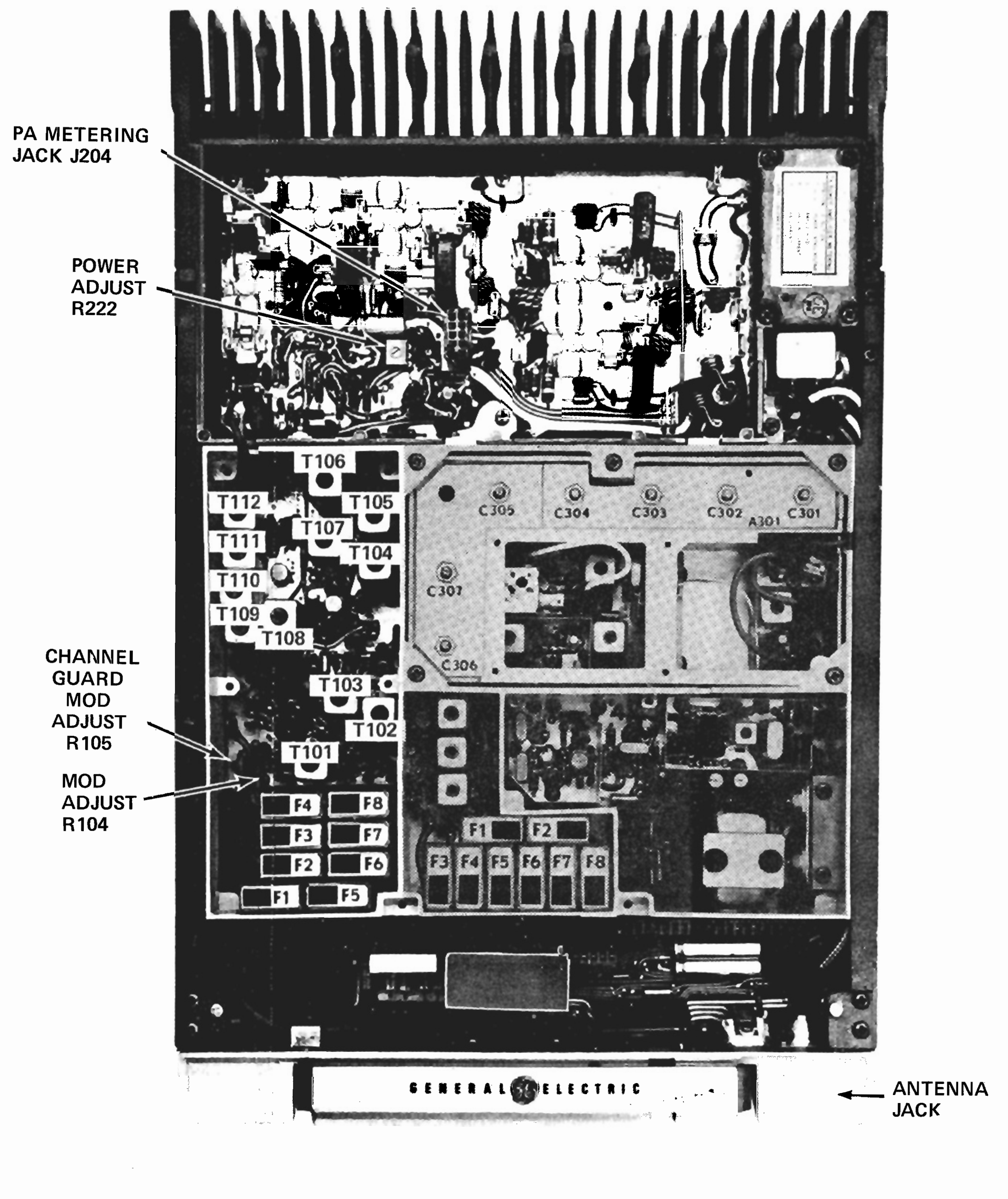


Figure 9 - Frequency Characteristics Vs. Temperature



TRANSMITTER ALIGNMENT

EQUIPMENT REQUIRED

1. GE Test Set Model 4EX3A11 or Test Kit 4EX8K12.
2. A 50-ohm wattmeter connected to antenna jack J203.
3. A frequency counter.

PRELIMINARY CHECKS AND ADJUSTMENTS

1. Place ICOMs on Exciter Board (crystal frequency = operating frequency ÷ 12).
2. For a large change in frequency or a badly mis-aligned transmitter, pre-set the slugs in T104 and T105 to the bottom of the coil form. Pre-set all of the other slugs to the top of the 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 on 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, the voltage reading at position "F" with the HIGH SENSITIVITY button pressed may be converted to driver collector current by reading the curent 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 30 amperes full scale.
5. 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
1.	A (MOD-1)	T101	Maximum	Tune T101 for maximum meter reading on the lowest frequency.
2.	B (MOD-2)	T102 & T103	Maximum	Tune T102 and then T103 for the maximum meter reading on the lowest frequency.
3.	C (MULT-1)	T104	Minimum	Tune T104 for a dip in meter reading.
4.	D (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)	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)	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)	T111 & T112	Maximum	Move the black metering plug to the Power Amplifier metering jack and tune T111 and then T112 for maximum meter reading.
8.	G (AMPL-1)	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)	T111 & T112	Maximum	Move the black metering plug back to the Power Amplifier metering jack and re-adjust T111 and T112 for maximum meter reading.
10.		R219		With the battery voltage at 13.6 Volts or the PA collector voltage at 13.0 Volts, set Power Adjust potentiometer R219 on the PA board for the desired power output (from 10 to 35 Watts). If the battery voltage is not at 13.6 Volts or the collector voltage at 13.0 Volts and full rated output is desired (35 Watts at 13.6 Volts), set R219 for the output power according to the battery voltage or collector voltage shown in Figure 10. NOTE: The PA collector voltage is measured as described in the PA POWER INPUT section.

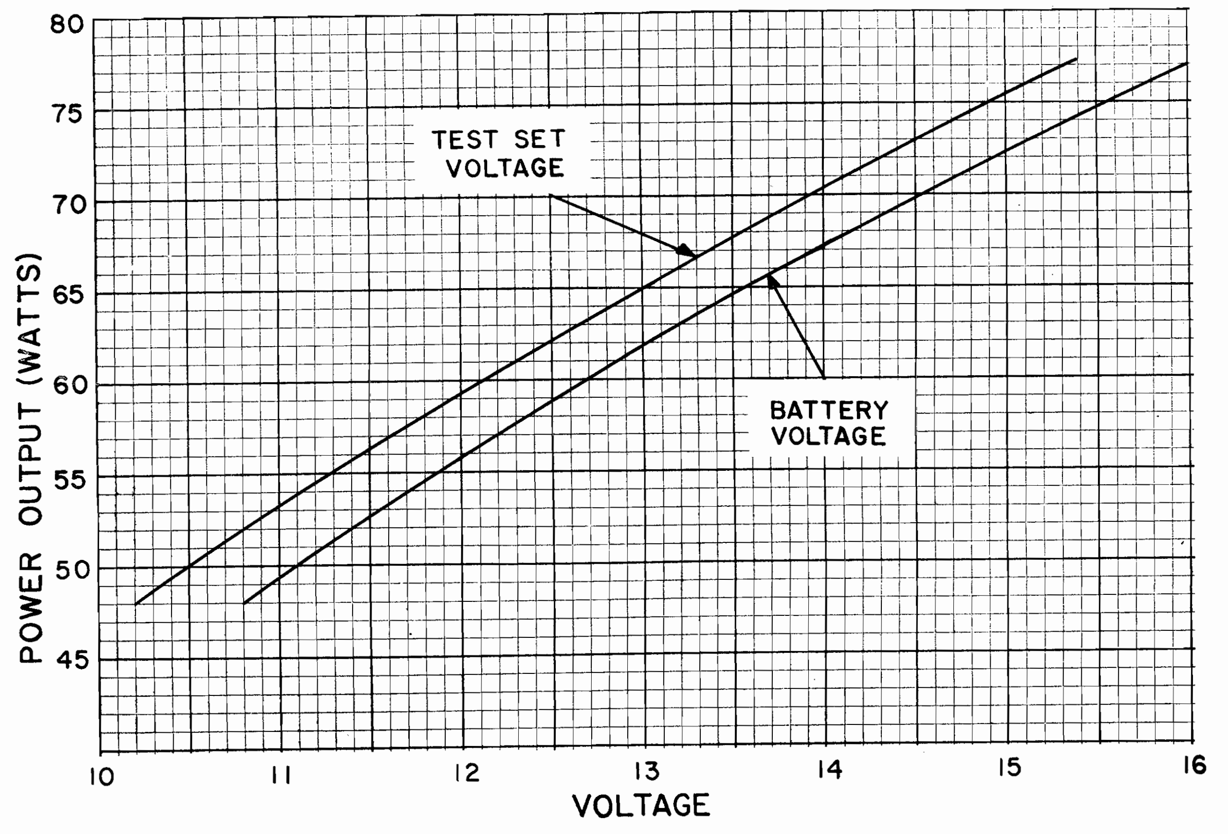


Figure 10 - Power Output Setting Chart

TEST PROCEDURES

These Test Procedures are designed to assist you in servicing a transmitter that is operating--but not properly. Problems encountered could be low power output, tone and voice deviation, defective audio sensitivity, and modulator adjust control set too high. Once a defect is pin-pointed, refer to the "Service Check" and the additional corrective measures included in the Transmitter Troubleshooting Procedure. Before starting with the Transmitter Test Procedures, be sure the transmitter is tuned and aligned to the proper operating frequency.

CAUTION

Before bench testing the MASTR II Mobile 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): 14.5 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 limit 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 18 Volts.

Routine transmitter tests should be performed at EIA Standard Test Voltages (13.6 VDC for loads of 6 to 16 amperes; 13.4 VDC for loads of 16 to 36 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 REQUIRED

for test hookup as shown:

1. Wattmeter similar to:
   Bird # 43
   Jones # 711N
2. VTVM similar to:
   Triplett # 850
   Heath # IM-21
3. Audio Generator similar to:
   GE Model 4EX6A10
4. Deviation Meter (with a .75 kHz scale) similar to:
   Measurements # 720
5. Multimeter similar to:
   GE TEST SET MODEL 4EX3A11,
   MODEL 4EX8K12 or
   20,000 ohms-per-Volt voltmeter

POWER MEASUREMENT

TEST PROCEDURE

1. Connect transmitter output from the antenna jack to the wattmeter through a 50-ohm coaxial cable. Make sure the wattmeter is terminated into a 50-ohm load.
2. Key the transmitter and check the wattmeter for the desired power output.

SERVICE CHECK

Check the setting of the Power Adjust Control (R222).

Refer to the QUICK CHECKS on the Transmitter Troubleshooting Procedure.

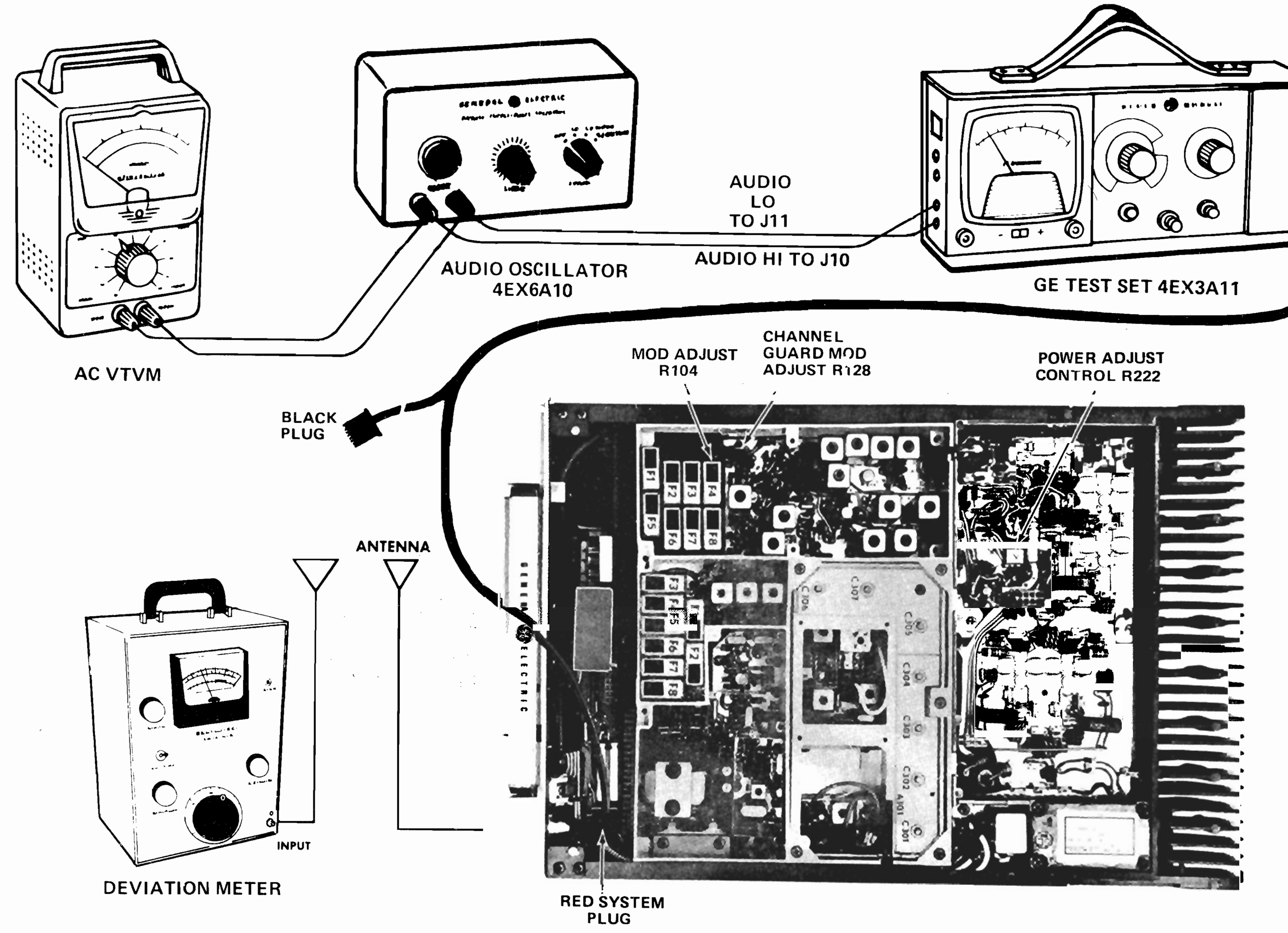
VOICE DEVIATION, SYMMETRY AND AUDIO SENSITIVITY

TEST PROCEDURE

1. Connect the test equipment to the transmitter as shown.
2. In radios with Channel Guard, set Channel Guard Mod Adjust R105 for zero tone deviation.
3. Set the Audio generator output to 1.0 VOLTS RMS and frequency to 1 kHz.
4. Key the transmitter and adjust Deviation Meter to carrier frequency.
5. Deviation reading should be ±4.5 kHz in radios without Channel Guard, and ±3.75 kHz in radios with Channel Guard.
6. If necessary, adjust MOD ADJUST control R104 for the proper deviation on plus (+) or minus (-) deviation, whichever is greater.

NOTES:-- MASTR II transmitters are adjusted for 4.5 kHz deviation at the factory. The factory adjustment will prevent the transmitter from deviating more than 5.0 kHz under the worst conditions of frequency, voltage and temperature.

7. If the deviation reading plus (+) or minus (-) differs by more than 0.5 kHz, recheck Steps 1 and 2 as shown in the Transmitter Alignment Chart.
8. 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. If not, refer to the Transmitter Troubleshooting Procedure.



TONE DEVIATION WITH CHANNEL GUARD

TEST PROCEDURE

1. Set up the Deviation Meter and monitor the output of the transmitter.
2. Remove the 1000 Hz signal from the audio generator.
3. Key the transmitter and check for 0.75 kHz deviation. If the reading is low or high, adjust Channel Guard MOD ADJUST R105 for a reading of 0.75 kHz.

NOTES:

1. On units supplied with Channel Guard, the Phase Modulator Tuning should be adjusted carefully to insure proper performance. (Refer to Steps 1 and 2 in the Transmitter Alignment Chart).
2. The Tone Deviation Test Procedures should be repeated every time the Tone Frequency is changed.

STEP I - QUICK CHECKS

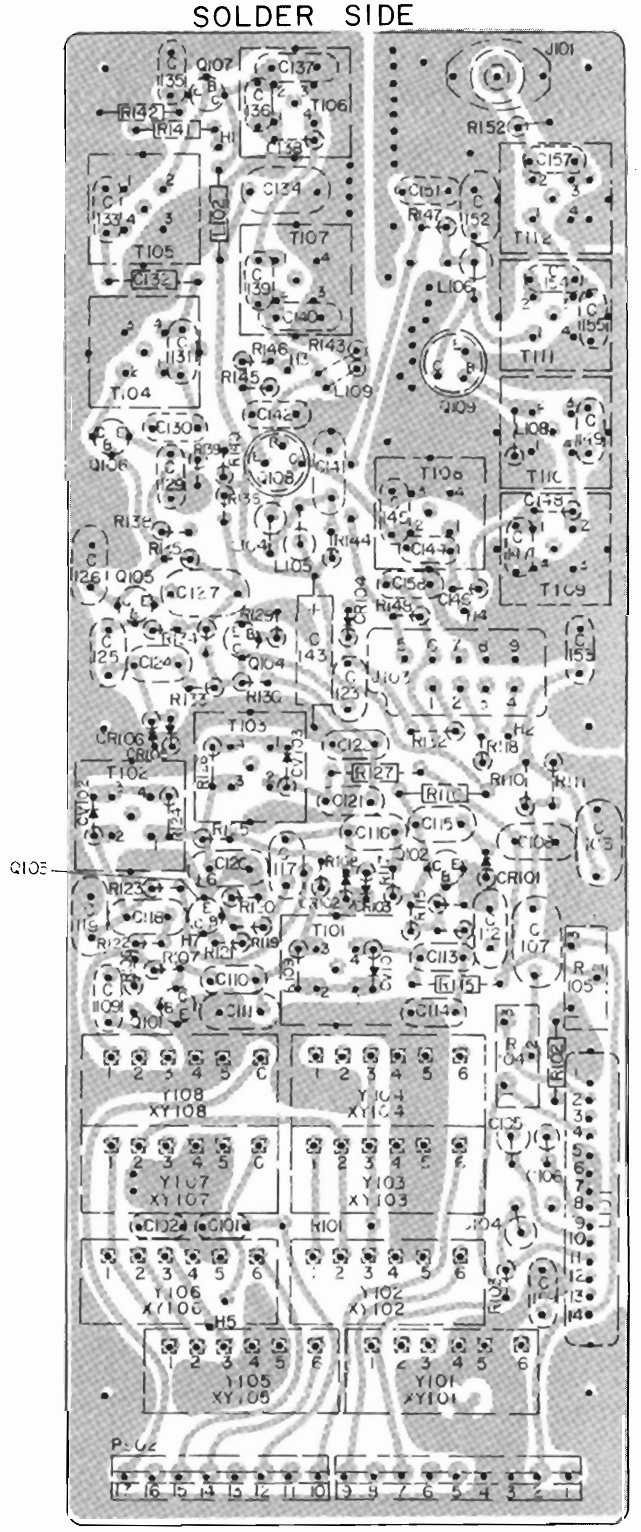
METER POSITION GE TEST SET	PROBABLE DEFECTIVE STAGE HIGH METER READING	LOW METER READING	ZERO METER READING
	EXCITER		
A (MOD-1	Q102, 10-Volt Regulator	Q102, CV101, T101, 10-Volt regulator	ICOM, Q101, Q102, CR101, 10-Volt regulator or Channel Selector switch ground.
B (MOD-2)	Q104, 10-Volt regulator	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, CR201
"C" (AMPL-1 POWER CONTROL VOLT-AGE)	Q215	Q215	No Exciter output, Q215, Q206, CR201
"F" (DRIVER CURRENT)	Q203	Q203, Low Output from Q201, Q202	Q203, Q202, Q201. Check Pos. D & C
"G" (PA CURRENT)	Q204, Q205	Q201, Q202, Q203, Q204, Q205	Q205, Q204, Q203, Q202, Q201, Q215

TROUBLESHOOTING PROCEDURE

138—174 MHz, 65-WATT TRANSMITTER

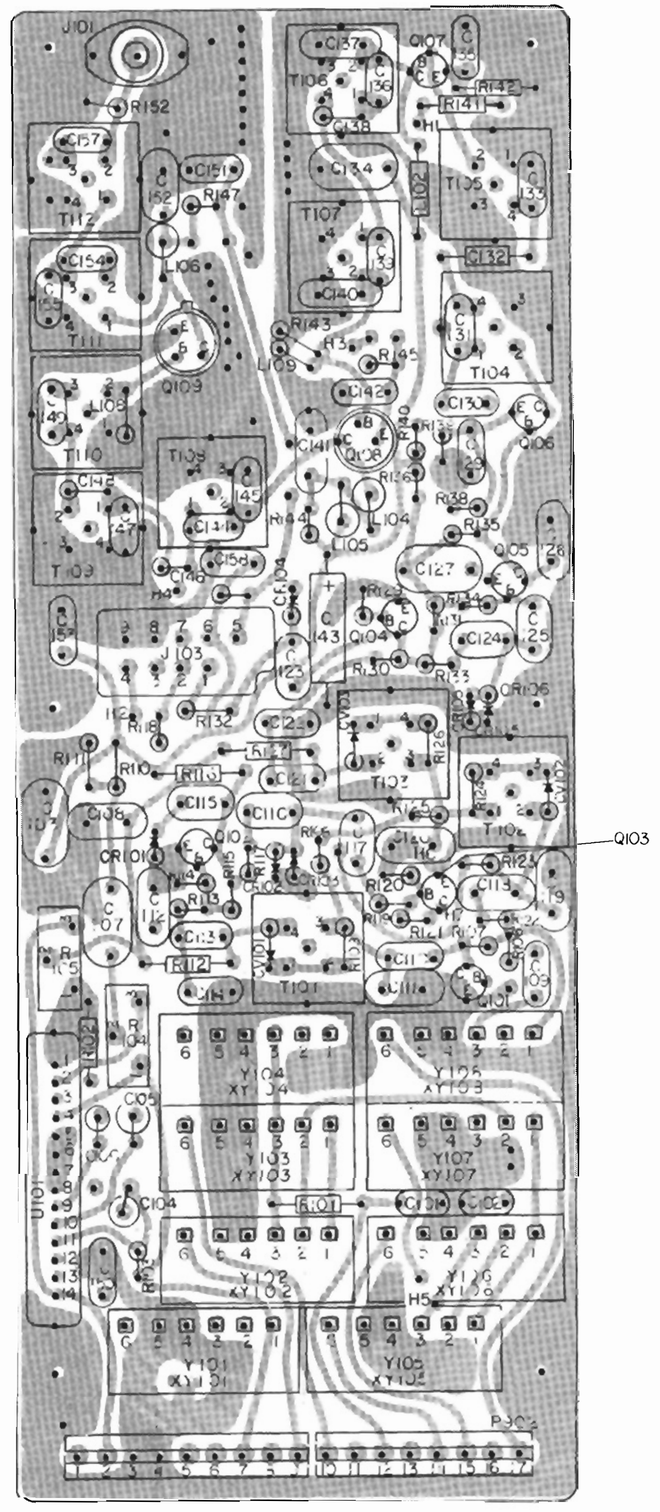
EXCITER BOARD

SOLDER SIDE



(19D416850, Sh. 2, Rev. 3)

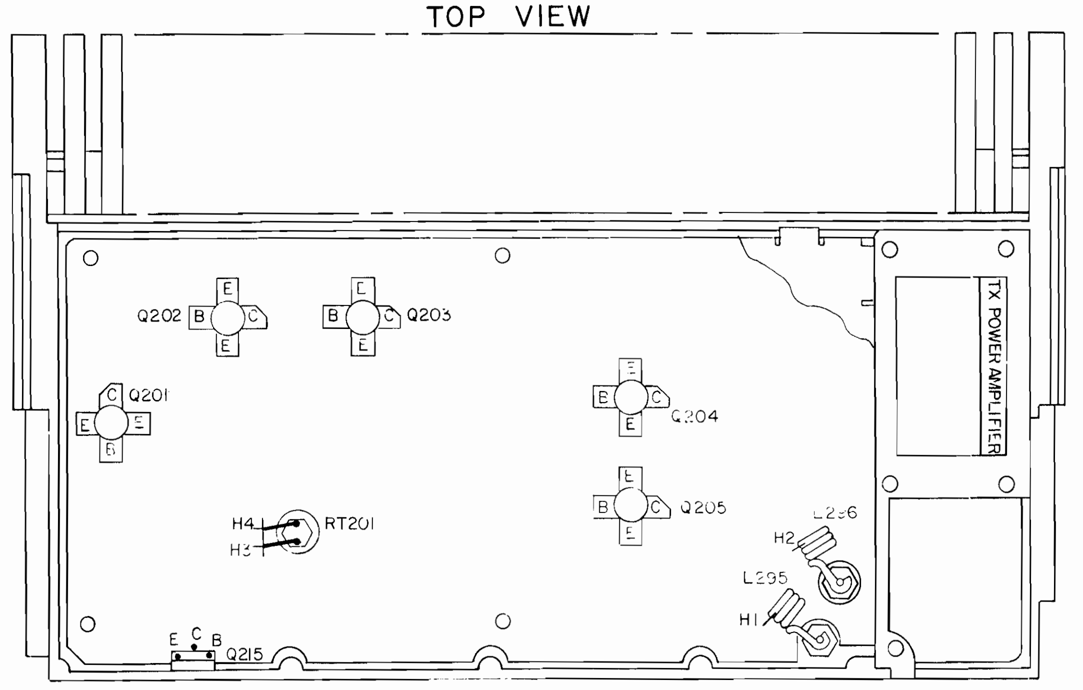
COMPONENT SIDE



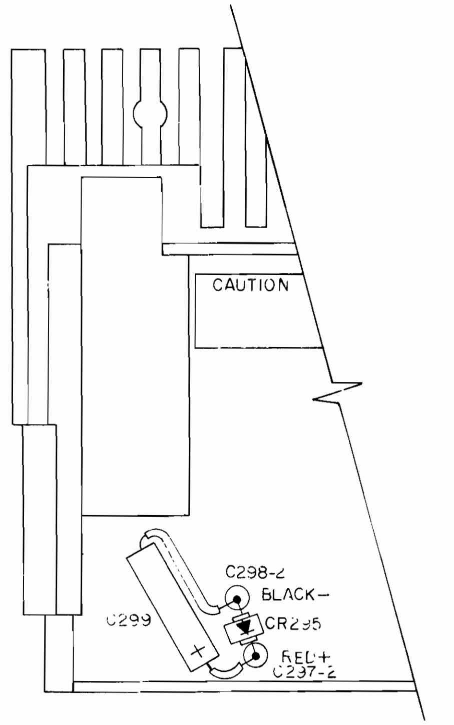
(19D416850, Sh. 2, Rev. 3)
(19D416850, Sh. 3, Rev. 3)

PA ASSEMBLY

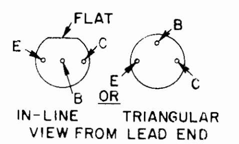
TOP VIEW



BOTTOM VIEW

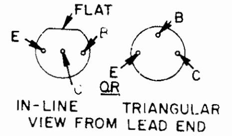


LEAD IDENTIFICATION
FOR Q101-Q109, Q206, Q210, Q211

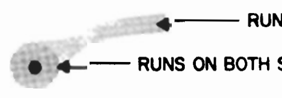


NOTE: LEAD ARRANGEMENT, AND NOT CASE SHAPE, IS DETERMINING FACTOR FOR LEAD IDENTIFICATION.

LEAD IDENTIFICATION
FOR Q201-Q205, Q207, Q208, Q209



NOTE: LEAD ARRANGEMENT, AND NOT CASE SHAPE, IS DETERMINING FACTOR FOR LEAD IDENTIFICATION.

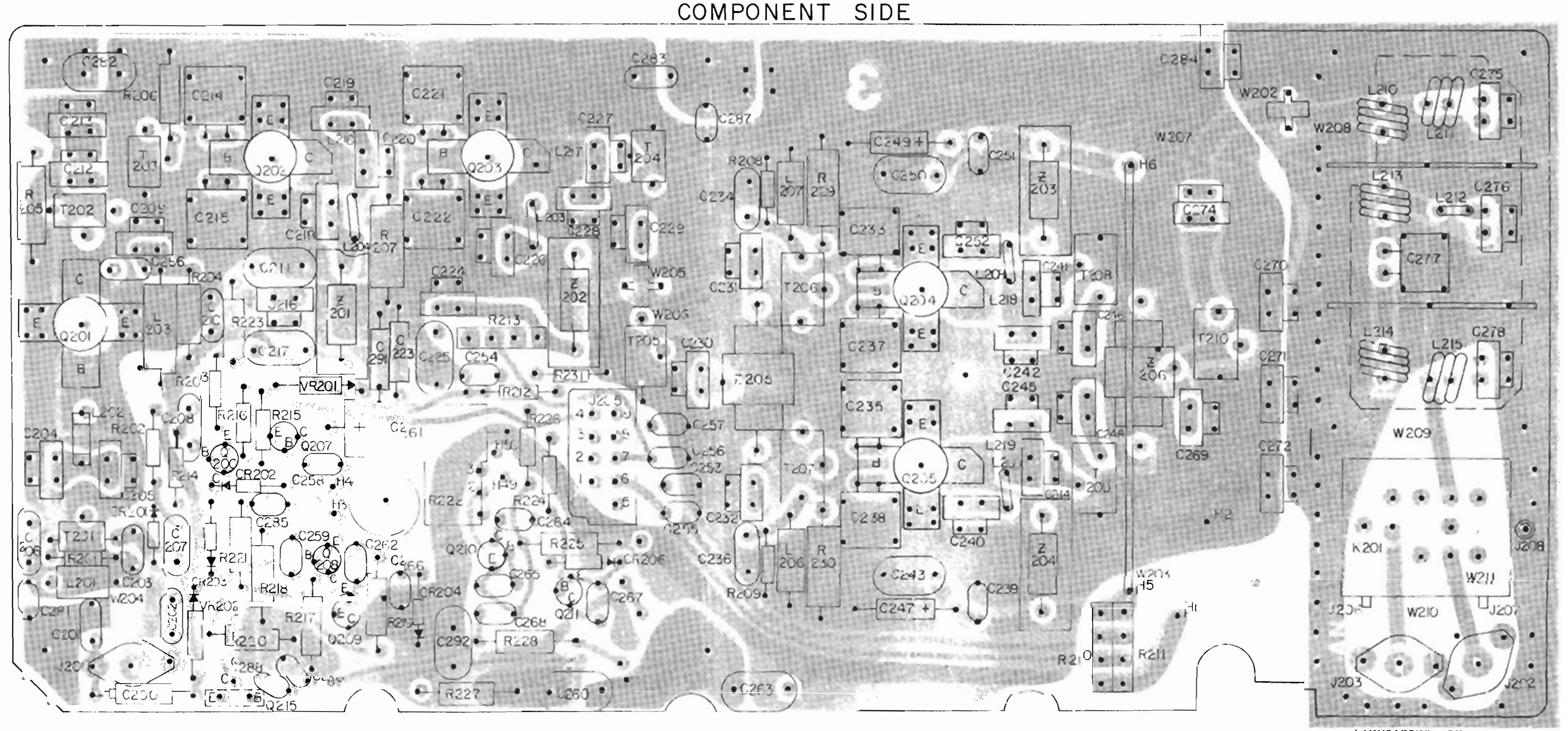


RUNS ON SOLDER SIDE
RUNS ON BOTH SIDES
RUNS ON COMPONENT SIDE

(19R622039, Rev. 5)

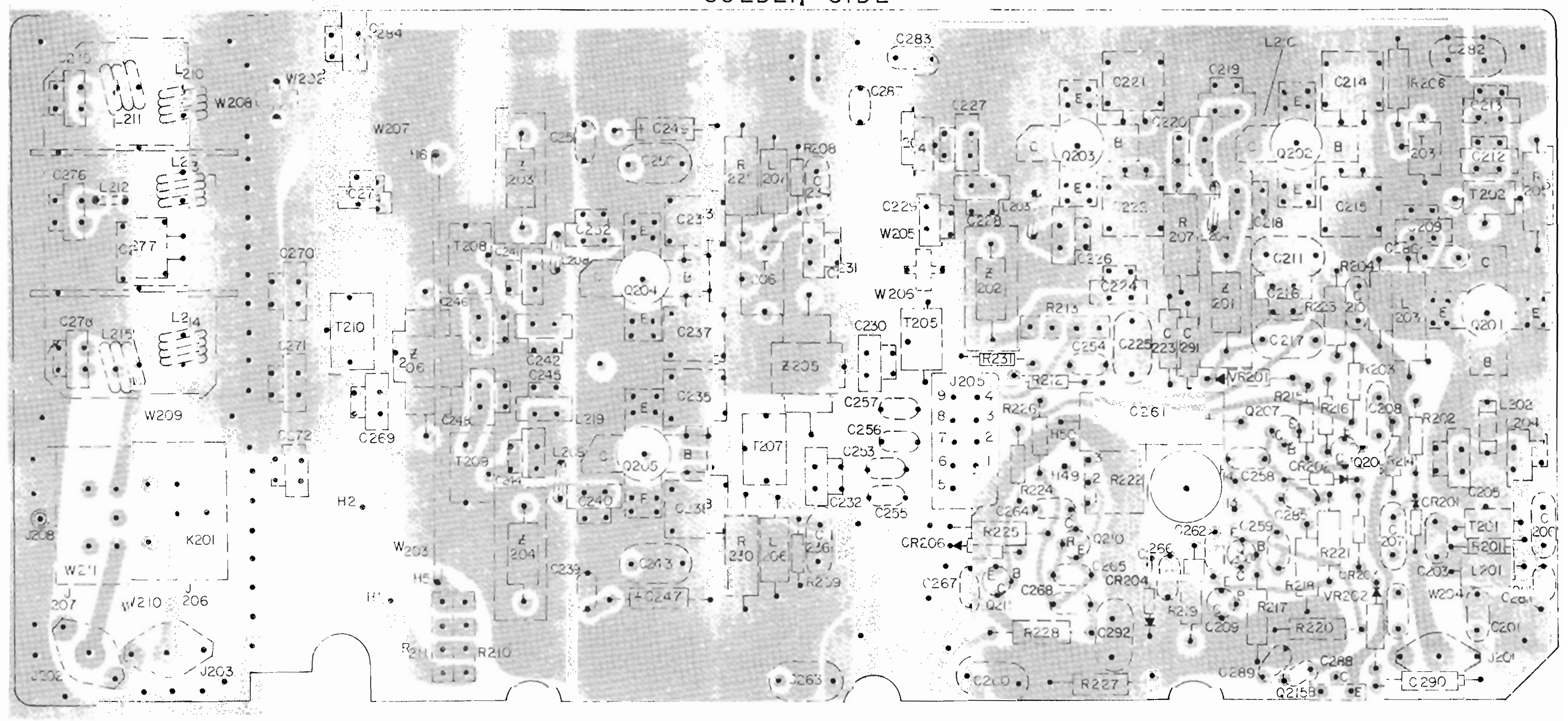
PA BOARD

COMPONENT SIDE



(19D416894, Sh. 2, Rev. 3)
(19D416894, Sh. 3, Rev. 3)

SOLDER SIDE



(19D416894, Sh. 2, Rev. 3)

OUTLINE DIAGRAM

138—174 MHz, 65-WATT TRANSMITTER

PRODUCTION CHANGES

Changes in the equipment to improve performance or to simplify circuits are identified by a "Revision Letter", which is stamped after the model number of the unit. The revision stamped on the unit includes all previous revisions. Refer to the Parts List for descriptions of parts affected by these revisions.

REV. A - Exciter Board 19D416859G1-4

To improve operation. Changed C132, C137, C138, C141, C145, C148, R134, R139, R144, R145, Q108, Q109, and added L109.

'. B - Exciter Board 19D416859G1, G3

To improve operation. Deleted C136L. Changed C136H, C137, C144L, C145, C146, CV103 and added C137L, C145L, C146L, CV103L, L108 and R152.

PARTS LIST

LBI-4554B

138-174 MHz EXCITER BOARD
19D416859G1-G4

SYMBOL	GE PART NO.	DESCRIPTION
		19D416859G1 2 FREQ 138-155 MHz (L) 19D416859G2 2 FREQ 150.8-174 MHz (H) 19D416859G3 8 FREQ 138-155 MHz (L) 19D416859G4 8 FREQ 150.8-174 MHz (H)
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C101 and C102	19A116080P1	Polyester: 0.01 µf ±20%, 50 VDCW.
C103	19A116080P107	Polyester: 0.1 µf ±10%, 50 VDCW.
C104	5496267P10	Tantalum: 22 µf ±20%, 15 VDCW; sim to Sprague Type 150D.
C105	5496267P14	Tantalum: 15 µf ±20%, 20 VDCW; sim to Sprague Type 150D.
C106	5496267P9	Tantalum: 3.3 µf ±20%, 15 VDCW; sim to Sprague Type 150D.
C107	19A116080P107	Polyester: 0.1 µf ±10%, 50 VDCW.
C108	5494481P107	Ceramic disc: 470 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C109 and C110	5494481P111	Ceramic disc: 1000 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C111	5494481P112	Ceramic disc: 1000 pf ±10%, 1000 VDCW; sim to RMC Type JF Discap.
C112	5494481P107	Ceramic disc: 470 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C113 thru C117	5494481P111	Ceramic disc: 1000 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C118 and C119	5494481P112	Ceramic disc: 1000 pf ±10%, 1000 VDCW; sim to RMC Type JF Discap.
C120	7489162P43	Silver mica: 470 pf ±5%, 300 VDCW; sim to Electro Motive Type DM-15.
C121	5494481P112	Ceramic disc: 1000 pf ±10%, 1000 VDCW; sim to RMC Type JF Discap.
C122	5494481P107	Ceramic disc: 470 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C123 thru C125	5494481P111	Ceramic disc: 1000 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C126	7489162P27	Silver mica: 100 pf ±5%, 500 VDCW; sim to Electro Motive Type DM-15.
C127	19A116080P107	Polyester: 10 µf ±10%, 50 VDCW.
C129 and C130	5494481P111	Ceramic disc: 1000 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C131L	5496219P249	Ceramic disc: 27 pf ±5%, 500 VDCW, temp coef -80 PPM.
C131H	5496219P248	Ceramic disc: 24 pf ±5%, 500 VDCW, temp coef -80 PPM.
C132*	5491601P118	Phenolic: 0.75 pf ±5%, 500 VDCW.
		Earlier than REV A:
	5491601P117	Phenolic: 0.68 pf ±5%, 500 VDCW.
C133L	5496219P249	Ceramic disc: 27 pf ±5%, 500 VDCW, temp coef -80 PPM.
C133H	5496219P248	Ceramic disc: 24 pf ±5%, 500 VDCW, temp coef -80 PPM.
C134	19A116080P107	Polyester: 0.1 µf ±10%, 50 VDCW.
C135	19A116080P105	Polyester: 0.047 µf ±10%, 50 VDCW.
C136*	5496219P246	Ceramic disc: 20 pf ±5%, 500 VDCW, temp coef -80 PPM. Added by REV B.
C136L*	5496219P348	Ceramic disc: 24 pf ±5%, 500 VDCW, temp coef -150 PPM. Deleted by REV B.
C136H*	5496219P246	Ceramic disc: 20 pf ±5%, 500 VDCW, temp coef -80 PPM. Deleted by REV B.
C137*	5496219P251	Ceramic disc: 33 pf ±5%, 500 VDCW, temp coef -80 PPM. Deleted by REV B.
		Earlier than REV A:
	5496219P249	Ceramic disc: 27 pf ±5%, 500 VDCW, temp coef -80 PPM.
C137L*	5496219P254	Ceramic disc: 43 pf ±5%, 500 VDCW, temp coef -80 PPM. Added by REV B.
C137H*	5496219P251	Ceramic disc: 33 pf ±5%, 500 VDCW, temp coef -80 PPM. Added by REV B.
C138*	5491601P115	Phenolic: 33 pf ±5%, 500 VDCW.
		Earlier than REV A:
	5491601P113	Phenolic: 0.47 pf ±5%, 500 VDCW.
C139L	5496219P247	Ceramic disc: 22 pf ±5%, 500 VDCW, temp coef -80 PPM.
C139H	5496219P243	Ceramic disc: 13 pf ±5%, 500 VDCW, temp coef -80 PPM.
C140	5496219P348	Ceramic disc: 24 pf ±5%, 500 VDCW, temp coef -80 PPM.
C141*	5490008P127	Silver mica: 100 pf ±10%, 500 VDCW; sim to Electro Motive Type DM-15.
		Earlier than REV A:
	19A116080P107	Polyester: 0.1 µf ±10%, 50 VDCW.
C142	7489162P25	Silver mica: 82 pf ±5%, 500 VDCW; sim to Electro Motive Type DM-15.
C143	5496267P10	Tantalum: 22 µf ±20%, 15 VDCW; sim to Sprague Type 150D.
C144L*	5496219P243	Ceramic disc: 13 pf ±1%, 500 VDCW, temp coef -80 PPM.
		In REV A and earlier:
	5496219P244	Ceramic disc: 15 pf ±5%, 500 VDCW, temp coef -80 PPM.
C144H	5496219P241	Ceramic disc: 10 pf ±0.25 pf, 500 VDCW, temp coef -80 PPM.
C145*	5496219P249	Ceramic disc: 27 pf ±5%, 500 VDCW, temp coef -80 PPM. Deleted by REV B.
		Earlier than REV A:
	5496219P246	Ceramic disc: 20 pf ±5%, 500 VDCW, temp coef -80 PPM.
C145L*	5496219P252	Ceramic disc: 36 pf ±5%, 500 VDCW, temp coef -80 PPM. Added by REV B.
C145H*	5496219P249	Ceramic disc: 27 pf ±5%, 500 VDCW, temp coef -80 PPM. Added by REV B.
C146*	5491601P113	Phenolic: 0.47 pf ±5%, 500 VDCW. Deleted by REV B.
		Earlier than REV A:
	5491601P117	Phenolic: 0.68 pf ±5%, 500 VDCW.
C146L*	5491601P109	Phenolic: 0.33 pf ±5%, 500 VDCW. Added by REV B.
C146H*	5491601P113	Phenolic: 0.47 pf ±5%, 500 VDCW. Added by REV B.
C147L	5496219P239	Ceramic disc: 8.0 pf ±0.25 pf, 500 VDCW, temp coef -80 PPM.
C147H	5496219P236	Ceramic disc: 5.0 pf ±0.25 pf, 500 VDCW, temp coef -80 PPM.
C148*	5491601P111	Phenolic: 0.39 pf ±5%, 500 VDCW.
		Earlier than REV A:
	5491601P117	Phenolic: 0.68 pf ±5%, 500 VDCW.
C149L	5496219P241	Ceramic disc: 10 pf ±0.25 pf, 500 VDCW, temp coef -80 PPM.
C149H	5496219P237	Ceramic disc: 6.0 pf ±0.25 pf, 500 VDCW, temp coef -80 PPM.
C151	19A116655P19	Ceramic disc: 1000 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C152	19A116080P107	Polyester: 0.1 µf ±10%, 50 VDCW.
C153	19A116655P19	Ceramic disc: 1000 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C154L	5496219P238	Ceramic disc: 7.0 pf ±0.25 pf, 500 VDCW, temp coef -80 PPM.
C154H	5496219P236	Ceramic disc: 5.0 pf ±0.25 pf, 500 VDCW, temp coef -80 PPM.
C155H	5496219P241	Ceramic disc: 10 pf ±0.25 pf, 500 VDCW, temp coef -80 PPM.
C155L	5496219P243	Ceramic disc: 13 pf ±5%, 500 VDCW, temp coef -80 PPM.
C157L	5496219P238	Ceramic disc: 7.0 pf ±0.25 pf, 500 VDCW, temp coef -80 PPM.
C157H	5496219P236	Ceramic disc: 5.0 pf ±0.25 pf, 500 VDCW, temp coef -80 PPM.
C158 and C159	19A116655P19	Ceramic disc: 1000 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
		- - - - - - - DIODES AND RECTIFIERS - - - - - -
CR101 thru CR106	19A115250P1	Silicon.
CV101 and CV102	5495769P8	Silicon, capacitive: 33 pf ±20%, at 4 VDC.
CV103*	5495769P8	Silicon, capacitive: 33 pf ±20%, at 4 VDC. Deleted by REV B.
CV103L*	5495769P9	Silicon, capacitive: 33 pf ±20%, at 4 VDC. Added by REV B.
CV103H*	5495769P8	Silicon, capacitive: 33 pf ±20%, at 4 VDC. Added by REV B.
		- - - - - - - JACKS AND RECEPTACLES - - - - - -
J101	19A116832P1	Receptacle, coaxial: sim to Cinch 14H11613.
J103	19B219374G1	Connector. Includes:
	19A116651P1	Contacts. (9).
		- - - - - - - - - - - INDUCTORS - - - - - - - - - -
L102	19B209420P130	Coil, RF: 27.0 µh ±10%, 3.60 ohms DC res max; sim to Jeffers 441316-5.
L104	7488079P7	Choke, RF: 1.50 µh ±10%, 0.50 ohms DC res max; sim to Jeffers 4411-10K.
L105	7488079P18	Choke, RF: 15.0 µh ±10%, 1.20 ohms DC res max; sim to Jeffers 4421-9K.
L106	7488079P5	Choke, RF: 0.68 µh ±10%, 0.15 ohms DC res max; sim to Jeffers 4411-5K.
L108*	19B209420P123	Coil, RF: 6.80 µh ±10%, 1.80 ohms DC res max; sim to Jeffers 4446-2. Added to low split by REV B.
L109*	19B209420P123	Coil, RF: 6.80 µh ±10%, 1.80 ohms DC res max; sim to Jeffers 4446-2. Added by REV A.
		- - - - - - - - - - - - PLUGS - - - - - - - - - - -
P902		Includes:
	19B219594P2	Contact strip: 8 pins.
	19B219594P3	Contact strip: 9 pins.
		- - - - - - - - - - - TRANSISTORS - - - - - - - - -
Q101	19A115910P1	Silicon, NPN; sim to Type 2N3906.
Q102 thru Q106	19A115330P1	Silicon, NPN.
Q107	19A115328P1	Silicon, NPN.
Q108* and Q109*	19A115329P2	Silicon, NPN.
		Earlier than REV A:
	19A115329P1	Silicon, NPN.
		- - - - - - - - - - - RESISTORS - - - - - - - - - -
R101	3R152P561K	Composition: 560 ohms ±10%, 1/4 w.
R102	3R152P391K	Composition: 390 ohms ±10%, 1/4 w.
R103	3R152P102K	Composition: 1000 ohms ±10%, 1/4 w.
R104	19B209358P106	Variable, carbon film: approx 75 to 10,000 ohms ±10%, 0.25 w; sim to CTS Type X-201.
R105	19B209358P108	Variable, carbon film: approx 100 to 50,000 ohms ±10%, 0.25 w; sim to CTS Type X-201.
R106	3R152P393K	Composition: 39,000 ohms ±10%, 1/4 w.
R107	3R152P331K	Composition: 330 ohms ±10%, 1/4 w.
R108	3R152P102K	Composition: 1000 ohms ±10%, 1/4 w.
R109	3R152P103K	Composition: 10,000 ohms ±10%, 1/4 w.
R110	3R152P104K	Composition: 0.10 megohm ±10%, 1/4 w.
R111	3R152P474K	Composition: 0.47 megohm ±10%, 1/4 w.
R112	3R152P223K	Composition: 22,000 ohms ±10%, 1/4 w.
R113	3R152P680K	Composition: 68 ohms ±10%, 1/4 w.
R114	3R152P222K	Composition: 2200 ohms ±10%, 1/4 w.
R115	3R152P562K	Composition: 5600 ohms ±10%, 1/4 w.
R116	3R152P471K	Composition: 470 ohms ±10%, 1/4 w.
R117	3R152P561K	Composition: 560 ohms ±10%, 1/4 w.
R118	3R152P433J	Composition: 43,000 ohms ±5%, 1/4 w.
R119	3R152P821K	Composition: 820 ohms ±10%, 1/4 w.
R120	3R152P102K	Composition: 1000 ohms ±10%, 1/4 w.
R121	3R152P562K	Composition: 5600 ohms ±10%, 1/4 w.
R122	3R152P471K	Composition: 470 ohms ±10%, 1/4 w.
R123	3R152P223K	Composition: 22,000 ohms ±10%, 1/4 w.
R124	3R152P103K	Composition: 10,000 ohms ±10%, 1/4 w.
R125	3R152P102K	Composition: 1000 ohms ±10%, 1/4 w.
R126	3R152P103K	Composition: 10,000 ohms ±10%, 1/4 w.
R127	3R152P223K	Composition: 22,000 ohms ±10%, 1/4 w.
R129	3R152P222K	Composition: 2200 ohms ±10%, 1/4 w.
R130	3R152P562K	Composition: 5600 ohms ±10%, 1/4 w.
R131	3R152P471K	Composition: 470 ohms ±10%, 1/4 w.
R132	3R152P433J	Composition: 43,000 ohms ±5%, 1/4 w.
R133	3R152P561K	Composition: 560 ohms ±10%, 1/4 w.
R134*	3R152P223K	Composition: 22,000 ohms ±10%, 1/4 w.
		Earlier than REV A:
	3R152P333K	Composition: 33,000 ohms ±10%, 1/4 w.
R135	3R152P102K	Composition: 1000 ohms ±10%, 1/4 w.
R136	3R152P470K	Composition: 47 ohms ±10%, 1/4 w.
R138	3R152P473K	Composition: 47,000 ohms ±10%, 1/4 w.
R139*	3R152P181K	Composition: 180 ohms ±10%, 1/4 w.
		Earlier than REV A:
	3R152P301J	Composition: 300 ohms ±5%, 1/4 w.
R140	3R152P271K	Composition: 270 ohms ±10%, 1/4 w.
R141	3R152P103K	Composition: 10,000 ohms ±10%, 1/4 w.
R142	3R152P620J	Composition: 62 ohms ±5%, 1/4 w.
R143	3R152P331K	Composition: 330 ohms ±10%, 1/4 w.
R144*	3R152P181K	Composition: 180 ohms ±10%, 1/4 w.
		Earlier than REV A:
	3R152P331K	Composition: 330 ohms ±10%, 1/4 w.
R145*	3R152P390K	Composition: 39 ohms ±10%, 1/4 w.
		Earlier than REV A:
	3R152P470J	Composition: 47 ohms ±5%, 1/4 w.
R146	3R152P333K	Composition: 33,000 ohms ±10%, 1/4 w.
R147	3R152P200J	Composition: 20 ohms ±5%, 1/4 w.
R148	3R77P100J	Composition: 10 ohms ±5%, 1/2 w.
R152*	3R152P391K	Composition: 390 ohms ±10%, 1/4 w. Added by REV B.
		- - - - - - - - - - - TRANSFORMERS - - - - - - - -
T101	19D416843G9	Coil. Includes:
	5493185P12	Tuning slug.
T102 and T103	19D416843G1	Coil. Includes:
	5493185P12	Tuning slug.
T104	19D416843G3	Coil. Includes:
	5493185P12	Tuning slug.
T105	19D416843G2	Coil. Includes:
	5493185P12	Tuning slug.
T106 and T107	19D416843G7	Coil. Includes:
	5493185P12	Tuning slug.
T108 and T109	19D416843G5	Coil. Includes:
	5493185P13	Tuning slug.
T110		COIL ASSEMBLY 19D416843G8
		- - - - - - - - - - - RESISTORS - - - - - - - -
R1	3R152P151K	Composition: 150 ohms ±10%, 1/4 w.
		- - - - - - - - - - MISCELLANEOUS - - - - - - - -
	5493185P13	Tuning slug.
T111	19D416843G4	Coil. Includes:
	5493185P12	Tuning slug.
T112	19D416843G6	Coil. Includes:
	5493185P12	Tuning slug.
		- - - - - - - INTEGRATED CIRCUITS - - - - - - -
U101	19D416542G1	Audio Transmitter.
		- - - - - - - - - - - SOCKETS - - - - - - - - - -
XY101 thru XY108		Socket. Part of Mechanical Construction. Includes:
	19A116779P1	Contact, electrical: sim to Molex 08-54-0404. Quantity (6) with each.
		- - - - - - - - - - - OSCILLATORS - - - - - - - -
		<u>NOTE</u>: When reordering specify ICOM Frequency.
		ICOM Freq = $\frac{\text{Operating Frequency}}{12}$
Y101 thru Y108	19A129393G17	Externally compensated, ±5 PPM, 138-174 MHz.
Y101 thru Y108	19A129393G14	Internally compensated, ±2 PPM, 138-174 MHz.
		MECHANICAL PARTS
	19A129424G2	Can. (Used with T101-T112).
	4036555P1	Insulator, washer: nylon. (Used with Q108, Q109).

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

✱ COMPONENT VALUES AS FOLLOWS:

COMPONENT IDENTIFICATION	L 138-155 MHZ	H 150.8-174 MHZ
C131	27	24
C133	27	24
C137	43	33
C139	22	13
C144	13	10
C145	36	27
C146	.33	.47
C147	8	5
C149	10	6
C154	7	5
C155	13	10
C157	7	5
R152	390	NONE

▲ THESE COMPONENTS NOT PRESENT ON 2ND EXCITER IN WIDE SPACE XMTR COMBINATIONS.

VOLTAGE READINGS

VOLTAGE READINGS ARE TYPICAL READINGS MADE WITH THE TRANSMITTER KEYED, AND MEASURED WITH A 20,000 OHMS-PER-VOLT METER WITH REFERENCE TO A- AND NOT CHASSIS GROUND.

AN RF CHOKE (25-50 MICROHENRYS) IS USED IN THE HOT METER LEAD TO AVOID DETUNING RF CIRCUITS.

(19R621902, Rev. 9)

EXCITER BOARD	REV LETTER	FREQ RANGE	NO. FREQ.
19D416859G1	B	138-155	2
19D416859G2	A	150.8-174	2
19D416859G3	B	138-155	8
19D416859G4	A	150.8-174	8

ALL RESISTORS ARE 1/2 WATT UNLESS OTHERWISE SPECIFIED AND RESISTOR VALUES IN OHMS UNLESS FOLLOWED BY K=1000 OHMS OR MEG=1,000,000 OHMS. CAPACITOR VALUES IN PICOFARADS (EQUAL TO MICROMICROFARADS) UNLESS FOLLOWED BY UF=MICROFARADS. INDUCTANCE VALUES IN MICROHENRYS UNLESS FOLLOWED BY MH=MILLIHENRYS OR H=HENRYS.

IN ORDER TO RETAIN RATED EQUIPMENT PERFORMANCE, REPLACEMENT OF ANY SERVICE PART SHOULD BE MADE ONLY WITH A COMPONENT HAVING THE SPECIFICATIONS SHOWN ON THE PARTS LIST FOR THAT PART.

SCHEMATIC DIAGRAM

138—174 MHz, EXCITER BOARD
19D416859G1-G4

(19B621923, Rev. 13)

VOLTAGE READINGS

VOLTAGE READINGS ARE TYPICAL READINGS MADE WITH THE TRANSMITTER KEYED, AND MEASURED WITH A 20,000 OHMS-PER-VOLT METER WITH REFERENCE TO A- AND NOT CHASSIS GROUND. AN RF CHOKE (25-50 MICROHENRYS) IS USED IN THE HOT METER LEAD TO AVOID DETUNING RF CIRCUITS.

NOTE: READINGS AT Q215 COLLECTOR AND IN THE POWER CONTROL CIRCUIT WERE TAKEN WITH THE TRANSMITTER ADJUSTED FOR 65 WATTS OUTPUT. THESE READINGS WILL VARY DEPENDING ON THE SETTING OF POWER ADJUST CONTROL R222.

PA. ASM.	REV LTR	HEAT SINK ASM.	REV LTR	CPNT. BD. ASM.	REV LTR	FREQ RANGE
19C320414G2	A	19B219688G3		19D416886G1	A	138-174 MHZ
19C320414G5	A	19B219688G15		19D416886G1	A	138-174 MHZ

IN ORDER TO RETAIN RATED EQUIPMENT PERFORMANCE REPLACEMENT OF ANY SERVICE PART SHOULD BE MADE ONLY WITH A COMPONENT HAVING THE SPECIFICATIONS SHOWN ON THE PARTS LIST FOR THAT PART.

ALL RESISTORS ARE 1/2 WATT UNLESS OTHERWISE SPECIFIED AND RESISTOR VALUES IN OHMS UNLESS FOLLOWED BY K=1000 OHMS OR MEG=1,000,000 OHMS. CAPACITOR VALUES IN PICOFARADS (EQUAL TO MICROMICROFARADS) UNLESS FOLLOWED BY UF= MICROFARADS. INDUCTANCE VALUES IN MICROHENRYS UNLESS FOLLOWED BY MH= MILLIHENRYS OR H=HENRYS.

NOTES:
1. 50 OHM MICROSTRIP PART OF PWB
2. PART OF PWB
3. Q201 THRU Q205 & Q215 ARE CALLED FOR ON PL19C320414.
4. ⏚ INDICATES A-
   ⏚ INDICATES VEHICLE GROUND

SCHEMATIC DIAGRAM

138—174 MHz, 65-WATT POWER AMPLIFIER
19C320414G2 & G5

Issue 3

PARTS LIST

LBI-4555A

POWER AMPLIFIER
138-174 MHz, 65 WATT
19C320414G2, G5

SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - - - - - INDUCTORS - - - - - - - - - -
L295 and L296	19A129562P1	Coil.
		- - - - - - - - - - - TRANSISTORS - - - - - - - - - -
Q201*	19A134060P1	Silicon, NPN.
		Earlier than REV A:
	19A129181P1	Silicon, NPN.
Q202*	19A134060P2	Silicon, NPN.
		Earlier than REV A:
	19A129181P3	Silicon, NPN.
Q203A*	19A134060P3	Silicon, NPN.
		Earlier than REV A:
	19A129181P4	Silicon, NPN.
Q204* and Q205*	19A134060P3	Silicon, NPN.
		Earlier than REV A:
	19A129181P4	Silicon, NPN.
Q215	19A116742P1	Silicon, NPN.
		- - - - - - - - - - - THERMISTORS - - - - - - - - - -
RT201	19A129379G1	Thermistor.
		POWER AMPLIFIER BOARD 19D416886G1
		- - - - - - - - - - - CAPACITORS - - - - - - - - - -
C201 and C202	19A116655P17	Ceramic disc: 680 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C203	7489162P7	Silver mica: 12 pf ±5%, 500 VDCW; sim to Electro Motive Type DM-15.
C204 and C205	19A116679P75J	Mica: 75 pf ±5%, 250 VDCW.
C206	7489162P19	Silver mica: 47 pf ±5%, 500 VDCW; sim to Electro Motive Type DM-15.
C207 and C208	7489162P131	Silver mica: 150 pf ±10%, 500 VDCW; sim to Electro Motive Type DM-15.
C209	19A116679P47K	Mica: 47 pf ±10%, 250 VDCW.
C210	19A116655P17	Ceramic disc: 680 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C211	19A116080P107	Polyester: 0.1 µf ±10%, 50 VDCW.
C212	19A116679P470K	Mica: 470 pf ±10%, 250 VDCW.
C213	19A116679P27J	Mica: 27 pf ±5%, 250 VDCW.
C214 and C215	19A116795P180J	Mica: 180 pf ±5%, 250 VDCW.
C216	19A116679P470K	Mica: 470 pf ±10%, 250 VDCW.
C217	19A116080P107	Polyester: 0.1 µf ±10%, 50 VDCW.
C218	19A116679P470K	Mica: 470 pf ±10%, 250 VDCW.
C219	19A116679P47J	Mica: 47 pf ±5%, 250 VDCW.
C220	19A116679P470K	Mica: 470 pf ±10%, 250 VDCW.
C221 and C222	19A116795P220J	Mica: 220 pf ±5%, 250 VDCW.

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES.

SYMBOL	G-E PART NO	DESCRIPTION
C223	5496267P13	Tantalum: 2.2 µf ±20%, 20 VDCW; sim to Sprague Type 150D.
C224	19A116679P470K	Mica: 470 pf ±10%, 250 VDCW.
C225	19A116080P107	Polyester: 0.1 µf ±10%, 50 VDCW.
C226 and C227	19A116679P470K	Mica: 470 pf ±10%, 250 VDCW.
C228	19A116679P150J	Mica: 150 pf ±5%, 250 VDCW.
C229 thru C232	19A116679P24J	Mica: 24 pf ±5%, 250 VDCW.
C233	19A116795P220J	Mica: 220 pf ±5%, 250 VDCW.
C234	7489162P23	Silver mica: 68 pf ±5%, 500 VDCW; sim to Electro Motive Type DM-15.
C235	19A116795P220J	Mica: 220 pf ±5%, 250 VDCW.
C236	7489162P23	Silver mica: 68 pf ±5%, 500 VDCW; sim to Electro Motive Type DM-15.
C237 and C238	19A116795P220J	Mica: 220 pf ±5%, 250 VDCW.
C239	19A116655P17	Ceramic disc: 680 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C240 and C241	19A116679P470K	Mica: 470 pf ±10%, 250 VDCW.
C242	19A116679P150J	Mica: 150 pf ±5%, 250 VDCW.
C243	19A116080P107	Polyester: 0.1 µf ±10%, 50 VDCW.
C244	19A116679P470K	Mica: 470 pf ±10%, 250 VDCW.
C245	19A116679P150J	Mica: 150 pf ±5%, 250 VDCW.
C246	19A116679P27J	Mica: 27 pf ±5%, 250 VDCW.
C247	5496267P13	Tantalum: 2.2 µf ±20%, 20 VDCW; sim to Sprague Type 150D.
C248	19A116679P27J	Mica: 27 pf ±5%, 250 VDCW.
C249	5496267P13	Tantalum: 2.2 µf ±20%, 20 VDCW; sim to Sprague Type 150D.
C250	19A116080P107	Polyester: 0.1 µf ±10%, 50 VDCW.
C251	19A116655P17	Ceramic disc: 680 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C252	19A116679P470K	Mica: 470 pf ±10%, 250 VDCW.
C253 thru C257	19A116655P8	Ceramic disc: 150 pf ±10%, 1000 VDCW; sim to RMC Type JF Discap.
C258 and C259	19A116655P17	Ceramic disc: 680 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C260	19A116080P107	Polyester: 0.1 µf ±10%, 50 VDCW.
C261	19A115680P4	Electrolytic: 50 µf +150% -10%, 25 VDCW; sim to Mallory Type TT.
C262	19A116655P17	Ceramic disc: 680 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C263	19A116080P107	Polyester: 0.1 µf ±10%, 50 VDCW.
C264 thru C267	19A116655P17	Ceramic disc: 680 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C268	19A116080P107	Polyester: 0.1 µf ±10%, 50 VDCW.
C269	19A116679P27J	Mica: 27 pf ±5%, 250 VDCW.
C270 thru C272	19A116679P470K	Mica: 470 pf ±10%, 250 VDCW.
C274	19A116679P220K	Mica: 220 pf ±10%, 250 VDCW.
C275	19A116679P8D	Mica: 8 pf ±.5 pf, 250 VDCW.
C276	19A116679P22J	Mica: 22 pf ±5%, 250 VDCW.
C277	19A116795P29J	Mica: 29 pf ±5%, 250 VDCW.
C278	19A116679P8D	Mica: 8 pf ±.5 pf, 250 VDCW.
C281	19A116655P17	Ceramic disc: 680 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C282	19A116080P107	Polyester: 0.1 µf ±10%, 50 VDCW.
C283	19A116655P17	Ceramic disc: 680 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C284	19A116679P470K	Mica: 470 pf ±10%, 250 VDCW.
C285	19A116655P17	Ceramic disc: 680 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C286	7489162P7	Silver mica: 12 pf ±5%, 500 VDCW; sim to Electro Motive Type DM-15.
C287	19A11665P17	Ceramic disc: 680 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C288 and C289	19A116655P8	Ceramic disc: 150 pf ±10%, 1000 VDCW; sim to RMC Type JF Discap.
C290	5496267P13	Tantalum: 2.2 µf ±20%, 20 VDCW; sim to Sprague Type 150D.
C291*	5496267P13	Tantalum: 2.2 µf ±20%, 20 VDCW; sim to Sprague Type 150D. Added by REV A.
C292*	19A116080P107	Polyester: 0.1 µf ±10%, 50 VDCW. Added by REV A.
		- - - - - - - - DIODES AND RECTIFIERS - - - - - - -
CR201 thru CR204	19A115250P1	Silicon.
CR206	19A115250P1	Silicon.
		- - - - - - - - JACKS AND RECEPTACLES - - - - - - - -
J201 thru J203	19A116832P1	Receptacle, coaxial: sim to Cinch 14H11613.
J205	19B219374G1	Connector, includes (9) 19A116651P1 contacts.
J206 and J207		(Part of K201).
J208	4033513P4	Contact, electrical: sim to Bead Chain L93-3.
		- - - - - - - - - - - - - RELAYS - - - - - - - - - - -
K201	19A116722P1	Relay, hermetic sealed: 125 ohms ±20%, 1 form C contact, 9.6 to 15.8 VDC (over the temp range indicated).
		- - - - - - - - - - - INDUCTORS - - - - - - - - - -
L201	7488079P16	Choke, RF: 10.0 µh ±10%, 0.60 ohms DC res max; sim to Jeffers 4421-7.
L202	19A129616P1	Strap.
L203	7488079P43	Choke, RF: 10.0 µh ±10%, 0.30 ohms DC res max; sim to Jeffers 4422-4K.
L204 and L205	19A129561P1	Coil.
L206 and L207	7488079P16	Choke, RF: 10.0 µh ±10%, 0.60 ohms DC res max; sim to Jeffers 4421-7K.
L208 and L209	19A129561P1	Coil.
L210	19A129569P1	Coil.
L211	19A129570P1	Coil.
L212	19A129575P1	Coil.
L213 and L214	19A129569P1	Coil.
L215	19A129570P1	Coil.
L216 thru L219		(Part of printed wiring board, 19D416894P1).
		- - - - - - - - - - - TRANSISTORS - - - - - - - - -
Q206	19A115910P1	Silicon, NPN; sim to Type 2N3904.
Q207 thru Q209	19A115768P1	Silicon, PNP; sim to Type 2N3702.
Q210	19A115910P1	Silicon, NPN; sim to Type 2N3904.
Q211	19A115779P1	Silicon, PNP; sim to Type 2N3251.
		- - - - - - - - - - - RESISTORS - - - - - - - - - -
R201	3R152P470J	Composition: 47 ohms ±5%, 1/4 w.
R202	3R152P331J	Composition: 330 ohms ±5%, 1/4 w.
R203	3R152P221J	Composition: 220 ohms ±5%, 1/4 w.
R204	3R77P510J	Composition: 51 ohms ±5%, 1/2 w.
R205	3R78P101J	Composition: 100 ohms ±5%, 1 w.
R206	3R77P220J	Composition: 22 ohms ±5%, 1/2 w.
R207	19B209022P137	Wirewound: 8.2 ohms ±10%, 2 w; sim to IRC Type BWH.
R208 and R209	3R152P510J	Composition: 51 ohms ±5%, 1/4 w.
R210 and R211	19C320212P1	Shunt.
R212	3R152P274J	Composition: 0.27 megohm ±5%, 1/4 w.
R213	19C320212P2	Shunt.
R214	3R152P222J	Composition: 2200 ohms ±5%, 1/4 w.
R215	3R152P682J	Composition: 6800 ohms ±5%, 1/4 w.
R216	3R152P101J	Composition: 100 ohms ±5%, 1/4 w.
R217	19A116278P253	Metal film: 3480 ohms ±2%, 1/2 w.
R218	19A116278P261	Metal film: 4220 ohms ±2%, 1/2 w.
R219	19A116278P201	Metal film: 1000 ohms ±2%, 1/2 w.
R220	19A116278P269	Metal film: 5110 ohms ±2%, 1/2 w.
R221	19A116278P261	Metal film: 4220 ohms ±2%, 1/2 w.
R222	19A116559P102	Variable, cermet: 5000 ohms ±20%, .5 w; sim to CTS Series 360.
R223	7147161P19	Composition: 1.0 ohms ±5%, 1/2 w.
R224	3R152P182J	Composition: 1800 ohms ±5%, 1/4 w.
R225	3R77P121J	Composition: 120 ohms ±5%, 1/2 w.
R226	3R152P682J	Composition: 6800 ohms ±5%, 1/4 w.
R227	3R77P561J	Composition: 560 ohms ±5%, 1/2 w.
R228	3R77P471J	Composition: 470 ohms ±5%, 1/2 w.
R229 and R230	19B209022P131	Wirewound: 4.7 ohms ±10%, 2 w; sim to IRC Type BWH.
R231	3R152P110J	Composition: 11 ohms ±5%, 1/4 w.
		- - - - - - - - - - - TRANSFORMERS - - - - - - - - -
T201 thru T203	19A129564G1	Coil.
T204	19A129574G1	Coil.
T205	19A129566G1	Coil.
T206 and T207	19A129564G1	Coil.
T208 and T209	19A129574G1	Coil.
T210	19A129566G1	Coil.
		- - - - - - - - VOLTAGE REGULATORS - - - - - - -
VR201	4036887P1	Silicon, Zener.
VR202	4036887P5	Silicon, Zener.
		- - - - - - - - - - - - CABLES - - - - - - - - - - -
W201 and W202	19A129571P1	Cable, strap.
W203	19B219851P1	Jumper.
W204 thru W211		(Part of printed wiring board, 19D416894P1).
		- - - - - - - - - - - - FILTERS - - - - - - - - - -
Z201 thru Z204	19B219649G1	Filter.
		- - - - - - - - - - - TRANSFORMERS - - - - - - - - -
Z205 and Z206	19A129563G1	Hybrid Transformer.
		HEAT SINK CASTING 19B219688G3 STANDARD 19B219688G15 SYSTEM
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C297 and C298	19A116708P1	Ceramic, feed-thru: 0.01 µf +100% -0%, 500 VDCW; sim to Erie Style 327.
C299	19A115680P10	Electrolytic: 200 µf +150% -10%, 18 VDCW; sim to Mallory Type TT.
		- - - - - - - - DIODES AND RECTIFIERS - - - - - -
CR295	19A116783P1	Silicon.
		- - - - - - - - - - - MISCELLANEOUS - - - - - - - - -
	4035306P59	Washer, fiber. (Used with T204, T208, T209, Z205, Z206).
	19A129361P2	Shield. (Located on each side of C276 on component board).
	19B219767P1	Solder mask. (Used on component board).
	19B219688G3	Heat sink, casting. (Includes C297-C299, CR295).
	19B219688G15	Heat sink, casting. (Includes C297-C299, CR295).
	19D416712P3	Insulator. (Located under component board).
	5492178P2	Washer, spring tension. (Used with Q201-Q205).
	N207P15C6	Nut, hex: No. 8-32. (Used with Q201-Q205).
	19A116022P1	Insulator, bushing. (Used with Q215).
	19A116023P1	Insulator, plate. (Used with Q215).
	19A129661P1	Insulator. (Located under component board at L295 and L296).
	N5602P015	"O" ring. (Used with Q215).
	N402P7C6	Flat washer: No. 6. (Used with Q215).
	19A129888P1	Insulator. (Used with Q215).

PRODUCTION CHANGES

Changes in the equipment to improve performance or to simplify circuits are identified by a "Revision Letter", which is stamped after the model number of the unit. The revision stamped on the unit includes all previous revisions. Refer to the Parts List for descriptions of parts affected by these revisions.

REV. A: Power Amplifier Assembly 19C320414G2, G5
Improve Performance. Replace Q201-Q205.

REV. A: Power Amplifier Board 19D416886G1
To improve performance. Added C291 and C292.