MOBILE RADIO

DESCRIPTION AND MAINTENANCE

66—88 MHz MASTR™ II EXECUTIVE TRANSMITTER

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DESCRIPTION

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

- Exciter Board; with audio IC, divide by 2 IC, crystal module modulator, amplifier and multiplier stages.
- Power Amplifier Assembly; with amplifier, PA final, power control and low pass filter assembly.
- Multi-frequency board; used with multi-frequency radios only (common to transmitter and receiver).

Figure 1 is a block diagram of the MASTR Executive II transmitter showing the exciter, PA board and multi-frequency board.

The exciter provides 300 milliwatts of modulated RF power to the power amplifier. In vehicles with a positive ground, a polarity converter is used to power the exciter.

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

MAINTENANCE

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

NOTE

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

DISASSEMBLY

To service the transmitter remove the two retaining screws from the front cap assembly and pull radio out of case assembly.

To remove exciter board:

(1) Unplug cables W216 (exciter output and when present W2601 (multi-frequency cable).

(2) Remove the six screws holding the exciter board to the mounting frame and gently lift exciter board out of radio.

To remove PA Board:

(1) Remove PA top cover and unplug the exciter/PA cable W216; unsolder the PA/low pass filter cable W214 from

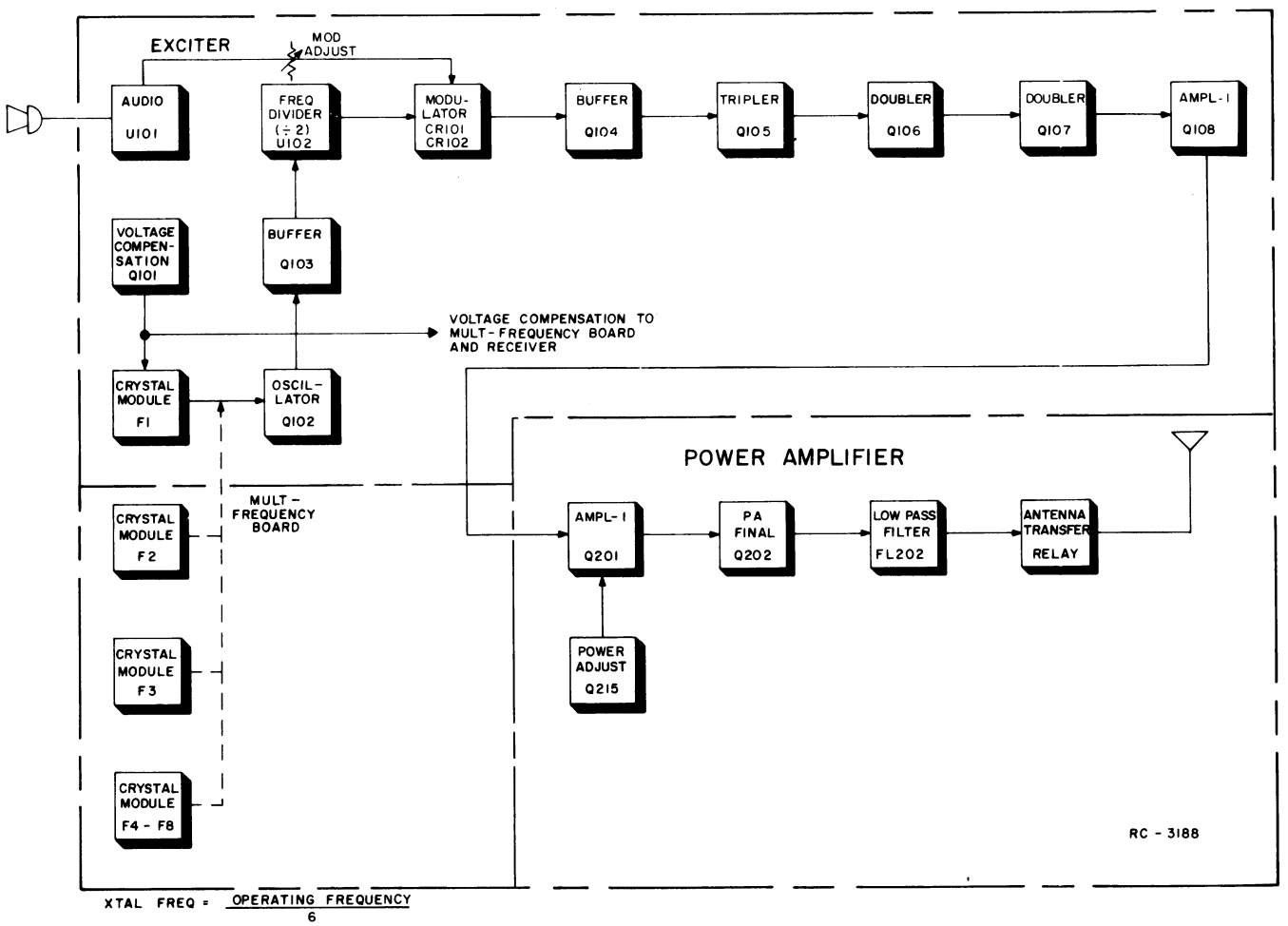


Figure 1 - Transmitter Block Diagram

W2 and shield from ground (G12). NOTE: The PA heat sink assembly pivots 90° to permit access to the PA board.

(2) Unsolder the power leads from E1 and G11. Remove the screw holding the power adjust transistor to the chassis.

(3) Remove the Amplifier and PA transistor hold-down nuts and washers from the rear of the PA assembly.

(4) Remove the four PA board mounting screws, 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.

To replace the PA RF transistor:

(1) Unsolder one lead at a time with a 50-watt soldering iron. Use a scribe or Xacto® knife to hold the lead away from the printed circuit board until the solder cools.

(2) Turn the PA board over.

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

(4) Trim the new transistor leads (if required) to the lead length of the removed transistor. The letter "C" on the top of the transistor indicates the collector. (See Figure 2 for transistor lead identification).

(5) Apply a coat of silicon grease to the mounting surface of the support and to both sides of the insulator. Also

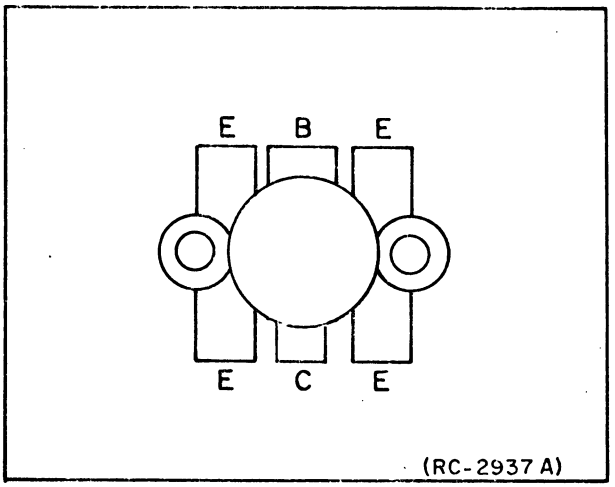


Figure 2 - PA Transistor Lead Identification for Q201 and Q202

between the mounting surfaces of Q201 and Q202 and the heat sink. Replace the PA board and loosely insert the four hold-down screws. Place the transistor in the mounting hole. Align the leads as shown in the Outline Diagram. Then hold the body of the transistor and replace the transistor mounting hardware, using moderate torque (6 inch-pounds). A torque wrench must be used for these adjustments since transistor damage can result if too little or too much torque is used. Tighten the PA board hold down screws.

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

CAUTION

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

TROUBLESHOOTING

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

MODULATION LEVEL ADJUSTMENT

MOD ADJUST Control R108 has been 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 over-modulation 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 P902-4 (Mike High) through a 0.5 microfarad (or larger) DC blocking capacitor, and P902-5 (Mike-Low) on the SAS board.
2. Adjust the audio oscillator for 1-Volt RMS at 1000 Hz.
3. For transmitters without Channel Guard, set MOD ADJUST R108 for a 4.5-kilohertz swing with the deviation polarity set to give the highest reading as indicated on the frequency modulation monitor.
4. For transmitters with Channel Guard, set Channel Guard MOD ADJUST for zero tone deviation. Next, with the 1-Volt signal at 1000 Hz applied, set MOD ADJUST R108 for a 3.75 kHz deviation. Then remove the signal from the audio oscillator and set Channel Guard MOD ADJUST for 0.75 kHz tone deviation.
5. For multi-frequency transmitters, set the deviation as described in Step 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 (10 amperes full scale).

Example:

P_i = 13.2 Volts x 4.2 amperes = 56 watts

OSCILLATOR FREQUENCY ADJUSTMENT

First, check the frequency to determine if any adjustment is required. The frequency should be set using 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 30°C (86°F).

The oscillator should be reset only when the frequency shows deviation in excess of the following limits:

A. ±0.5 PPM, when the radio is at 30°C (86°F)

B. ±5 PPM at any other temperature within the range of 30°C to +75°C (-22°F to +167°F)

If an adjustment is required, proceed as follows:

If the radio is at an ambient temperature of 30°C (86°F), set the oscillator for the correct operating frequency.

If the radio is not at an ambient temperature of 30°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 crystal oscillators):

1. Maintain the radio at 30°C (±5°C) and set the oscillator to desired frequency, or
2. Maintain the radio at 30°C (+5°C, -15°C) offset the operating frequency as a function of actual temperature, by the amount shown in Figure 4.

For example: Assume the ambient temperature of the radio is 20°C (68°F). At that temperature, the curve shows a correction factor of 129.2 Hz.

Set the oscillator for a reading of 129.2 Hz higher than the licensed operating frequency. If a negative correction factor is obtained (at temperatures above 30°C), set the oscillator for the indicated frequency lower than the licensed operating frequency.

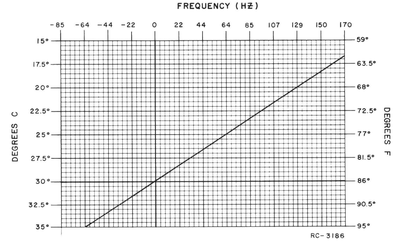
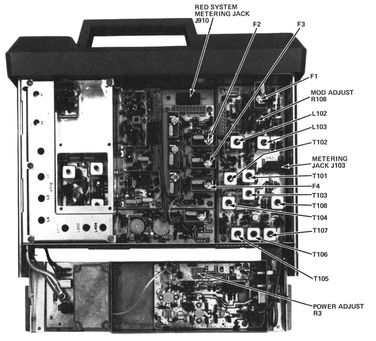


Figure 4 - Frequency Offset Chart



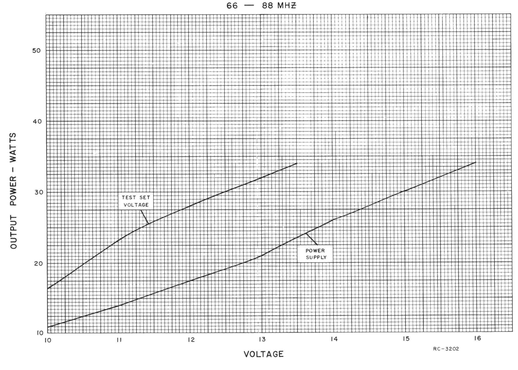


Figure 5 - Power Output Setting Chart

TRANSMITTER ALIGNMENT

EQUIPMENT

1. GE Test Set Model 4EX3A11 or Test Kit 4EX8K12.
2. A 50-ohm wattmeter connected to antenna jack J2.
3. A frequency counter.
4. Deviation Monitor.

PRELIMINARY CHECKS AND ADJUSTMENTS

1. Place crystal modules for F1 on Exciter Board and F2-F8 on multi-frequency board. (crystal frequency = operating frequency ÷ 6.)
2. For a large change in frequency or a badly mis-aligned transmitter, preset slugs for L101, L102, T101 and T102 to the bottom of the coil form. Preset slugs for T103 thru T108 to top of coil form.

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

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

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

4. Connect the red plug on the GE Test Set to the SAS 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 "G" with the HIGH SENSITIVITY button pressed may be converted to PA collector current by reading the current as 10 amperes full scale.
5. Rotate Power Adjust potentiometer R3 on PA Board all the way counterclockwise.
6. All adjustments are made with the transmitter keyed. Unkey the transmitter between steps to avoid unnecessary heating.

ALIGNMENT PROCEDURE

STEP	METER POSITION	TUNING CONTROL	METER READING	PROCEDURE
1.	A (MULT-1)	L101, L102 & T101	See Procedure	Tune L101 then L102 (yellow) for maximum meter reading. Then tune T101 for a dip in meter reading.
2.	B (MULT-2)	T102, T101 & T103	See Procedure	Tune T102 (green) for maximum meter reading and re-adjust T101 (green) for maximum meter reading. Then tune T103 (Red) for a dip in meter reading.
3.	C (MULT-3)	T104, T103 & T105	See Procedure	Tune T104 (Blue) for maximum meter reading and re-adjust T103 (Red) for maximum meter reading. Then tune T105 for a dip in meter reading.
4.	D (AMPL-1)	T106, T105 & T107	See Procedure	Tune T106 (Green) for maximum meter reading, and then re-adjust T105 for maximum meter reading. Then tune T107 for dip.
5.	F (Rel. Power out)	T107, T106 & T108	Maximum	Tune T107 and then T106 for maximum meter reading. Retune T107 for maximum meter reading , then tune T108 for maximum meter reading or power out.
6.	B (MULT-2)	T102 & T103	Maximum	Tune for maximum meter reading.
7.	C (MULT-3)	T103 & T104	Maximum	Tune T103 and T104 for maximum meter reading.
8.	D (AMPL-1)	T105 & T106	Maximum	Tune T105 and T106 for maximum meter reading.
9.	F	T107 & T108	Maximum	Tune T107 and T108 for maximum power output.
10.	D	T107 & T108	Maximum	Connect the black metering plug to the PA metering jack and tune T107 and T108 for maximum power out.
11.		R3	See Procedure	With the battery voltage at 13.6 Volts or the PA collector voltage at 13.0 Volts, set Power Adjust potentiometer R3 on the PA board for the desired power output from 8 to 25 watts as read on the wattmeter connected to antenna jack J2. If the battery voltage is not at 13.6 Volts or the collector voltage at 13.0 Volts and full rated output is desired (25 watts at 13.6 Volts), set R3 for the output power according to the battery voltage or collector voltage shown in Figure 5. NOTE The PA collector voltage is measured as described in the PA POWER INPUT section.

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 Executive 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): 16 Volts

These voltages are specified at the normal vehicle battery terminals of the radio and take the voltage drop of standard cables into account. The voltage 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 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; 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 R3.

Refer to the QUICK CHECKS on the Transmitter Troubleshooting Procedure.

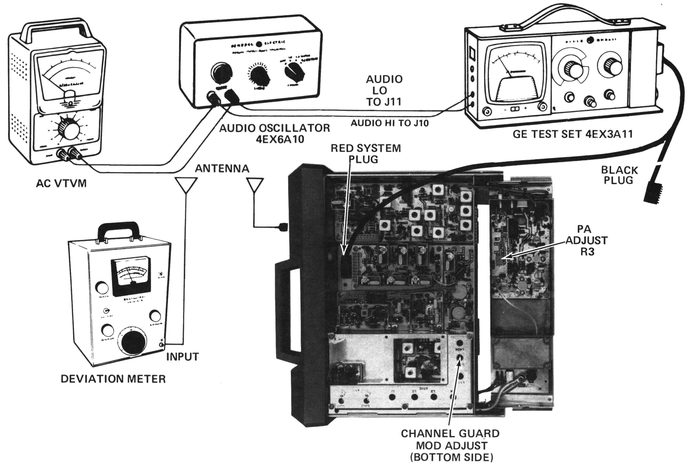
VOICE DEVIATION, SYMMETRY AND AUDIO SENSITIVITY

TEST PROCEDURE

1. Connect the test equipment to the transmitter as shown.
2. In radios with Channel Guard, set Channel Guard Mod Adjust for zero tone deviation.
3. Set the Audio generator output to 1.0 VRMS 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 R108 for the proper deviation on plus (+) or minus (-) deviation, whichever is greater.

NOTES:-- MASTR Executive 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 Step 1 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

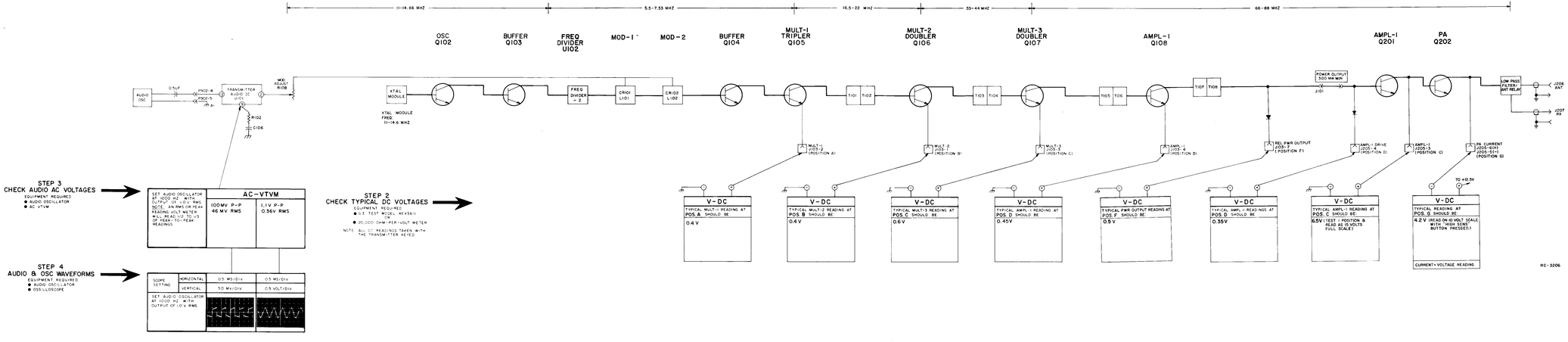
1. Set up the Deviation Meter and monitor the output of the transmitter.
2. Remove the 1000 Hz signal from the audio generator.
3. Key the transmitter and check for 0.75 kHz deviation. If the reading is low or high, adjust Channel Guard MOD ADJUST for a reading of 0.75 kHz.

NOTES:

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

STEP 1 - QUICK CHECKS

METER POSITION OR TEST SET	PROBABLE DEFECTIVE STAGE		
	HIGH METER READING	LOW METER READING	ZERO METER READING
	EXCITER BOARD		
A (MULT-1)	Q104, Q105, T101	Q104, Q105, CR101, CR102, L101, L102, U102, VR101, Q103	Q105, Q104, T101, Q102, U102, Q103, VR101
B (MULT-2)	Q106, T102	T101, T102, T103, Q106, R126	T101, T102, T103, Q106, R126
C (MULT-3)	Q107	T103, T104, T105, Q107, R131	T103, T104, Q107, R131
D (AMPL-1)	Q108,	T105, T106, Q108 C187, C185, R134	T105, T106, Q108, L107, L105
F (POWER OUT)	W216	CR103, R137, R136, T107, T108	Q108, CR103, R136 C187, C152, T107, T108
	POWER AMPLIFIER		
"D" (AMPL-1 DRIVE)	R8	Q108, C147-C152, C81, low output from Exciter	No output from Exciter, C81, C24, R7, R8
"E" (AMPL-1 POWER CONTROL VOLTAGE)	Q215, R3	Q201, Q202,	Q215, R3
"G" (PA CURRENT)	Q202	Q201, Q202,	Q202, Q201, Q215, R3



ORDERING SERVICE PARTS

Each component appearing on the schematic diagram is identified by a symbol number to simplify locating it in the parts list. Each component is listed by symbol number, followed by its description and GE Part Number.

Service parts may be obtained from Authorized GE Communication Equipment Service Stations or through any GE Radio Communication Equipment Sales Office. When ordering a part, be sure to give:

1. GE Part Number for component
2. Description of part
3. Model number of equipment
4. Revision letter stamped on unit

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance.

Should further information be desired, or should particular problems arise which are not covered sufficiently for the purchaser's purposes, contact the nearest Radio Communication Equipment Sales Office of the General Electric Company.
