DESCRIPTION AND MAINTENANCE

806—825 MHz, 25/35 WATT MASTR® EXECUTIVE II TRANSMITTERS

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DESCRIPTION

MASTR® Executive II transmitters are crystal controlled, frequency modulated transmitters designed for one through four frequency operation in the 806-825 MHz frequency band. This solid state, high reliability transmitter uses two integrated circuits, an FM ICOM module and discrete components to provide 25-Watts (Station) or 35-Watts (Mobile) of transmitted RF power. The transmitter consists of:

- Exciter Board with audio processor, oscillator board, FM ICOMS and frequency multiplier/amplifier stages.
- Power Amplifier Assembly; with amplifier, driver, PA final, power control and low pass filter assembly.

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

In addition to providing 65 milliwatts of RF power to the PA in the transmit mode, the exciter also provides 15 milliwatts RF injection to the receiver lst mixer in the receive mode.

The exciter contains the audio processor and the frequency multiplier/amplifier necessary to generate the transmitted RF carrier frequency. (This same frequency is always used to generate the receiverlst IF frequency). The FM ICOMS are located on a separate oscillator board located adjacent to the exciter board. The oscillator board is plugged into the exciter.

The power amplifier assembly utilizes six transistors (five stages) to provide rated output power, a low pass filter and a power control circuit to adjust the output power level for desired output. The radio operates in vehicles with negative ground only.

MAINTENANCE

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) Remove exciter top cover and unplug cables from exciter output jacks J101 and J102.

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

PA ASSEMBLY REMOVAL AND REPLACEMENT

NOTE

Component placement and connections on the printd wire board are very critical on the fixed tuned PA. For this reason it is recommended that the entire PA assembly be returned to the factory for servicing.

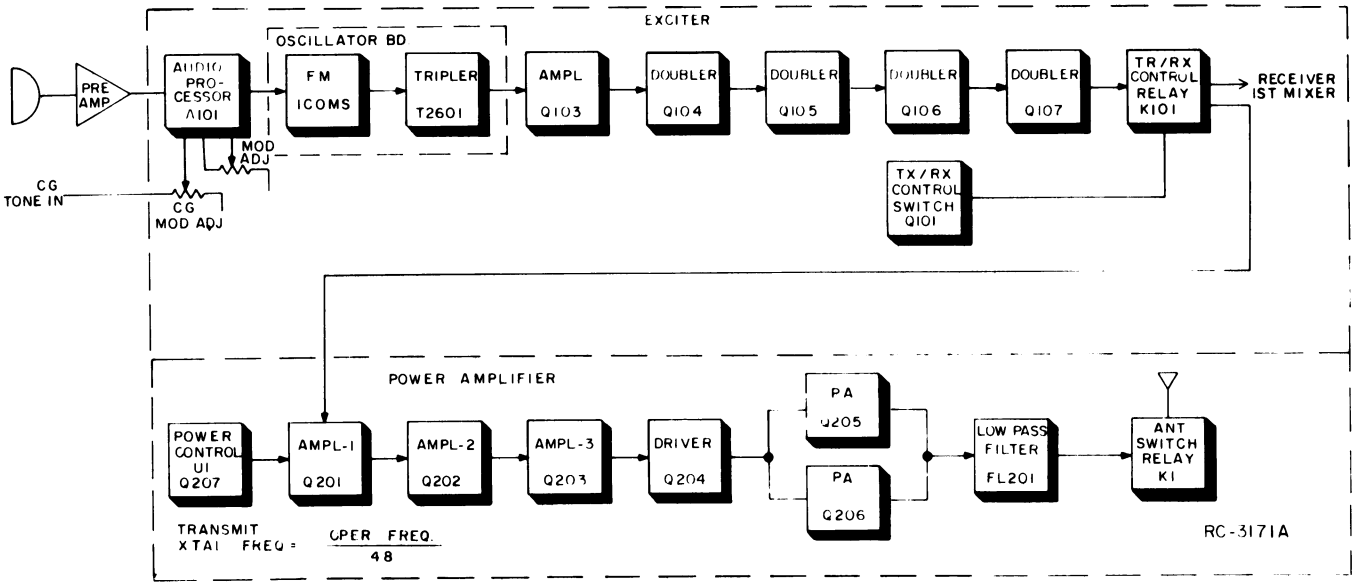

Figure 1 - Transmitter Block Diagram

To remove PA assembly:

1. Remove exciter cover and disconnect PA RF input cable from J101.
2. Unplug DC power input cable from J203.
3. Using a Phillips head screwdriver remove screw securing RF output cable to PA assembly and unplug RF output cable from J202 on Low Pass Filter.
4. Remove the two end screws securing the hinged PA assembly to the chassis and remove PA assembly.

To replace PA assembly, perform the above procedures in reverse order.

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. Be extremely careful to avoid damaging transistor when working with the PA Assembly.

TROUBLESHOOTING

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

10 VOLT REGULATOR U2601

SYMPTOM	PROCEDURE
No 10-Volt output	1. Check input voltage (A+) at P902-8 and U2601-1. 2. Remove the Power/Control cable from J901. Check for shorts from Pins 3, 7 and 14 to A-. These readings should be no less than 100 ohms. 3. Check Pass transistor Q2601. 4. Replace U2601.
Regulator output too high	1. Check Q2601. 2. Replace U2601.

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MODULATION LEVEL ADJUSTMENT

The MOD ADJUST Control R103 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 P902-4 (Mike High) through a 0.5 microfarad (or larger) DC blocking capacitor, and P902-5 (Mike-Low) on the exciter board.
2. Adjust the audio oscillator for 1-Volt RMS at 1000 Hz.
3. For transmitters without Channel Guard, set MOD ADJUST R103 for a 4.5-kilohertz swing with the deviation polarity that provides 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 R103 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 = 12.6 Volts x 7.9 amperes = 100.8 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 3 to 10 times better than the tolerance to be maintained, and with the entire radio as near as possible to an ambient temperature of 27.5°C (81.5°F).

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 27.5°C (81.5°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 (±5 PPM) at any temperature within the ranges of -30°C to -5°C (-22°F to +23°F) or +55°C to +60°C (+131°F to +140°F).

If the radio is at an ambient temperature of 27.5°C (81.5°F), set the oscillator for the correct operating frequency.

If the radio is not at an ambient temperature of 27.5°C, setting errors can be minimized as follows:

A. To hold the setting error to ±0.2 PPM (which is considered reasonable for 2 PPM ICOMS):

1. Maintain the radio at 27.5°C (±10°C) and offset the oscillator, as a function of actual temperature, by the amount shown in Figure 2.

For example: Assume the ambient temperature of the radio is 23.5°C (74.3°F). At that temperature, the curve shows a correction factor of 0.2 PPM. (At 806 MHz, 1 PPM is 806 Hz. At 825 MHz, 1 PPM is 825 Hz.

With an operating frequency of 806 MHz, set the oscillator for a reading of 162 Hz (0.2 x 806 Hz) higher than the licensed operating frequency. If a negative correction factor is obtained (at temperatures above 27.5°C) set the oscillator for the indicated PPM lower than the licensed operating frequency.

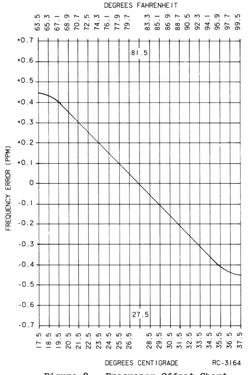
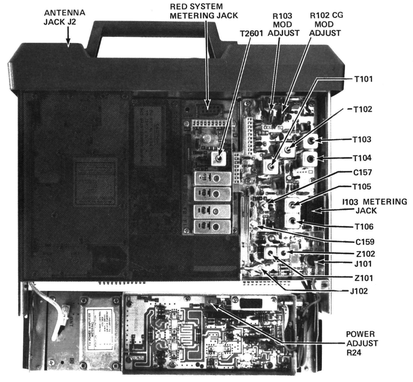


Figure 2 - Frequency Offset Chart



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.

PRELIMINARY CHECKS AND ADJUSTMENTS

1. Place all FM ICOMs on oscillator Board, (crystal frequency = operating frequency ÷ 48).
2. Preset all slugs (including Z101 and Z102) to the top of the coil form. Set R24 (Power Adjust) fully CCW.
3. Set C157 and C159 to minimum capacity (not meshed).

NOTE

The tuning frequency for multi-frequency transmitters is determined by the operating frequency and the frequency spread between transmitters. Refer to the table below for maximum frequency spread.

4. For multi-frequency transmitters equipped with 19D424068G1 exciters with a frequency spread less than that specified in column (1) tune the transmitters to the lowest frequency. For a frequency spread exceeding the limits specified in column (1) tune the transmitters using a center frequency tune up ICOM.
5. For multi-frequency transmitters equipped with 19D424068G2 exciters tune transmitters to lowest frequency.

Multi-Frequency Transmitter Tuning

Transmitter Frequency Range	Maximum Frequency Spread (19D424068G1)		Maximum Frequency Spread (19D424068G2)
	(1) Without center tuning	(2) With center tuning	
806-825 MHz	-0, +3 MHz	±3 MHz	+5 MHz

6. 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 "F" 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.

ALIGNMENT PROCEDURE

NOTE

Do not key transmitter during Alignment unless directed to do so. The exciter doubles as the receiver oscillator multiplier and therefore operates continuously.

STEP	METER POSITION	TUNING CONTROL	METER READING	PROCEDURE
		NOTE: When aligning transmitter, proceed as instructed below. DO NOT retune a previously tuned control unless specifically directed to do so.		
1.	B (MULT-1)	T2601, T101	See Procedure	Tune T2601 for maximum meter reading. Then tune T101 for a dip (small) in meter reading.
2.	C (AMPL)	T102, T103	See Procedure	Tune T102 for maximum meter reading, then tune T103 for a dip (small) in meter reading.
3.	D (MULT-2)	T104, T105	See Procedure	Tune T104 for maximum meter reading and then tune T105 for a dip in meter reading.
4.	F (MULT-3)	T106, C157	See Procedure	Tune T106 for maximum meter reading and then tune C157 for a dip in meter reading.
5.	G (MULT-4)	C159, Z101	See Procedure	Tune C159 for maximum meter reading, and then tune Z101 for a dip in meter reading.
6.	A (Rel. Power Out)	Z102	Maximum	Tune Z102 for maximum meter reading.
		NOTE: In transmitters equipped with exciter 19D424068G2 proceed to STEP 11.		
7.	C (AMPL)	T101, T102	Maximum	Alternately tune T101 and T102 for maximum meter reading.
8.	D (MULT-2)	T103, T104	Maximum	Alternately tune T103 and T104 for maximum meter reading.
9.	F (MULT-3)	T105, T106	Maximum	Alternately tune T105 and T106 for maximum meter reading.
10.	G (MULT-4)	C157, C159	Maximum	Tune C157 and C159 for maximum meter reading.
11.	D (INPUT DRIVE)	Z101, Z102	Maximum	Plug Test Set into PA metering jack, key transmitter and alternately tune Z101 and Z102 for maximum meter reading.
12.	WATT METER	R24	17 Watts	Key transmitter and set Power Adjust control for a reading of approximately 17 watts as indicated on wattmeter.
13.	D (INPUT DRIVE)	Z101, Z102	Maximum	Key transmitter and alternately tune Z101 and Z102 for maximum meter reading.
14.	WATT METER	R24		With the battery voltage at 13.6 Volts, key transmitter and set Power Adjust potentiometer R24 on the PA board for the desired power output from 10 to 35 Watts.

*Does not apply to transmitters using 19D424068G2 exciters.

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): 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 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 R24.

Refer to the QUICK CHECKS on the Transmitter Troubleshooting Procedure.

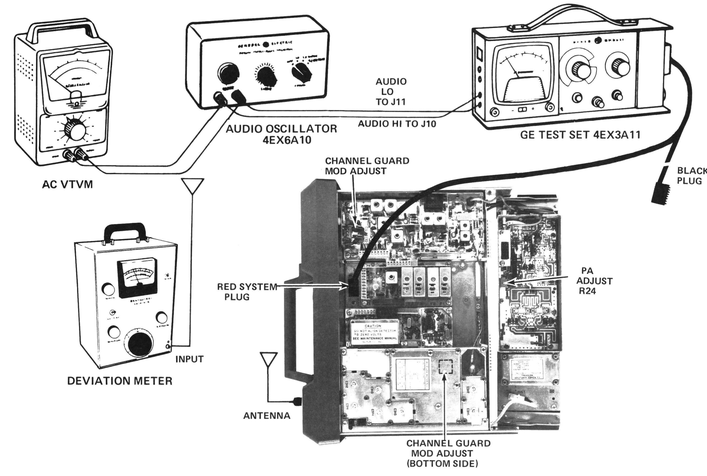
VOICE DEVIATION, SYMMETRY AND AUDIO SENSITIVITY

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 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 R103 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 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 for a reading of 0.75 kHz.

NOTE:

The Tone Deviation Test Procedures should be repeated every time the Tone Frequency is changed.

STEP I - QUICK CHECKS

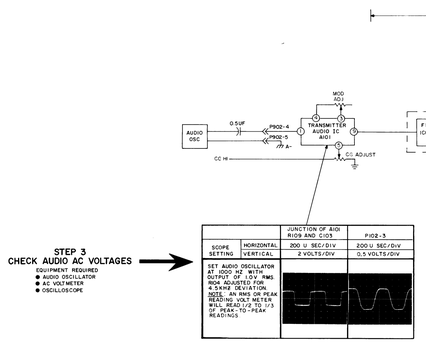
METER POSITION OF TEST SET	PROBABLE DEFECTIVE STAGE		
	HIGH METER READING	LOW METER READING	ZERO METER READING
EXCITER			
A (REL PWR)		Q106, Q107	Q103-Q107, CR102, C174, R153-R155, R157
B (MULT-1)	Q103, T101 10-Volt Regulator	T1 (Osc. Mod) Q103	T1 (Osc. Mod), T101 Q103
C (AMPL)	Q104, T103	Q104, T101, T102	Q104, T101, T102, T103
D (MULT-2)	Q105, T105	Q105, T104 T103	T104, T105, T103, Q105
F (MULT-3)	Q106, C155	Q106, T105, T106	T106, T105, L105, Q106
G (MULT-4)	Q107, Z101, Z102	Q107, C157, C159, Z101, Z102	Q107, C157, C159, Z101, Z102
POWER AMPLIFIER			
"C" (POWER CONTROL)		Q207, R24, U1, Q201	Q207, U1, R24
"D" (AMPL-1 INPUT)		Low Output from Exciter, CR1, C1	No Output from Exciter, CR1, C1
"F" (DRIVER CURRENT)	Q204, L22, L23, R11	Q203, Q204, Low Output from Exciter	No Output from Exciter, Q201-Q204 Check POS. C & D (K101, Q101, CR103 in Exciter)
"G" (PA CURRENT)	Q205, Q206	Q201-Q206	Q201-Q207

STEP 3
CHECK AUDIO AC VOLTAGES

EQUIPMENT REQUIRED
- AUDIO OSCILLATOR
- AC VOLTMETER
- OSCILLOSCOPE

SCOPE SETTING	HORIZONTAL	JUNCTION OF A101 R109 AND C103	P102-3
		200 U SEC/DIV	200 U SEC/DIV
	VERTICAL	2 VOLTS/DIV	0.5 VOLTS/DIV

SET AUDIO OSCILLATOR AT 1000 HZ WITH OUTPUT OF 1.0 V RMS. ADJUST FOR MAXIMUM DEVIATION. NOTE: AN RMS OR PEAK READING VOLT METER WILL READ 1/2 TO 1/3 OF PEAK-TO-PEAK READINGS

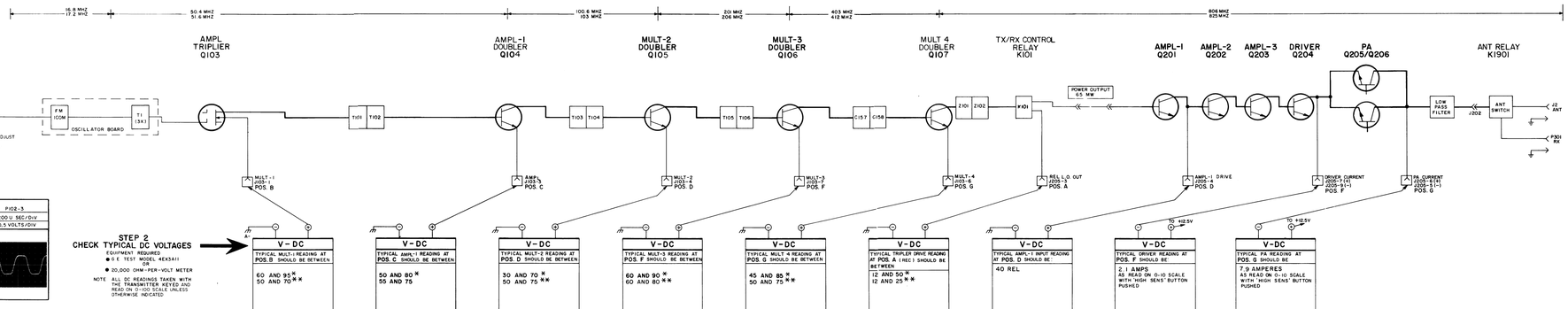


STEP 2
CHECK TYPICAL DC VOLTAGES

EQUIPMENT REQUIRED
- 0 E TEST MODEL 4EX3A11 OR
- 20,000 OHM-PER-VOLT METER

NOTE: ALL DC READINGS TAKEN WITH THE TRANSMITTER KEYED AND READ ON 0-100 SCALE UNLESS OTHERWISE INDICATED

* READINGS WHEN TRANSMITTER EQUIPPED WITH EXCITER 19042406BG1
** READINGS WHEN TRANSMITTER EQUIPPED WITH EXCITER 19042406BG2



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