MOBILE RADIO

DESCRIPTION AND MAINTENANCE
851-870 MHz, 90 WATT MASTR® II STATION TRANSMITTER

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ILLUSTRATION

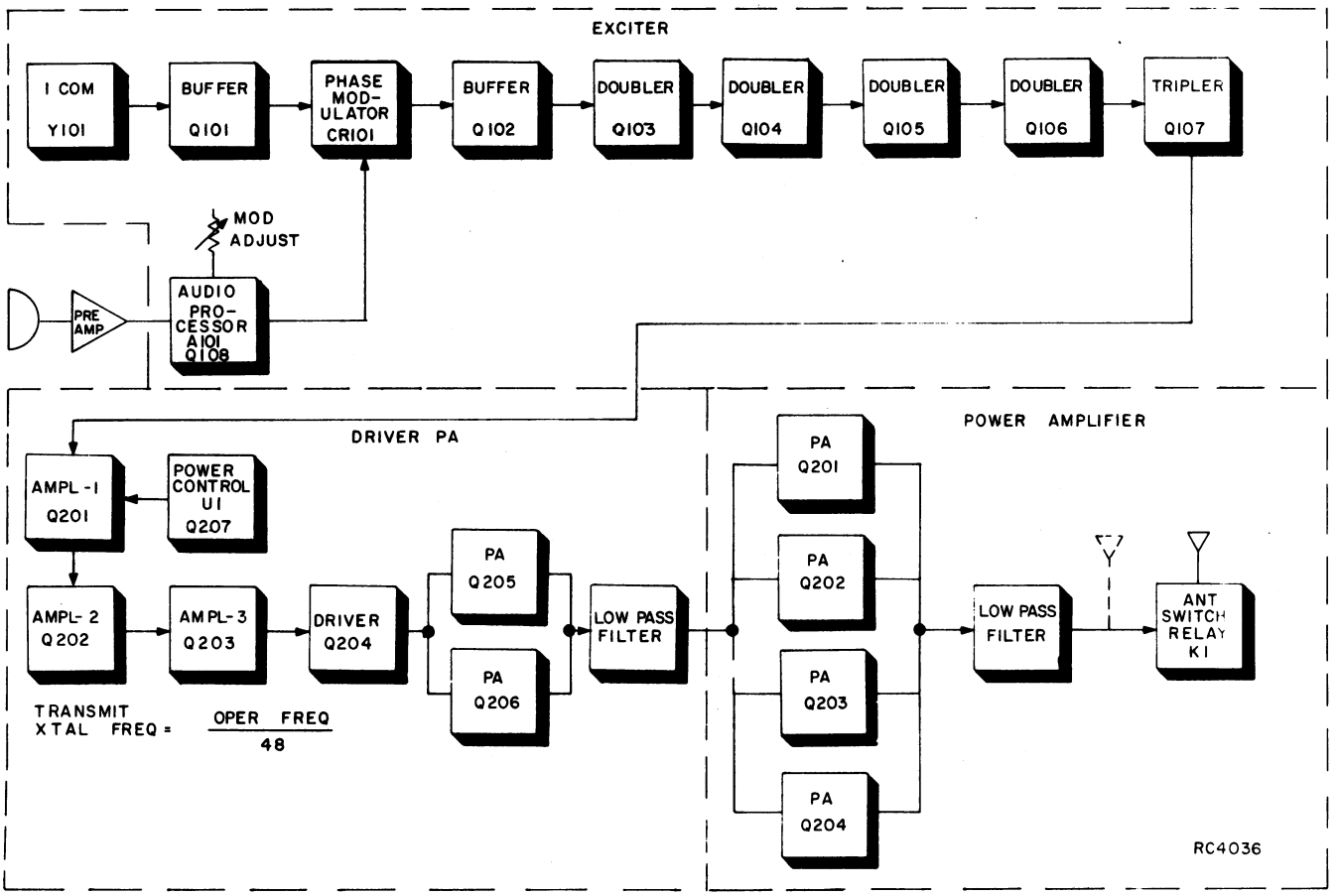

Figure 1 - Transmitter Block Diagram

GENERAL ELECTRIC COMPANY • MOBILE COMMUNICATIONS DIVISION
WORLD HEADQUARTERS • LYNCHBURG, VIRGINIA 24502 U.S.A.

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DESCRIPTION

The 851-870 MHz, 90 Watt MASTR® II transmitter is a crystal controlled, phase modulated transmitter designed for single frequency operation. The transmitter utilizes both integrated circuit (ICs) and discrete components and consists of the following modules:

- Exciter Board; with audio, modulator, amplifier and multiplier stages.
- Driver PA Assembly; with amplifier, driver, PA final, power control and low pass filter assembly.
- Power Amplifier with low pass filter assembly; with or without Antenna Relay.

Figure 1 is a block diagram of the 851-870 MHz MASTR II transmitter, showing the exciter, driver, and the Power Amplifier boards.

The Exciter contains the ±1 PPM Integrated Circuit Oscillator Module (ICOM), audio Processor, modulator and multipliers to provide the station operating frequency.

The driver PA assembly uses six RF power transistors to provide a minimum of 35 Watts drive power.

The PA assembly uses four RF power transistors in parallel to provide Rated Power output. The output power is adjustable over a range of 30 to 90 watts.

R24, located on the driver PA module, is used to adjust the PA assembly output power to any level from 30 Watts to rated RF output. The power control circuit consists of R24, Q207, Power Control IC (U1), and a directional coupler.

MAINTENANCE

DISASSEMBLY

For a more complete mechanical parts breakdown refer to the station MAINTENANCE MANUAL. To service the transmitter exciter from the front of the station:

1. Turn the two latching knobs on the front of the radio housing counter-clockwise to unlatch the radio housing front door.
2. Swing the door down.
3. Remove cover from the radio housing.

To remove Exciter Board:

1. Unplug the cables P101 and J902 from the Exciter.
2. Remove the four screws and two stand-offs holding the exciter board to the mounting frame and gently lift the exciter board out of the radio.

POWER AMPLIFIER AND DRIVER PA ASSEMBLY REMOVAL AND REPLACEMENT

NOTE

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

1. Disconnect the Driver PA RF input cable W202 at P101.
2. Disconnect the Driver PA RF output cable 19A136932G4 at J201.
3. Disconnect the Receiver cable at J945, 19A143454G1 for Simplex or 19A136932G6 for Isoplexer or Isolator panel options.
4. Disconnect the Red and Black DC input power leads.
5. Remove the six screws securing the Driver PA assembly to the chassis and remove the assembly.

To replace Driver 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 Driver PA or PA Assembly.

PA ASSEMBLY REMOVAL AND REPLACEMENT

To remove PA assembly:

1. Disconnect the PA RF input cable from J211.
2. Disconnect the Antenna cable from J212.
3. Disconnect the Receiver cable from J214 for Simplex.
4. Disconnect the Red and Black DC input power leads.
5. Remove the six screws securing the PA Assembly to the rack and remove the PA assembly.

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

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MODULATION LEVEL ADJUSTMENT

The MOD ADJUST (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. Voltmeter
4. GE Test Set Model 4EX3A11 or 4EX8K12
5. Frequency Counter
6. Oscilloscope
7. 50 ohm Wattmeter

PROCEDURE

1. Connect the audio oscillator and the meter across audio input terminals J10 (Green-Hi) and J11 (Black-Lo) on GE Test Set, and connect red Test Set plug to the System rear metering plug. If not using GE Test Set, connect audio oscillator and meter across P902-6 (Mike High) through a 0.5 microfarad (or larger) DC blocking capacitor, and P902-5 (Mike-Low) on the System Board.
2. Adjust the audio oscillator for 1 Volt RMS at 1000 Hz.
3. For transmitters without Channel Guard, set MOD ADJUST R103 for a 4.5 kHz 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 R102 for zero tone deviation. Next, with the 1 Volt signal at 1000 Hz applied, set MOD ADJUST R103 for 3.75 kHz deviation. Then remove the signal from the audio oscillator and set Channel Guard MOD ADJUST R102 for 0.75 kHz tone 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 K 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 (3V scale) and with the HIGH SENSITIVITY button pressed (30 amperes full scale).

Example:

P_i = 13.4 Volts x 18.4 amperes = 250 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 27.5°C (81.5°F).

MASTR II ICOMs should be reset only when the frequency shows deviation in excess of the following limits:

A. ±0.2 PPM, when the radio is at 27.5°C (81.5°F)

B. ±1 PPM at any other temperature within the range of -30°C to +85°C (-22°F to +185°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 27.5°C (81.5°F), set the oscillator for the correct operating frequency.

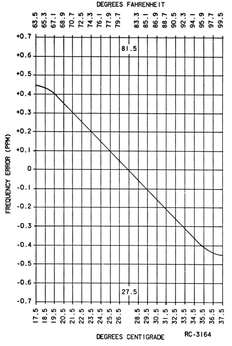
If the radio is not at an ambient temperature of 27.5°C, setting errors can be minimized as follows:

A. To hold the setting error to ±0.1 PPM (which is considered reasonable for 1 PPM ICOMs):

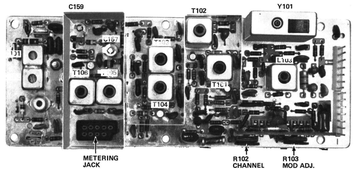
1. Maintain the radio at 27.5°C (81.5°F) and set the oscillator to desired frequency, or -
2. Maintain the radio at 27.5°C (110°C) and offset the oscillator, as a function of actual temperature, by the amount shown in the chart below.

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 0.44 PPM. (At 851 MHz, 1 PPM is 851 Hz. At 875 MHz, 1 PPM is 875 Hz.)

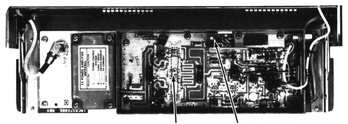
With an operating frequency of 851 MHz, set the oscillator for a reading of 374 Hz (0.44 x 851 Hz) higher than the licensed operating frequency. If a negative correction factor is obtained (at temperatures above 27.5°C), set the oscillator for the indicated PPM lower than the licensed operating frequency.



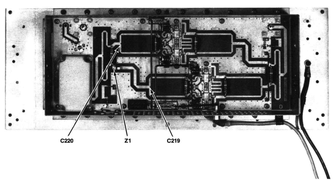
EXCITER



DRIVER AMPLIFIER



POWER AMPLIFIER



TRANSMITTER ALIGNMENT

EQUIPMENT REQUIRED

1. GE Test Set Model 4EX3A11 or Test Kit 4EX8K12.
2. A 50 ohm wattmeter capable of dissipating 150 Watts connected to the output terminal of the PA assembly.
3. A frequency counter.

PRELIMINARY CHECKS AND ADJUSTMENTS

1. Place ICOM on Exciter Board (crystal frequency = operating frequency ÷ 48).
2. For a large change in frequency or a badly mis-aligned transmitter, preset all slugs to the top of the coil form.
3. Set Z101 and Z102 to top of coil form.
4. Set both air variable capacitors to minimum capacity (not meshed).
5. 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.

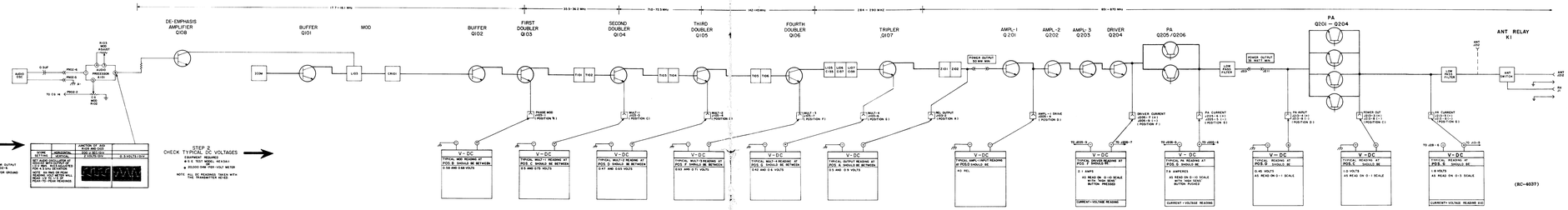
NOTE

With the Test Set connected to the driver metering jack, the voltage reading at position "G" with the HIGH SENSITIVITY button pressed may be converted to driver collector current by reading the current as 10 amperes full scale.

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
				NOTE When aligning transmitter, proceed as instructed below. DO NOT retune a previously tuned control unless specifically directed to do so.
1.	B (PHASE MOD)	L103, T101	See Procedure	Tune L103 for maximum meter reading. Then tune T101 for a dip (small) in meter reading.
2.	C (MULT-1)	T102 and T103	See Procedure	Tune T102 for maximum meter reading, then tune T103 for a dip in meter reading.
3.	D (MULT-2)	T104 and T105	See Procedure	Tune T104 for maximum meter reading and then tune T105 for a dip in meter reading.
4.	F (MULT-3)	T106 and C157	See Procedure	Tune T106 for maximum meter reading and then tune C157 for a dip in meter reading.
5.	G (MULT-4)	C159 and Z101	See Procedure	Tune C159 for maximum meter reading, and then tune Z101 for a dip in meter reading.
6.	A (REL OUTPUT)	Z102	Maximum	Tune Z102 for maximum meter reading.
7.	B (PHASE MOD)	L103	Maximum	Tune L103 for maximum meter reading.
8.	C (MULT-1)	T101 & T102	Maximum	In order, tune T101 and T102 for maximum meter reading.
9.	D (MULT-2)	T103 & T104	Maximum	Tune T103 and then T104 for maximum meter reading.
10.	F (MULT-3)	T105 & T106	Maximum	Tune T105 and then T106 for maximum meter reading.
11.	G (MULT-4)	C157 & C159	Maximum	Tune C157 and then C159 for maximum meter reading.
12.	D (INPUT DRIVE)	Z101, Z102	Maximum	Plug Test Set into Driver PA metering jack. Then alternately tune Z101 and Z102 for maximum meter reading.
13.				Install the 19B234368G1 Balance Test Lamp across R15 of driver. R15 is the output network balancing resistor.
14.		C221 & C222		Rotate both C221 and C222 air variable capacitors to their full minimum capacitance position. Use a NON-METALLIC tuning tool (12 VDC appears on the stator).
15.	G	R24	0-7.5 NOT TO EXCEED 10.0 (NOTE)	Key the transmitter and set Power Adjust Control (R24) for RATED POWER OUTPUT at the PA power output jack.
16.	G	C221	Minimum	Starting with C221, tune for a dip in collector current of the driver with the high-sensitivity button pressed on the test set. Note the value of the current at this dip. Return C221 to minimum capacitance position.
17.	G	C222	Minimum	Repeat Step 16 for C222.
18.	G	C221 or C222	Minimum	After you have determined which of the two variable capacitors (C221 or C222) results in the greatest dip in collector current, adjust that capacitor for minimum current.
19.	G	C221 or C222	See Procedure	Tune the other air variable capacitor (C221 or C222) for the best driver balance as indicated by the minimum brightness of the Test Lamp and by equal illumination of each half of the filament.
20.	G			Install the 19B234368G1 Balance Test lamp across R10 of the 90 Watt PA. R10 is the output network balancing resistor.
21.	G	C219 and C220		Rotate both C219 and C220 air variable capacitors to their full minimum capacitance position. Use a NON-METALLIC tuning tool to avoid possible RF arc-over.
22.	G	R24	0-7.5 NOT TO EXCEED 10.0 (NOTE)	Key the transmitter and set Power Adjust Control R24 on the driver for 50-Watts output as measured at the PA output jack.
23.	G	Z1	See Procedure	Adjust Z1 on the PA for minimum brilliance of the Balance Test Lamp.
24.	G	R24 and Z1	See Procedure	Increase power output to the RATED 90 WATTS by adjusting R24. Re-adjust Z1 for minimum Balance Test Lamp brilliance.
25.	G	C219 and C220	See Procedure	Alternately adjust the two variable capacitors C219 and C220 for maximum power output from the PA.
26.	G	Z1	See Procedure	Re-adjust Z1 to maintain minimum brilliance of the Balance Test Lamp.
27.	G	R24	See Procedure	Reset R24 on the driver to maintain the RATED 90 WATT output at the PA output jack.
28.	G	C219, C220, Z1, R24	Minimum	Repeat Steps 25, 26, 27 until no further decrease in the collector current of the driver can be obtained at rated power.



STEP 1- QUICK CHECKS

METER POSITION GE TEST SET	PROBABLE DEFECTIVE STAGE		
	HIGH METER READING	LOW METER READING	ZERO METER READING
EXCITER			
B (PHASE MOD)	Q102, Q103, T101	Q102, Q103, T101 ICOM	Q102, Q103, T101, ICOM
C (MULT-1)	Q104, T103	T101, T102, Q104	T101, T102, Q104, T103
D (MULT-2)	Q105, T105	T103, T104, Q105	T103, T104, Q105, T105
E (MULT-3)	Q106, C155	Q106, T105, T106	Q106, T105, T106, L105
G (MULT-4)	Q107, Z101, Z102	Q107, C159, C157	Q107, C159, C157, Z101, Z102
A (REL OUTPUT)		Q107	Q107, C174, CR102, R154, R153
DRIVER AMPLIFIER			
"C" (POWER CONTROL)		Q207, R24, U1, Q201	Q207, U1, R24
"D" (AMPL-1 INPUT)		Low Output from Exciter, CR1	No Output from Exciter, CR1, C1
"F" (DRIVER PA 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" (DRIVER PA CURRENT)	Q205, Q206	Q201-Q206	Q201-Q207
POWER AMPLIFIER			
"D" (POWER INPUT)	Check Setting of R24 Power Adjust	Check Setting of R24 Power Adjust	Check Driver Output
"C" (POWER OUT)	Check R24 Setting Q201-Q204	Check R24 Setting Q201-Q204	Check R24 Setting Q201-Q204 PA B+
"G" (PA CURRENT)	Check R24 Setting Q201-Q204	Check R24 Setting Q201-Q204	Check R24 Setting Q201-Q204 PA B+

TROUBLESHOOTING PROCEDURE

851—870 MHz, 90 WATT TRANSMITTER