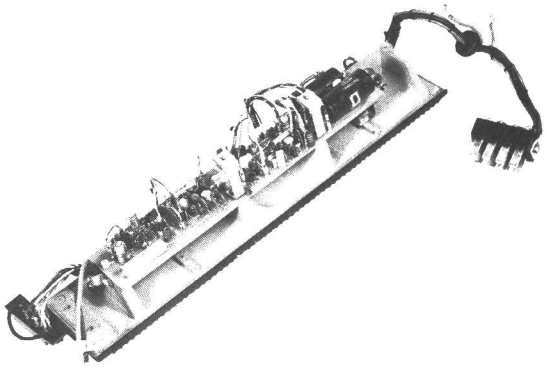
MOBILE RADIO

MASTR *Imperial*

POWER REGULATOR MODEL 4EP77A10



SPECIFICATIONS *

OUTPUT

	Voltage	Current
Receiver	Regulated +10 volts	125 milliamperes
Receiver Audio	Regulated +10 volts	50 milliamperes
Receiver Muting	Switched +10 volts	2.5 milliamperes
Transmitter Exciter	Continuous +10 volts	155 milliamperes
Transmitter PA	Keyed +10 volts	5 milliamperes

BATTERY DRAIN

Transmitter		
33-50 MHz	13.6 volts	12.0 amperes
150.8-174 MHz	13.6 volts	6.0 amperes
450-470 MHz	13.6 volts	9.5 amperes
Receiver		
Standby (Squelched)	13.8 volts	200 milliamperes
Standby (Unsquelched)	13.8 volts	1.2 amperes

BATTERY VOLTAGE — 13.6 volts ±20%, negative-ground 12-volt system

TEMPERATURE RANGE — -30°C to +60°C (-22°F to +140°F)

EP-77-A

hese 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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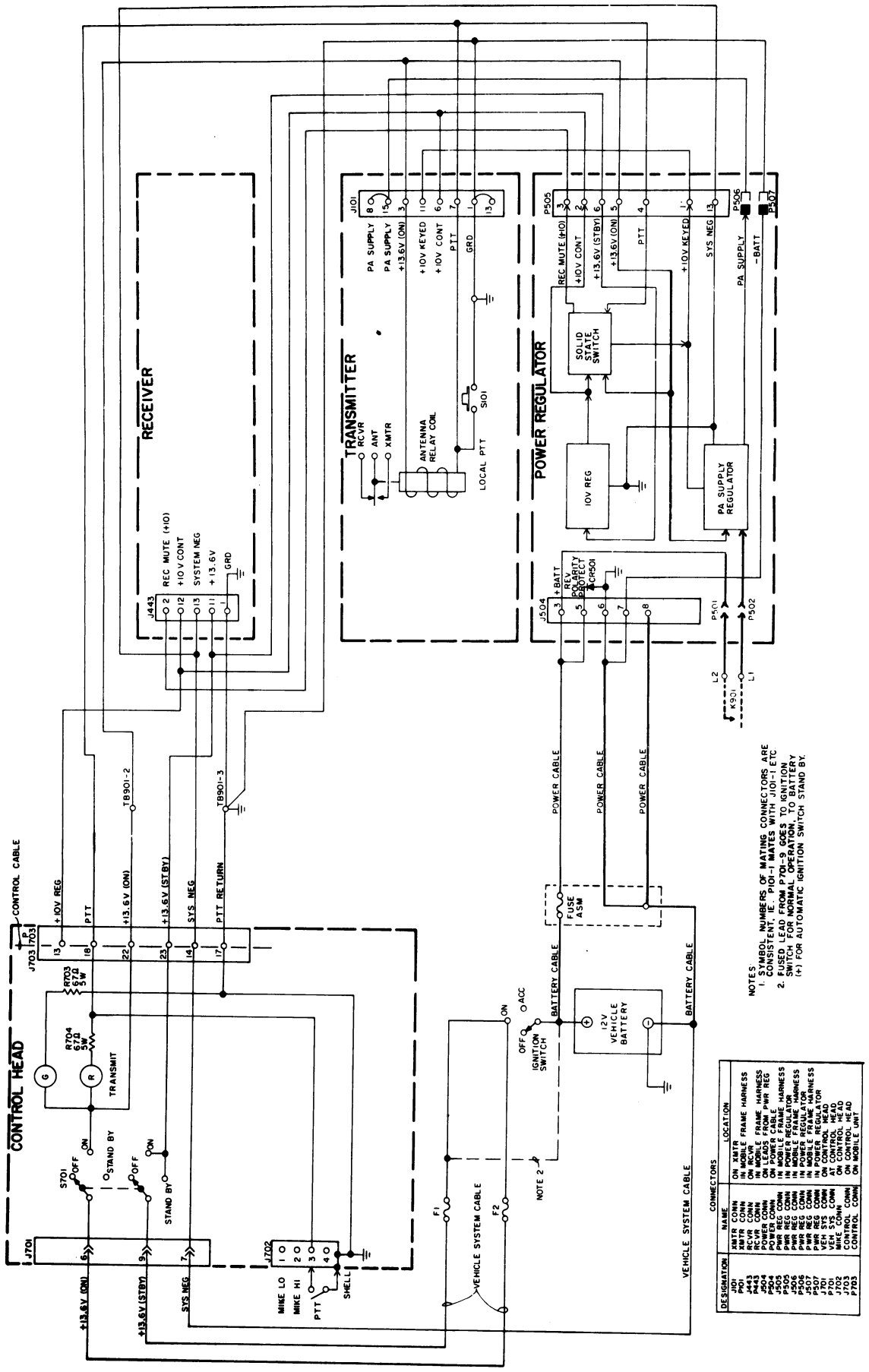
WARNING

No one should be permitted to handle any portion of the equipment that is supplied with voltage or RF power; or to connect any external apparatus to the units while the units are supplied with power. KEEP AWAY FROM LIVE CIRCUITS.



(19D416907, Rev. 0)

Figure 1 - 12-Volt, Negative Ground Power Distribution Diagram

DESCRIPTION

Transistorized Power Regulator Model 4EP77A10 contains the protective circuits for the transmitter PA stages, and provides all the regulated supply voltages for the two-way radio. Regulation of critical supply voltages provides improved performance over the wide range of input voltages encountered in mobile communications. The power regulator operates in 12-Volt, negative ground systems only, and provides the following supply voltages:

- A continuous, regulated +10 Volts for the transmitter exciter and receiver.
- A keyed, regulated +10 Volts for the transmitter exciter, receiver muting, power regulator protective circuitry and Channel Guard.
- A keyed, controlled +12.5 Volts for the transmitter PA supply.

Supply voltage (+13.6 Volts) for the receiver audio stages, transmitter PA regulator, the 10-Volt regulator, antenna switching relay and carrier control timer is taken directly from the vehicle battery. A simplified power distribution and switching diagram is shown in Figure 1.

The 10-Volt keying circuit, one stage of the 10-Volt regulator, two DC amplifiers stages, one RF power control stage, one constant current stage, two reference stages (integrated circuit), a differential amplifier comprising two stages, and the receiver mute circuit are mounted on printed wiring board A501.

PA regulator transistor Q501 and 10-Volt regulator Q502 are mounted on the regulator casting which acts as a heat sink for these stages.

CIRCUIT ANALYSIS

+10 VOLT REGULATOR

The +10-Volt regulator provides a closely-controlled supply voltage for the transmitter, receiver, Channel Guard and multi-frequency boards, and Carrier Control Timer.

Supply voltage from the vehicle battery is applied to the collector of regulator transistor Q502 through L6, causing the transistor to conduct (see Figure 2). When the output voltage at the emitter of Q502 tries to increase, the voltage at the base of Q10 tends to become more positive, causing Q10 to conduct harder. With Q10 conducting harder, the voltage at the base of transistor Q502 becomes less positive and Q502 conducts less. This increases the voltage drop across Q502, keeping the output voltage constant.

When the output voltage tries to decrease, Q10 conducts less, causing Q502 to conduct harder. This reduces the voltage drop across Q502, keeping the output constant.

Potentiometer R28 is used to set the emitter-base voltage of Q10 for the desired 10-Volt output. R26 limits maximum current through Q10. R36 provides bias current for Zener diode VR3, and R37 provides bias for Q502. The output voltage is metered at receiver centralized metering jack J442.

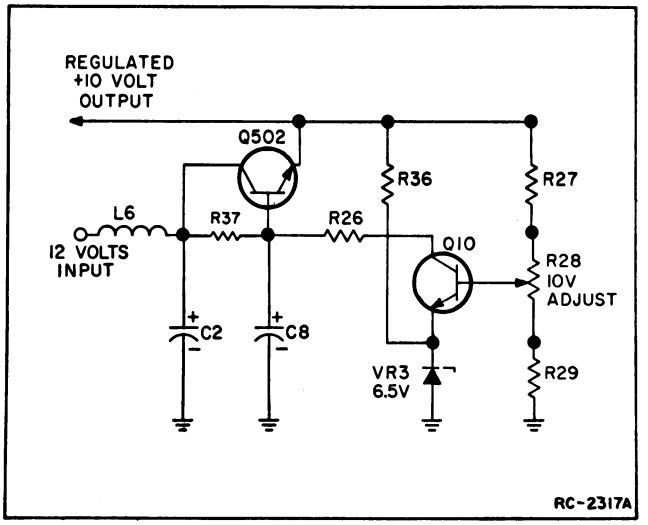


Figure 2 - +10 Volt Regulator Circuit

KEYED +10 VOLTS

A keyed +10 Volts is used to activate the transmitter and mute the receiver. Turning the OFF-ON switch on the control unit to the ON position applies the vehicle battery voltage to the anode of CR1. (see Figure 3). This forward biases the diode so that the battery voltage is applied to the base of gating transistor Q8.

With the battery voltage applied to the base of Q8, keying the microphone grounds the emitter, causing it to conduct. When conducting, the collector voltage of Q8 drops near ground potential, turning on PNP transmitter switching transmitter Q11. The nominal +10-Volt collector output voltage is applied to the transmitter exciter board, and to the transmitter PA regulator protective circuitry to key the transmitter.

The +10 Volts at the collector of Q11 also forward biases CR2, and VR4, turning off receiver switching transistor Q9. This removes +10 Volts normally applied to the receiver audio board, and mutes the receiver.

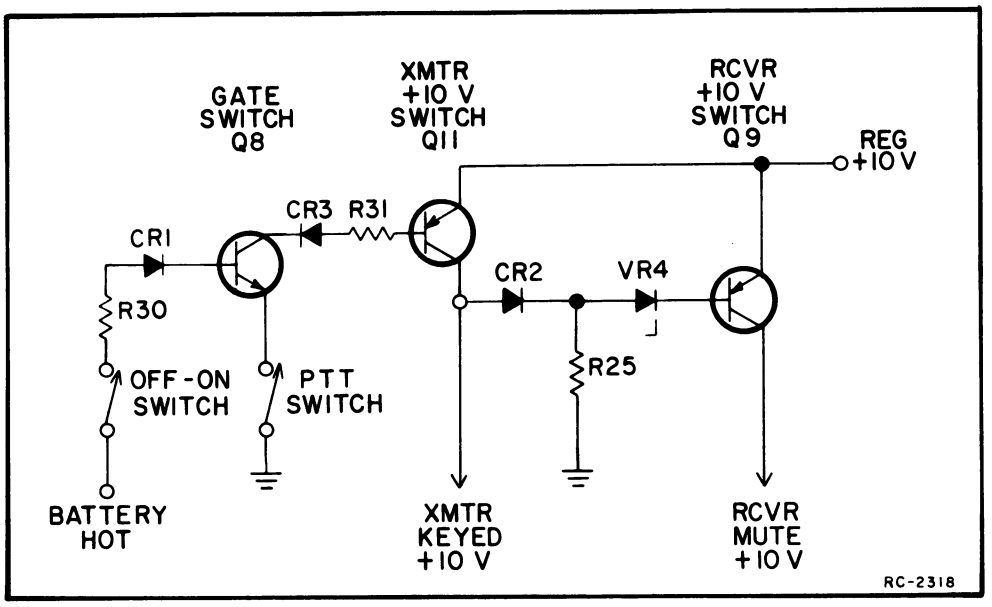


Figure 3 - +10 Volt Keying Circuit

Releasing the PTT switch on the microphone turns off the transmitter 10-Volt switch (Q11) on the regulator board, turning on the receiver switching transistor Q9. This applies +10 Volts to the receiver audio board permitting the receiver noise squelch circuit to operate.

PROTECTIVE CIRCUITS

The power regulator board, A501, senses the PA collector current and the input supply voltage and uses these parameters to control the collector voltage of the transmitter controlled amplifier stage. A differential amplifier (Q1 & Q3) is used to control a 2-stage D.C. amplifier (Q6 & Q7) which in turn controls the emitter-base bias of the controlled amplifier pass transistor Q501 (see Figure 4). An integrated circuit (Q4A & Q4B) is used as the reference transistor for the PA collector sensing voltage and the DC input voltage. Q5 is used in conjunction with potentiometer R13 to provide a means of adjusting the RF power output by controlling the transmitter controlled amplifier collector voltage.

The voltage drop (approximately 100 MV) across the transmitter PA Collector metering resistor is used to sense the current changes as a result of detuning or an antenna mismatch. This voltage appears between J18 and J2 of the power regulator board A501. Bias for Q4B is determined by precision resistors R1, R2, and R3 in addition to the voltage drop across the metering resistor.

When the PA collector current increases, Q4B conducts harder, causing the base voltage of Q1 to rise. Increasing the base voltage to Q1 lowers its collector voltage, causing Q6 and Q7 to conduct less. Reduced conduction of Q7 causes Q501 to conduct less, increasing the voltage drop from emitter to collector, which lowers the collector voltage supplied to the controlled amplifier stage. This reduces the RF driver power to the driver and PA stages and causes the collector current to drop, completing the regulation loop.

In a similar fashion an increase in input supply voltage causes the collector voltage of Q5 to rise. This results in a lower emitter-base voltage of Q3 is increased and Q3 conducts more, resulting in Q1 conducting less. The collector voltage of Q1 then drops and the regulation loop is completed as before. Q2 serves as a constant current source of approximately 4 milliamperes for the differential amplifier.

MAINTENANCE

HEAT SINK SERVICING

Since the metal heat sink of Q501, and Q502 are at collector potential, they must be electrically isolated from ground. However, there must be a good path for heat from the transistors to reach the cast aluminum radiator (heat sink) in which they are mounted, so that the heat will be dissipated by the heat sink. The insulators

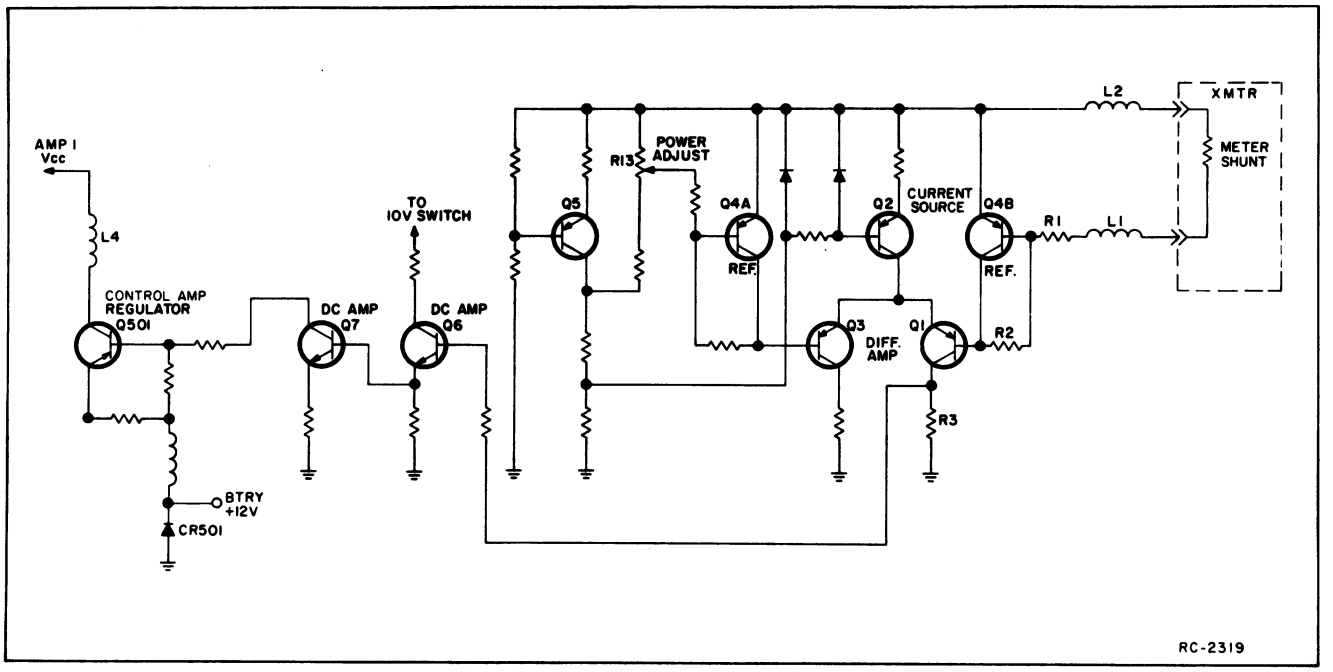


Figure 4 - PA Protective Circuits

used between the transistors and the heat sink not only isolate the transistors electrically, but also act as a good thermal conductor to conduct heat away from them.

Silicone grease is used on each side of the transistor insulators to improve the thermal contact, and allow the heat to be transferred more readily to the heat sink. Always make sure that there is a coating of silicone grease on each side of the insulator whenever one of the transistors is replaced.

RE-INSTALLATION

The MASTR Imperial mobile combination operates in 12-Volt, negative ground vehicle systems only! If the radio is ever moved to a different vehicle, always check the battery polarity and voltage of the new system before using the radio.

CAUTION

Do not install the MASTR Imperial in a vehicle system using a circuit breaker. The radio must be operated in a system protected by a 15-amp quick blow fuse (similar to GE Fuse Assembly 19B216021G4 and fuse 1R11-P4).

DISASSEMBLY (Figure 5)

To service the power regulator:

1. Pull the locking handle down and pull radio out of mounting frame.
2. Remove the two screws in bottom cover and take off cover.

To remove the power regulator from the system frame:

1. Complete Steps 1 and 2 above.
2. Remove the two Phillips-head retaining screws in the front casting and pull casting away from system frame.
3. Unplug the power cable and pry power connector out of connector supporting bracket. Next, unplug systems connector and the two clip-on connectors at the back of the power regulator.
4. Lift the Two-Way Radio away from power regulator.

ADJUSTMENT

The Power Regulator board A501 has two adjustments for setting the regulated +10 Volts and the power output.

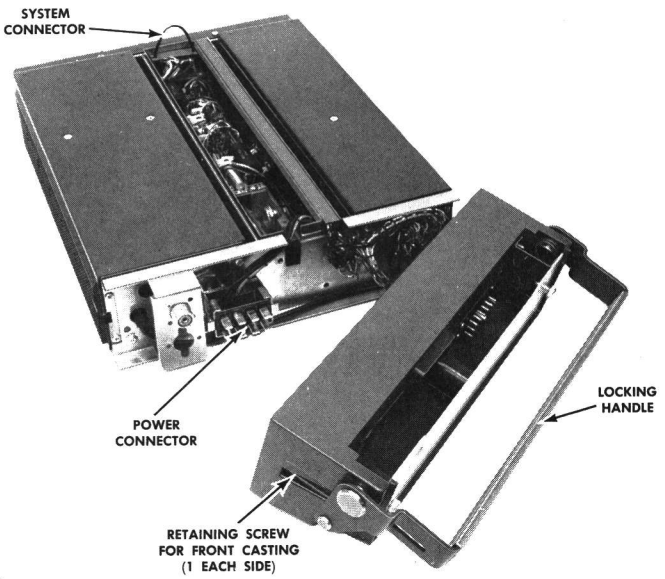


Figure 5 - Disassembly of Power Regulator

To set +10 Volts, connect the GE Test Set 4EX3A10 to Receiver Metering Jack J422 and check for +10 Volts at position J. If the reading is not +10 Volts adjust R28 on the Power Regulator board.

Power adjustment R13 regulates transmitter power out. For adjustment of R13 refer to the transmitter alignment procedure (LBI-4384 or LBI-4386).

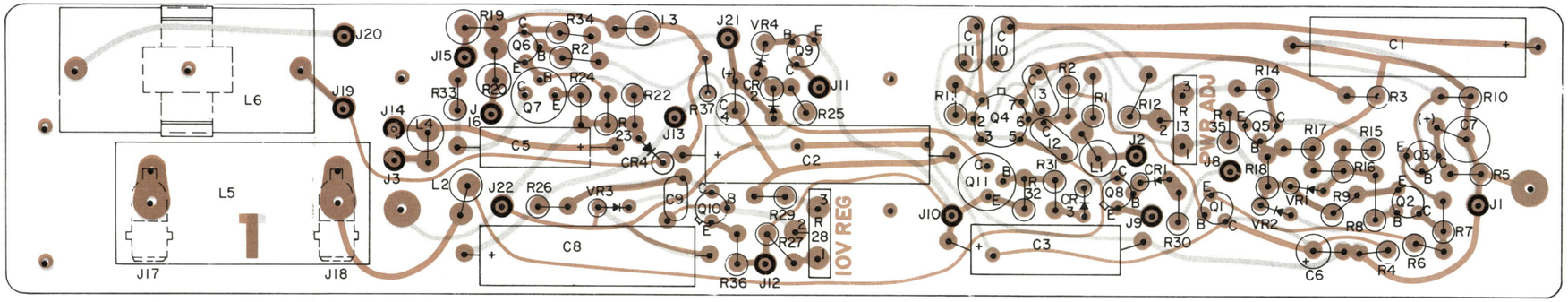
TROUBLESHOOTING PROCEDURE

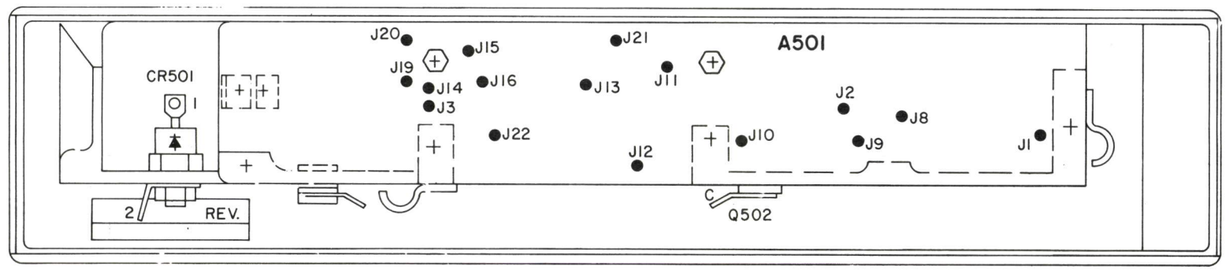
POWER REGULATOR MODEL 4EP77A10

This procedure should be used in conjunction with voltage readings on the power regulator schematic diagram (see Table of Contents).

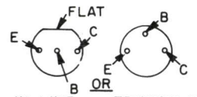
SYMPTOM	PROCEDURE
No PA supply voltage (Vcc) when transmitter is keyed. (Check with GE Test Set Model 4EX3A10 in Position G on the 15-volt scale, and polarity switch in (-) position).	1. Check the 15-amp input fuse in the battery cable. 2. Check Relay K901. 3. Check L5 and connections to L5 on Power Regulator Board A501.
No regulated +10 Volts.	1. Check input fuse. Check setting of R28. 2. Check for approximately +12 Volts at collector of Q502. If voltage is present, check for defective Q10, Q502 or VR3.
Receiver does not mute when transmitter is keyed.	1. Check CR2, VR4 and Q9. 2. Check wiring from A501-J11.
Vcc too low.	1. Check for high resistance or poor connections at P501, P502, P506, P517 and P518. 2. Check for defective L5.
No keyed 9.5 Volts	1. Check wiring from A501-J21. 2. Q8 and Q11 on A501. 3. Check PTT wiring from A501-J9.
No Pre-Driver Vcc at P505-9	1. Check voltages at A501-J3 2. Check voltages at Q501. 3. Check voltages on Q1-Q7.
Power output cannot be adjusted with R13.	1. Check voltages at A501-J3. It should vary as R13 is adjusted. 2. Check voltages indicated on schematic diagram.

POWER REGULATOR BOARD
A501





LEAD IDENTIFICATION
FOR Q6, Q8 & Q10

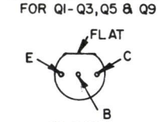


IN-LINE TRIANGULAR
VIEW FROM LEAD END

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

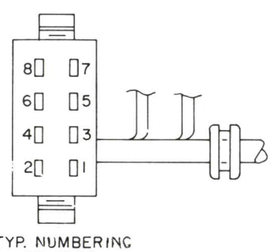
RUNS ON SOLDER SIDE
RUNS ON BOTH SIDES
RUNS ON COMPONENT SIDE

LEAD IDENTIFICATION
FOR Q1-Q3, Q5 & Q9

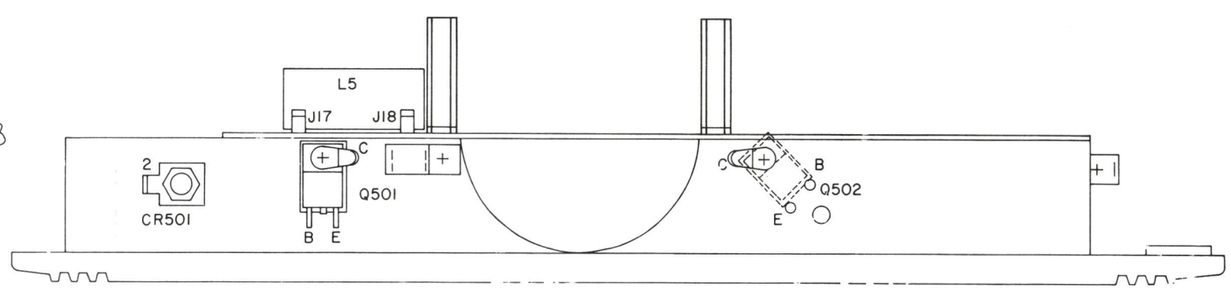


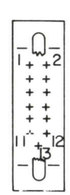
IN-LINE
VIEW FROM LEAD END

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



TYP. NUMBERING
OF J504



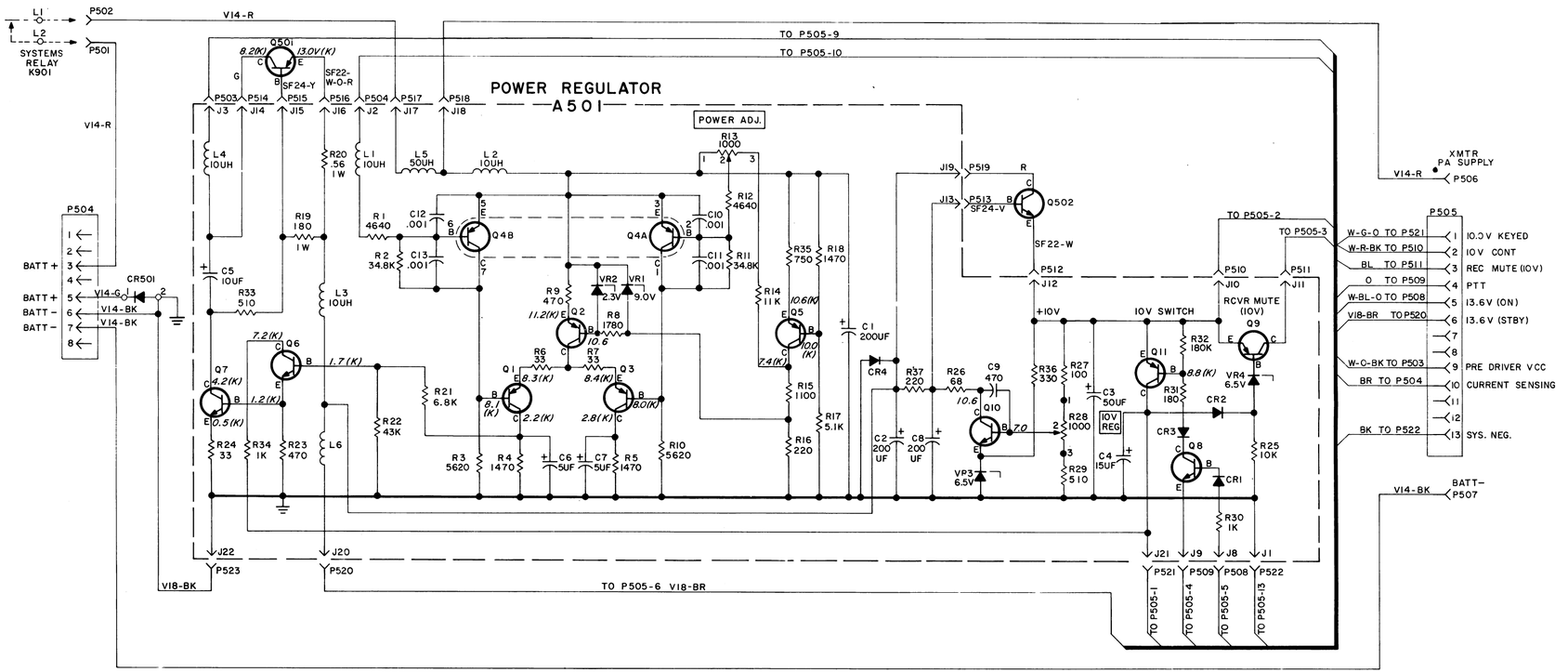


VIEW OF P505

OUTLINE DIAGRAM

POWER REGULATOR
MODEL 4EP77A10

(19D416943, Rev. 3)
(19D416417, Sh. 1, Rev. 1)
(19D416417, Sh. 2, Rev. 1)



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.

SEE APPLICABLE PRODUCTION CHANGE SHEETS IN INSTRUCTION BOOK SECTION DEALING WITH THIS UNIT, FOR DESCRIPTION OF CHANGES UNDER EACH REVISION LETTER.

THIS ELEM DIAG APPLIES TO	
MODEL NO	REV LETTER
4EP77A10	C

NOTES:

1. ALL WIRES N22 UNLESS OTHERWISE SPECIFIED.
2. VOLTAGE READINGS TAKEN WITH 20,000 OHMS PER VOLT METER. (K) FOLLOWING VOLTAGE READING IS IN THE KEYED MODE.

(19D416423, Rev. 7)

SCHEMATIC DIAGRAM

POWER REGULATOR MODEL 4EP77A10

PARTS LIST

LBI-4377C

POWER REGULATOR
MODEL 4EP77A10

SYMBOL	GE PART NO.	DESCRIPTION
A501		POWER REGULATOR BOARD 19D416535G1
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C1 and C2	19A115680P10	Electrolytic: 200 µf +150% -10%, 18 VDCW; sim to Mallory Type TT.
C3	19A115680P4	Electrolytic: 50 µf +150% -10%, 25 VDCW; sim to Mallory Type TT.
C4	5496267P14	Tantalum: 15 µf ±20%, 20 VDCW; sim to Sprague Type 150D.
C5	19A115680P8	Electrolytic: 10 µf +150% -10%, 25 VDCW; sim to Mallory Type TT.
C6 and C7	19A115680P2	Electrolytic: 5 µf +150% -10%, 25 VDCW; sim to Mallory Type TT.
C8	19A115680P10	Electrolytic: 200 µf +150% -10%, 18 VDCW; sim to Mallory Type TT.
C9	7774750P1	Ceramic disc: .00047 µf +100% -0%, 500 VDCW.
C10 thru C13	5494481P111	Ceramic disc: 1000 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
		- - - - - - - DIODES AND RECTIFIERS - - - - - -
CR1 thru CR3	19A115250P1	Silicon.
CR4*	4037822P1	Silicon. Added by REV B.
		- - - - - - - - INDICATING DEVICES - - - - - - - -
DS1*	4034664P1	Lamp, incandescent: 28 v; sim to GE2148. Deleted by REV B.
		- - - - - - - JACKS AND RECEPTACLES - - - - - - -
J1 thru J3	4033513P4	Contact, electrical: sim to Bead Chain L93-3.
J8 thru J16	4033513P4	Contact, electrical: sim to Bead Chain L93-3.
J17 and J18	4033284P3	Terminal; sim to Alcon 3-1243.
J19 thru J22	4033513P4	Contact, electrical: sim to Bead Chain L93-3.
		- - - - - - - - - - INDUCTORS - - - - - - - - - -
L1 thru L4	7488079P43	Choke, RF: 10.0 µh ±10%, 0.30 ohms DC res max; sim to Jeffers 4422-4K.
L5	19A115392P1	Choke, RF: 50 µh ±10%, .02 ohm DC res max.
L6	19A115894P1	Audio freq: 1.0 mh inductance, 0.35 ohms DC res.
		- - - - - - - - - - TRANSISTORS - - - - - - - - - -
Q1* thru Q3*	19A115852P1	Silicon, PNP; sim to Type 2N3906.
		In REV B and earlier:
	19A115768P1	Silicon, PNP; sim to Type 2N3702.

SYMBOL	GE PART NO.	DESCRIPTION
Q4	19A116597P1	Silicon, Dual, PNP; sim to Type 2N4939.
Q5*	19A115852P1	Silicon, PNP; sim to Type 2N3906.
		In REV B and earlier:
	19A115768P1	Silicon, PNP; sim to Type 2N3702.
Q6*	19A116774P1	Silicon, NPN; sim to Type 2N5210.
		In REV B and earlier:
	19A115362P1	Silicon, NPN; sim to Type 2N2925.
Q7	19A115300P1	Silicon, NPN; sim to Type 2N3053.
Q8*	19A116755P1	Silicon, NPN; sim to Type 2N3947.
		In REV B and earlier:
	19A115123P1	Silicon, NPN; sim to Type 2N2712.
Q9*	19A115852P1	Silicon, PNP; sim to Type 2N3906.
		In REV B and earlier:
	19A115768P1	Silicon, PNP; sim to Type 2N3702.
Q10*	19A116755P1	Silicon, NPN; sim to Type 2N3947.
		In REV B and earlier:
	19A115123P1	Silicon, NPN; sim to Type 2N2712.
Q11	19A115976P1	Silicon, PNP; sim to Type 2N4356.
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R1	19A116278P265	Metal film: 4640 ohms ±2%, 1/2 w.
R2	19A116278P353	Metal film: 34,800 ohms ±2%, 1/2 w.
R3	19A116278P273	Metal film: 5620 ohms ±2%, 1/2 w.
R4 and R5	19A116278P217	Metal film: 1470 ohms ±2%, 1/2 w.
R6 and R7	3R77P330J	Composition: 33 ohms ±5%, 1/2 w.
R8	19A116278P225	Metal film: 1780 ohms ±2%, 1/2 w.
R9	3R77P471J	Composition: 470 ohms ±5%, 1/2 w.
R10	19A116278P273	Metal film: 5620 ohms ±2%, 1/2 w.
R11	19A116278P353	Metal film: 34,800 ohms ±2%, 1/2 w.
R12	19A116278P265	Metal film: 4640 ohms ±2%, 1/2 w.
R13*	19B209358P103	Variable, carbon film: approx 25 to 1000 ohms ±10%, 0.2 w; sim to CTS Type X-201.
		Earlier than REV A:
	19B209358P102	Variable, carbon film: approx 25 to 500 ohms ±10%, 0.2 w; sim to CTS Type X-201.
R14	3R77P113J	Composition: 11,000 ohms ±5%, 1/2 w.
R15	3R77P112J	Composition: 1100 ohms ±5%, 1/2 w.
R16	3R77P221J	Composition: 220 ohms ±5%, 1/2 w.
R17	3R77P512J	Composition: 5100 ohms ±5%, 1/2 w.
R18	19A116278P217	Metal film: 1470 ohms ±2%, 1/2 w.
R19	3R78P181J	Composition: 180 ohms ±5%, 1 w.
R20	19B209022P109	Wirewound: 0.56 ohms ±10%, 2 w; sim to IRC Type BWH.
R21	3R77P682J	Composition: 6800 ohms ±5%, 1/2 w.
R22	3R77P433J	Composition: 43,000 ohms ±5%, 1/2 w.
R23	3R77P471J	Composition: 470 ohms ±5%, 1/2 w.
R24	3R77P330J	Composition: 33 ohms ±5%, 1/2 w.
R25	3R77P103J	Composition: 10,000 ohms ±5%, 1/2 w.
R26	3R77P680J	Composition: 68 ohms ±5%, 1/2 w.
R27	3R77P101J	Composition: 100 ohms ±5%, 1/2 w.
R28	19B209358P103	Variable, carbon film: approx 25 to 1000 ohms ±10%, 0.2 w; sim to CTS Type X-201.
R29	3R77P511J	Composition: 510 ohms ±5%, 1/2 w.
R30	3R77P102J	Composition: 1000 ohms ±5%, 1/2 w.

SYMBOL	GE PART NO.	DESCRIPTION
R31	3R77P181J	Composition: 180 ohms ±5%, 1/2 w.
R32	3R77P184J	Composition: 0.18 megohm ±5%, 1/2 w.
R33	3R77P511J	Composition: 510 ohms ±5%, 1/2 w.
R34	3R77P102J	Composition: 1000 ohms ±5%, 1/2 w.
R35	3R77P751J	Composition: 750 ohms ±5%, 1/2 w.
R36	3R77P331J	Composition: 330 ohms ±5%, 1/2 w.
R37*	3R152P221K	Composition: 220 ohms ±10%, 1/4 w. Added by REV B.
		- - - - - - - VOLTAGE REGULATORS - - - - - - -
VR1	4036887P7	Silicon, Zener.
VR2	4036887P1	Silicon, Zener.
VR3 and VR4	4036887P6	Silicon, Zener.
		- - - - - - - DIODES AND RECTIFIERS - - - - - -
CR501	19A115617P2	Silicon.
		- - - - - - - JACKS AND RECEPTACLES - - - - - -
J504	19A121524G1	Connector, phen: 8 contacts rated at 15 amps at 1100 VRMS.
		- - - - - - - - - - PLUGS - - - - - - - - - -
P501 and P502	19B209151P1	Terminal, solderless: sim to AMP 42284-5.
P503 and P504	4029840P2	Contact, electrical: sim to Amp 42827-2.
P505	19B204781P1	Plug, phen: 13 female contacts.
P506 and P507	19B209151P1	Terminal, solderless: sim to AMP 42284-5.
P508 thru P516	4029840P2	Contact, electrical: sim to Amp 42827-2.
P517 and P518	19B209151P1	Terminal, solderless: sim to AMP 42284-5.
P519	4029840P2	Contact, electrical: sim to Amp 42827-2.
P520	4029840P1	Contact, electrical: sim to AMP 41854.
P521 thru P523	4029840P2	Contact, electrical: sim to Amp 42827-2.
		- - - - - - - - - - TRANSISTORS - - - - - - - - - -
Q501	19A116375P1	Silicon, PNP.
Q502	19A116118P3	Silicon, NPN.
		HARNESS ASSEMBLY 19D416413G2 (Includes P501-P504, P505-P514, P516-P523, Q501).
		MECHANICAL PARTS (See RC-2321)
1	19C311823P1	Heat sink.
2	4036835P3	Terminal, solderless.
3	N404P13C6	(Not Used).
4	19A121220P1	(Not Used).
5	7160861P28	(Not Used).
6	19B201074P306	(Not Used).
7	7763541P5	Clip, spring tension.
8	4036555P1	Insulator, disc. (Used with Q7, Q11).
9	19B201074P305	Screw, tap: No. 6-32 x 5/16.
10	7763541P4	Clip, spring tension.

SYMBOL	GE PART NO.	DESCRIPTION
11	19B200525P153	Rivet, tubular. (Used with L6).
12	7118719P10	Retainer. (Used with L6).
13	4035711P4	(Not Used).
14	19B200525P52	(Not Used).
15	19A116023P1	Insulator, plate. (Used with Q501, Q502).
16	4036835P9	Terminal, solderless. (Used with Q501, Q502).
17	19A121882P1	Washer. (Used with Q501, Q502).
18	19A121271P1	Insulator. (Used with P505).
19	5490407P8	Grommet, rubber. (Used with J504).

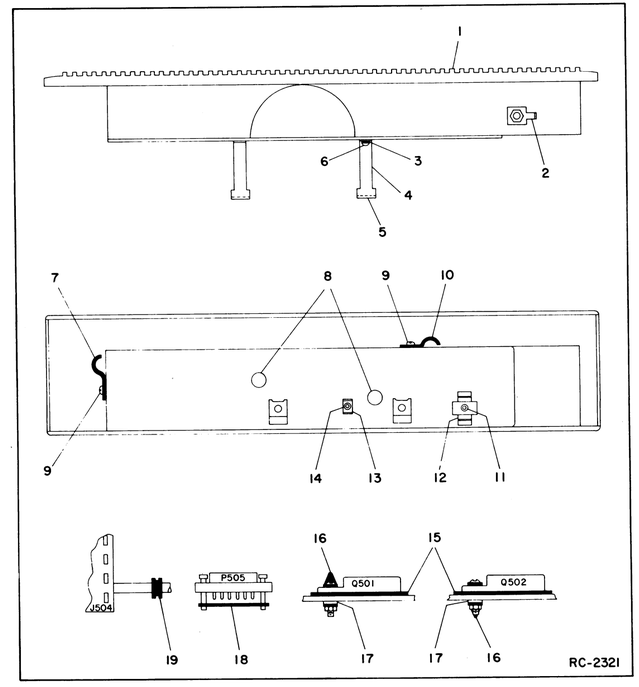
PRODUCTION CHANGES

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 - To compensate for transistor variations.
Changed R13.

REV. B - To improve reliability.
Deleted DS1.
Added R37 and CR4.

REV. C - To incorporate new transistors.
Changed Q1-Q3, Q5, Q6, Q8 and Q9.



*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

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.

MAINTENANCE MANUAL

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MOBILE RADIO DEPARTMENT
GENERAL ELECTRIC COMPANY • LYNCHBURG, VIRGINIA 24502

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