MAINTENANCE MANUAL
406-512 MHz, 100 WATT POWER AMPLIFIER ASSEMBLY
19D4246B6G14-17, G31-34, G37 AND G38 (MOBILE AND STATION)
19D4246B9G14-17, G31-34, G38 AND G39 (CONTINUOUS DUTY STATION)

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DESCRIPTION

The PA assembly uses two amplifier modules to provide rated output power. The PA Driver module uses four RF power transistors to provide RF drive to the PA module. The Power Amplifier module consists of four paralleled RF Power Transistors connected by a transmission line splitter arrangement at the input, and a combiner arrangement at the output. R213, located on the PA Driver module, is used to adjust the output power over a range of 30 Watts to rated output power. The power control circuit consists of R213, Q215 and Power Control IC (U201). Included in the PA assembly, is a Low Pass Filter/Antenna Switch module used to suppress undesired harmonic frequency components and provide antenna switching for the receiver and the transmitter.

SUPPLY VOLTAGE

Supply voltage for the PA is connected through power leads from the system board to feed through capacitors C297 and C298 on the bottom of the PA assembly (See Schematic Diagram). C297, C298, C299 prevent RF from getting on the power leads. Diodes CR295 will cause the main fuse assembly to blow if the polarity of the power leads is reversed, providing reverse voltage protection for the radio.

The PA assembly is insulated from vehicle ground to permit operation in positive or negative ground vehicles.

NOTE

In positive ground vehicles, A-"hot" with respect to vehicle ground. Shorting the transmitter PA printed wiring board ground pattern to the radio case may cause one of the in-line fuses to blow.

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), power control voltage, driver current, PA current and PA voltage.

CIRCUIT ANALYSIS

RF POWER AMPLIFIER ASSEMBLY

The exciter output is coupled through at 50 ohm RF cable to the PA Drive module input jack J201. The 50 ohm RF input is coupled through a matching network comprised of C206, C207, C208 and W202 to the base of power amplifier Q201.

Part of the RF input is rectified by CR201 and metered at J205-4 through resistor R201. The rectified RF is also applied to the power control IC (U201).

Collector voltage for Q201 is applied direct from the DC power input through collector stabilizing network R205 and L202 and collector feed network L203 and C210.
CIRCUIT ANALYSIS

The 500 milliwatt, 50 ohm output of Q201 is coupled to the base of a second power amplifier Q202 through a matching network consisting of T201, C214, C215, C216 and L204.

Collector voltage to Q202 is controlled by power control IC (U201), Q215 and R213, and is applied through a collector stabilizing network L206 and R206 and collector feed network L205 and C218.

The 6 Watt, 50 ohm output of Q202 is coupled to the base of Q203 through C219 and the matching network of T202, C222, C224, C225 and L207. The collector voltage to Q203 is coupled through collector stabilizing network L209 and R214 and collector feed network L208 and C228.

The 20-Watt output of Q203 is coupled through an impedance matching network (C229, C230, C233 and T203) that matches the output impedance of Q203 to the input impedance of driver amplifier Q204 through a 50-ohm micro strip (W204) and input impedance matching network T204, C234, C235 and C236.

The collector voltage for Q204 is coupled through collector stabilizing network L212 and R208 and collector feed network C239 and L211. Collector current for Q204 is metered across tapped manganese resistor R212. The reading taken in position F on the 15-Volt scale with the High Sensitivity button pressed and read as 0-15 amperes full scale.

Following Driver amplifier Q204 is 50-ohm a matching network (C237, C238, and T205) that matches the 40 Watt output of Q204 to the 50-ohm input of the PA module, through 50-ohm micro strip W207 and a 50-ohm strap W211.

Supply voltage for Q216 through Q219 is coupled through identical stabilizing networks and the collector feed networks. Supply voltage is measured in position G on the 15-volt range with the polarity switch in the (-) position (read as 15 volts full scale).

Collector current for Q216 through Q219 is metered across paralleled tapped manganese resistors R210 and R211 located on the PA Driver module. The reading is taken in Position G in the Test 1 position on the 3-Volt scale with the "High" Sensitivity Button pressed, and read as 30 amperes full scale.

The outputs of Q216 through Q219 are coupled through identical matching networks to the RF power combiner board. The RF power combiner consists of micro strip transmission line W4202, R4208, R4209, and R4210, and has a 50-ohm input and output impedance. The combiner adds the outputs of Q216 through Q219, and applies the combined RF output to the Low Pass Filter/Antenna Switch module via W4216. Capacitors C4243 through C4252 provide isolation for ground operation.

The input to the Low Pass Filter and to the antenna switch K201 is coupled through the 50-ohm micro strip W4250. The output is applied to the antenna at J203.

NOTE

For MAST® II High Power Solid State applications where "Combining" is used, four new Power Amplifiers (19D424895G40-443) have been added. The new PA's do not use the 40 Watt modules. Two separate PA's are used with a combiner panel to sum the power output of each PA.

On the PA module, the RF input is applied to the RF power splitter board. The RF power splitter consisting of micro strip transmission line W4201, C4265, C4266, R4201, R4202 and R4203, and has a 50-ohm input and output impedance. The outputs of the power splitter are applied to the four identical Class C Power Amplifiers (Q216 through Q219) via their respective identical matching networks.

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 placing transistors of this type.

POWER CONTROL CIRCUIT

The Power Control Circuit, located on the PA Driver module, consists of CR201, Power Control IC (U201), RT201, Q215, and R213.

When the transmitter is keyed, rectified RF from CR201 is applied to Switch Q1 of Power Control IC (U201), turning it on (See Figure 1). Turning on Q1 turns on voltage regulator Q2, supplying a constant voltage via Pin 14 to Power Adjust potentiometer R213. R213 through Pin 12 connect to the base of Q5. Q5, Q6 and Q215 operate as an amplifier chain to supply voltage to the collector of Q202 (Ampl-2). The setting of R213 determines the voltage applied to the base of Q5. The higher the voltage at the base of Q5, the harder the amplifiers conduct, supplying more
collector voltage to Q202. The lower the voltage at the base of Q5, the less collector voltage is supplied to Q202. Reducing the supply voltage to Q202 reduces the drive to Q203 and Q204, thereby reducing the power output of the PA. The power output can be adjusted by R213 from 30 Watts to rated power output.

Temperature protection is provided by Q3, Q4 in IC U201 and thermistor RT201 which is mounted on the PA heatsink. Under normal operating conditions, the circuit is inactive (Q3 is on and Q4 is off). When the heatsink temperature reaches approximately 115°C the resistance of RT201 decreases. This increases the base voltage applied to Q3, turning it off. Turning off Q3 allows Q4 to turn on, decreasing the voltage at Power Adjust potentiometer R213. This reduces the base voltage to Q5 which causes Q6 and Q215 to conduct less, reducing the collector voltage to Q202 (Ampl-2). This reduces the transmitter output power, keeping the heatsink at a maximum of approximately 115°C. When the heatsink temperature decreases below 115°C, the temperature control circuit turns off, allowing the normal transmitter power output.

ANTENNA MATCHING UNIT

The Antenna Matching Unit is used only in continuous duty duplex stations to optimize impedance matching between the power amplifier and the load. It consists of a Pi network (C2-C5 and L1) and a reverse directional coupler. RF from the low pass filter is applied to the Pi network through the reverse directional coupler and then to the duplexer load. The reverse directional coupler permits monitoring the reflected power by connecting a DC voltmeter across TP1 (+) and ground (−). C2 and C4 are tuned for minimum DC voltage which represents minimum reflected Power. L1 may also be pushed toward or away from the filter cover wall to further reduce the DC voltage. C2, C4 and L1 should be alternately tuned until an absolute minimum voltage reading is obtained. The residual voltage reading after tuning may vary from one transmitter to the next depending on output power level, operating frequency and the load.

Figure 1 - Power Control IC-U201
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<thead>
<tr>
<th>SYMBOL</th>
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**Production Changes**

- Change in part number: X to Y
- Description update: Description A to Description B
- Additional notes: Additional information