

MAINTENANCE MANUAL
851-870 MHz, 110 WATT POWER AMPLIFIER
19D902797G5

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DESCRIPTION

The 800 MHz MASTR III Power Amplifier Assembly is a wide band RF power amplifier operating over the 851-870 MHz range without tuning. Its main function is to amplify the 10 mW FM signal from the Transmitter Synthesizer to the rated RF output at the antenna port. The output of the Power Amplifier Assembly is adjustable from rated power to 10dB below rated power at the PA output J104.

The assembly consists of a printed wiring board (A1) and associated components, including a power module

and an RF power transistor, mounted to the heat sink assembly. The printed wiring board (A1) contains both the power amplifier circuitry and the power control circuitry. The heatsink assembly includes a copper heat spreader for the power transistor.

Unfiltered supply voltage, A+, for the power amplifier circuits enters the assembly via feedthrough capacitor, C1. Power cable W4 routes the A+ from C1 to J103 on the PWB. Filtered A+ voltage for the power control circuit enters the assembly via control cable W13 which connects to the PWB at J201.

PA FAN PLATE ASSEMBLY
188D6127G1

| SYMBOL | PART NO. | DESCRIPTION |
|-------------|----------------|-----------------------------------|
| 4 | SBS 123 01/10 | Spring nut. |
| 5 | 19A702339P510 | Screw, thread forming, flat head. |
| 6 | 19A701312P5 | Washer, plain steel, 3.5 mm. |
| 7 | 19A702381P510 | Screw, thread forming, pan head. |
| 9 | 19A700136P19 | Sleeve |
| 10 | 105 8567/1 | Guard, fan. |
| 11 | 19A701863P12 | Clamp, loop. |
| 13 | 19A700033P6 | Washer, lock, ext tooth. |
| 14 | 19A700034P5 | Nut, hex, steel. |
| B1 and B2 | BKV 301 216/02 | DC fan. |
| W1 | 344A3337P4 | Cable. |
| WT1 and WT2 | 7142645P1 | Conductor, splice. |

PRODUCTION CHANGES

Changes in the equipment to improve 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 - **POWER AMPLIFIER 19D902797G5**
REV. A - **POWER AMPLIFIER BOARD 19D902797G5**

To correct minor PWB errors and incorporate a new RF output device. New PWB board and Q5 was RYN121655/1. C43 was 1.2 pF (344A3126P203).

Table 1 - General Specifications

| ITEM | SPECIFICATION |
|-------------------------|---|
| FREQUENCY | 851-870 MHz |
| OUTPUT POWER (RF) | 11 TO 110 W @ J104 |
| INPUT POWER (RF) | 10 mW min. into $\leq 2:1$ VSWR |
| TEMPERATURE RANGE | -30°C to +60°C (Ambient air) |
| SUPPLY VOLTAGE | 26.0V |
| CURRENT | 14A max. (11 A typical @ 110W, 26.0 V) |
| DUTY CYCLE | Continuous |
| STABILITY | Stable into 3:1 VSWR; all temp., voltage, FREQ. 11-110W |
| RUGGEDNESS AT HIGH VSWR | No damage into open or shorted load |

The Power Control circuitry sets the output power level by adjusting the PA Power Set level. It keeps the output power constant despite variations in input power, power amplifier gain, or temperature through the use of a feedback control loop in the PA assembly.

CIRCUIT ANALYSIS

POWER AMPLIFIER

The power amplifier section of the PA Board consists of a Small Signal Gain Stage, a Driver Module, a Final Power Stage, and Power Sense and Isolation Stages. All these gain stages have an input and output impedance of 50 ohms. Figure 1 is a block diagram showing the signal flow within the Power Amplifier Assembly.

Small Signal Gain Stage (U101)

This stage uses a broadband silicon monolithic microwave integrated circuit (MMIC) amplifier. The signal from transmitter synthesizer, typically 10 dBm (10 mW), is input through a 10 dB resistive pad (R101, R102, and R103). The stage amplifies the resulting 0 dBm (1 mW) signal to the necessary level to achieve desired PA output power (typical +5 dBm for 110W out).

Bias for the MMIC is supplied by an 8V regulator (U4). This voltage is DC coupled to pin 6 and is supplied through a dropping resistor, R43, for pin 2. Power control for the Power Amplifier Assembly is performed by controlling the RF level out of the MMIC by varying the control voltage at pin 5.

Driver Module (U2)

The Driver Module is a 35 dB gain, 4-stage, linear hybrid amplifier. The first two stages of the module are identical FET amplifiers, class A biased to provide maximum gain. Stages 3 and 4 are bipolar transistors, class AB biased to provide maximum saturated power and efficiency. The quiescent current of these stages is set by variable resistors R1, R2, R4, and R3 respectively. Typical bias current for each stage is 100, 90, 90 & 90mA respectively.

CAUTION

These currents are factory set. Field adjustment is not recommended, and may result in device failure.

The voltage for the bias circuitry is supplied by U7, a voltage regulator. A transistor switch, Q3, is used to apply this voltage when the unit is keyed. The nominal output power of this stage is 42.4 dBm (17.5W).

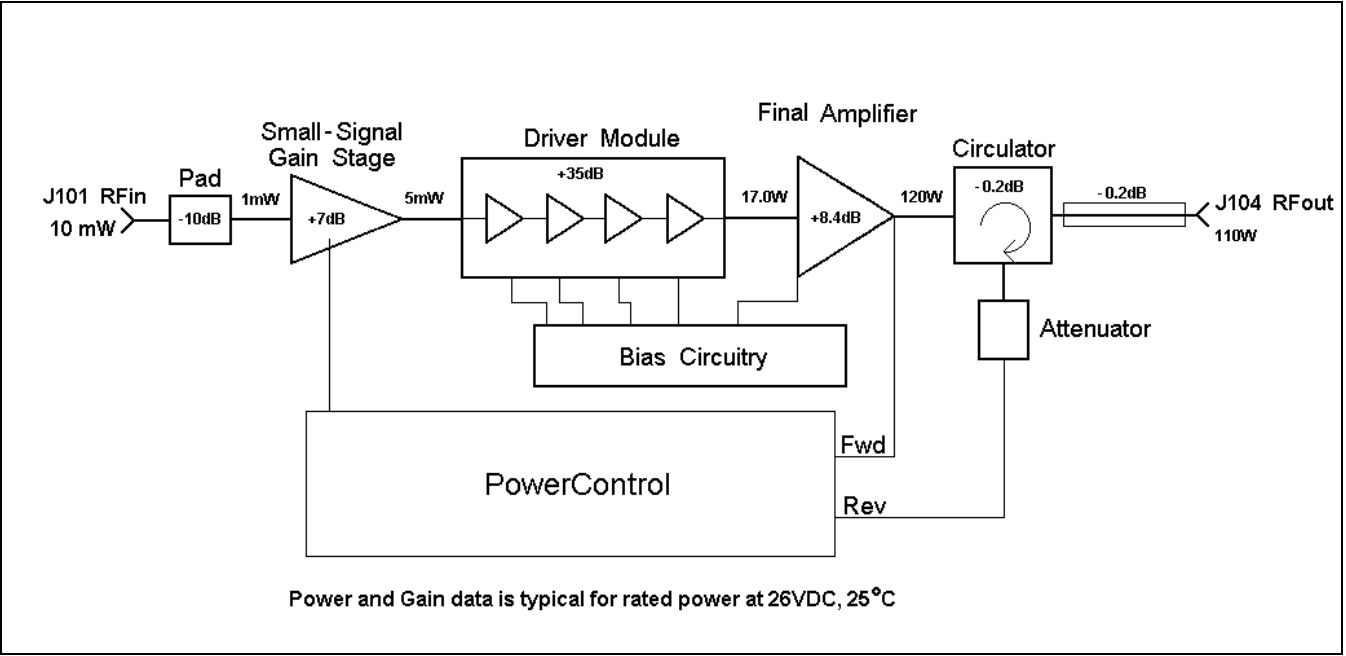


Figure 1 - Block Diagram

Final Power Stage (Q5)

The Final Power Stage of the unit consists of a push-pull pair of silicon bipolar power transistors mounted on a single flange, Q5, and its associated matching and bias circuitry. A quarter-wave transmission line transformer feeds a pair of 25 ohm lines in parallel, one of which is 180° longer than the other, to create a microstrip balun. The resulting balanced circuit is transformed by reactive components to match the input impedance of the final device. Similar circuitry is used on the output to match the device's output impedance. The quiescent current of transistor Q5 is set by variable resistor R48 for Class AB operation. Typical bias current is 400 mA for this stage.

CAUTION

These currents are factory set. Field adjustment is not recommended, and may result in device failure.

The result is a typical 8.4 dB gain stage capable of producing a nominal 50.8 dBm (120W) of RF power.

Power Sense and Isolation Stages

Integrated into the output microstrip balun, an eighth-wave directional coupler is used to sense the magnitude of forward power. D6, an active detector, is used to convert this level to a DC voltage proportional to forward power, and this voltage is sent to the power control circuitry.

The amplified signal from the Final Power Stage is fed to U6, a circulator, to provide 20 dB typical isolation from load mismatches. The device insertion loss of 0.2 dB maximum, along with the microstrip trace losses, provide 50.4 dBm (110W) of RF power at the PA output, J104.

The third port of the circulator is terminated by a 20 dB power attenuator, AT1, followed by a resistive pad, R35, R36, R39. Any signal reflected back into the Power Amplifier Assembly is directed by the circulator through the pads, and is converted to a DC voltage by D7. This voltage is sent to the power control circuitry.

POWER CONTROL

The Power Control circuitry performs four basic functions. It keys and unkeys the PA, sets the PA output power, protects the PA against adverse conditions, and provides a voltage proportional to output power at the interface cable.

Keying And Unkeying The PA

To key the PA, the digital controller places 5 volts on the PA key line, J201-2. Zero volts on the PA key line causes the PA to unkey. If the control cable (W13) is disconnected, with nothing actively driving the PA key line, the PA will remain unkeyed.

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PA Output Power Set

PA output power is set according to the level of the Power Set line. Four (4) volts on this line will produce minimum power. As the voltage increases toward eight (8) volts, the power will increase to the maximum rated output. The PA output power is initially set for an output of 110 watts at J104. This is done by adjusting R204 while injecting a 10 mW signal at J1 and applying 8 volts to J201-3. After setting the maximum power level, changing the output power is done by varying the voltage applied on the Power Set line.

PA Protection

The power control also protects the PA against over temperature and high VSWR conditions.

An over temperature condition exists when the flange temperature of the final output transistor reaches 80°C. At this point the output power will drop below its set level. The output power will continue to drop such that when the flange temperature reaches 125°C the PA output drops at least 10 dB below its set level.

Reflected power is limited to 25% of the set power. If the output VSWR degrades to worse than 3:1 the forward power will be reduced to limit the reflected power to 25% of the set power. The Power Sensor line indicates when the PA is operating in a cutback condition. If the PA is keyed and the power control is cutting back, the Power Sensor line will drop to zero (0) volts and the PA alarm light on the station will turn on.

Power Monitor

A DC voltage proportional to forward power, provided by the detection circuit of the Power Sense stage, is buffered and delivered to the PWR Monitor line of the interface connector.

Theory Of Operation

Power control of the MASTR III Power Amplifier is accomplished with a feedback control loop. The three possible feedback signals are: representation of forward power, temperature sensitive scaled representation of forward power, or representation of reflected power. The three signals are input to a diode summing junction which selects the largest of the three for use as the feedback.

The microstrip directional coupler samples the output power and produces a voltage, Vf, proportional to the forward output power. The power control compares the forward voltage, Vf, to a reference voltage at U3. The output of U3 adjusts the control voltage at pin 5 of the MMIC of the Small Signal Gain Stage. This varies the gain through the stage, and

controls the power output level of the Power Amplifier Assembly.

During over temperature operation, a scaled representation of the forward power is maintained constant by varying the control voltage line. Thermal resistor RT1 sensing an increase in temperature causes the output of U1.1 to increase. If the output of U1.1 becomes larger than the other feedback lines, the output of U3.2 will begin to decrease. This causes the gain of U101 to decrease. Since the scaling is a function of temperature the power is reduced as the temperature increases.

Under VSWR cutback operation the reverse voltage, Vr, representative of the reflected output power is held below a threshold by reducing the control voltage as necessary. If Vr increases at U1.2 beyond the preset threshold an increase at U3.2 will result. This causes a subsequent reduction in the control voltage to U1. Thus the power control circuit reduces the output power in order to limit the reflected power to 25% of the set power.

Signal Interface

The signal interface to the MASTR III Power Amplifier is supported by a six position feedthrough connector, J201, with the following pinout:

- 1 - PWR Sensor
- 2 - PA Key
- 3 - PA PWR Set
- 4 - PWR Monitor
- 5 - Ground
- 6 - Fil A+

Pwr Sensor

This line indicates when the PA is experiencing adverse conditions. Under normal operation, while the PA is keyed, this line will be proportional to forward power. Minimum power (zero watts) corresponds to 2.5 volts while maximum power corresponds to 4.5 volts. This voltage is not temperature compensated and no effort is made to calibrate this signal to an absolute power level. It is intended to provide a relative indication of forward power and to discriminate between normal and cutback operation.

Zero volts on this line, when the PA is keyed, indicates the forward power is cutback. This power cutback may be due to high reflected power or may be due to high PA tempera-

tures. This fault condition may indicate a problem with the PA or may indicate a system problem external to the Power Amplifier. High VSWR may be due to a poor antenna and high temperature may be due to a blocked cabinet vent. Zero volts on this line, when the PA is keyed, does not indicate zero forward power. Zero volts indicates the PA is protecting itself due to adverse conditions. If the adverse condition, either high VSWR or high temperature is eliminated, the power will return to normal and the PWR SENSOR voltage will rise above 2.5 volts.

PA Key (Interface Connector Pin 2)

This line is used to key and unkey the PA, UNKEY=0 volt and KEY=5 volts. The driver of this line must be capable of supplying 5 volts at 1.0 mA. The appropriate key sequence requires RF from the transmit synthesizer be input to the PA before the KEY line is energized.

PA PWR Set (Interface Connector Pin 3)

This line is used to set the RF Power Output of the PA. Minimum power output equals 4 volts and maximum power output equals 8 volts. The driver of this line must be capable of supplying 8 volts at 1.0 mA.

Fil A+ (Interfaces Connector Pin 6)

This line provides the filtered supply voltage for the Power Control. The driver of this line must be capable of supplying 13.4 volts ±20% at 100 mA.

PWR Monitor

This line provides a DC voltage proportional to forward power.

TROUBLESHOOTING GUIDE

| SYMPTOM | AREAS TO CHECK | INDICATIONS |
|---|--|--|
| 1. No power or low power at Antenna Port. | 1. Measure the transmitter output power before the duplexer or antenna switch (for simplex mode). 2. Measure the transmitter output power before the low pass filter. | The presence of power at this port is an indication of a defective duplexer, switch, or cables. The presence of power at this port is an indication of a defective filter or cables. |
| 2. No power at PA output port and PA ALARM is OFF. | 1. Station is in receive mode. | |
| 3. No power at PA output port and PA ALARM is ON. | 1. No RF input to the PA. Check connection between PA and TX Synthesizer. 2. Check the logic or DC inputs to the PA from the Interface Board through J201. a. J201-PA KEY b. J201-3 POWER SET c. J201-6 13.8 VF 3. Check the bias voltage on the base of Q5. 4. Check the bias voltage at module U2. pin 2 pin 4 pin 6 pin 8 Note: There is no pin 3 on module U2. Pin 4 is the 3rd pin physically. | TX Synthesizer should deliver a minimum of 10 mW (10dBm) to the PA. 5 volts during transmit 4 volts to 8 volts (4 volts represents zero RF power) 13.8 Vdc ±20% Voltage should be .73V nominal. Voltages should be: 14-18V nominal 14-18V nominal 0.7V nominal 0.7V nominal |
| 4. Low power at PA output port and PA ALARM is OFF. | 1. Low RF input to PA from TX Synthesizer. 2. Check the voltage on J201-3 (POWER SET). 3. Check the power supply voltage on the collector of Q5. 4. Check the bias voltage on the base of Q5. 5. Check the bias voltage at module U2. pin 2 pin 4 pin 6 pin 8 Note: There is no pin 3 on module U2. Pin 4 is the 3rd pin physically. | Power should be a minimum of 10 mW (10 dBm). For nominal output power, this voltage should be above 7 volts. Voltage should be nominal 26.0 Vdc. Voltage should be .73V nominal. Voltages should be: 14-18V nominal 14-18V nominal 0.7V nominal 0.7V nominal |
| 5. Low power at PA output port and PA ALARM is ON. | 1. Check for over temperature and/or a high VSWR condition due to a mismatch at the output port. | The power control circuit protects the PA by cutting back the power. In case of a mismatch, refer to symptom 1. |

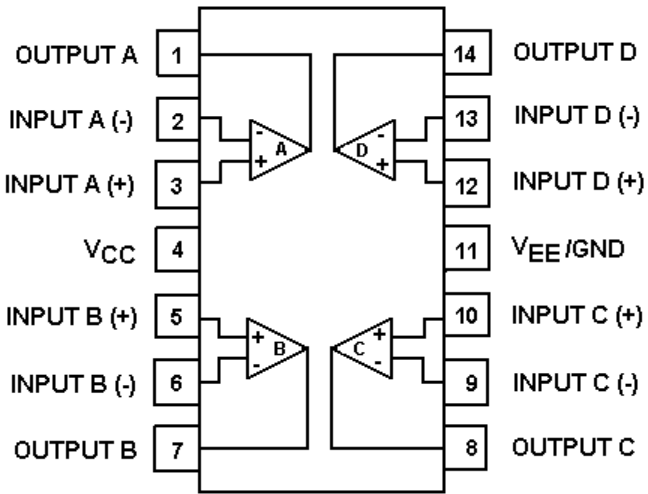
800 MHz POWER AMPLIFIER VOLTAGE CHART

| PARAMETER (50 ohm, -30°C to +60°C) | REFERENCE SYMBOL | READINGS (volts DC) |
|---------------------------------------|------------------|------------------------|
| SUPPLY VOLTAGE | A+ | 26.0 +5, - 20% |
| CONTROL VOLTAGE | Vctl | 0-2V |
| FORWARD VOLTAGE | Vf | 4-5V |
| REVERSE VOLTAGE | Vr | 2-4V |
| POWER SENSE | J201-1 | 2.5 - 4V |
| PA KEY | J202-2 | 5V |
| POWER SET | J202-3 | 4 - 8V |
| 13.8 VF | J201-6 | 13.8V ±20% |

RATED POWER FOR MASTR III 800 MHz BASE STATION

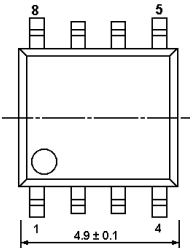
| FREQUENCY MHz | STANDARD | ADJUSTABLE RANGE |
|------------------|-----------------------------|--------------------------------|
| 851-870 | 100W, AFTER LOW PASS FILTER | 10-100W, AFTER LOW PASS FILTER |

IC DATA

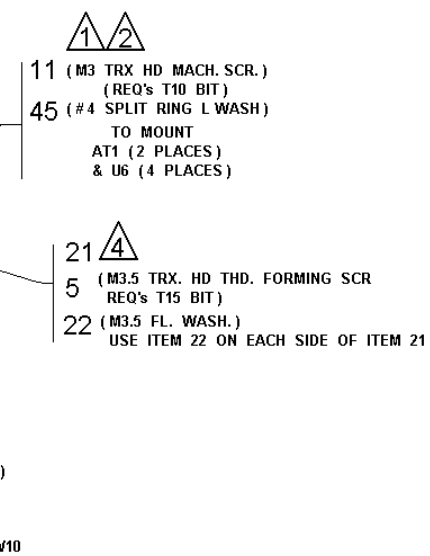


U3, U1
19A701789P4
Quad Op-Amp

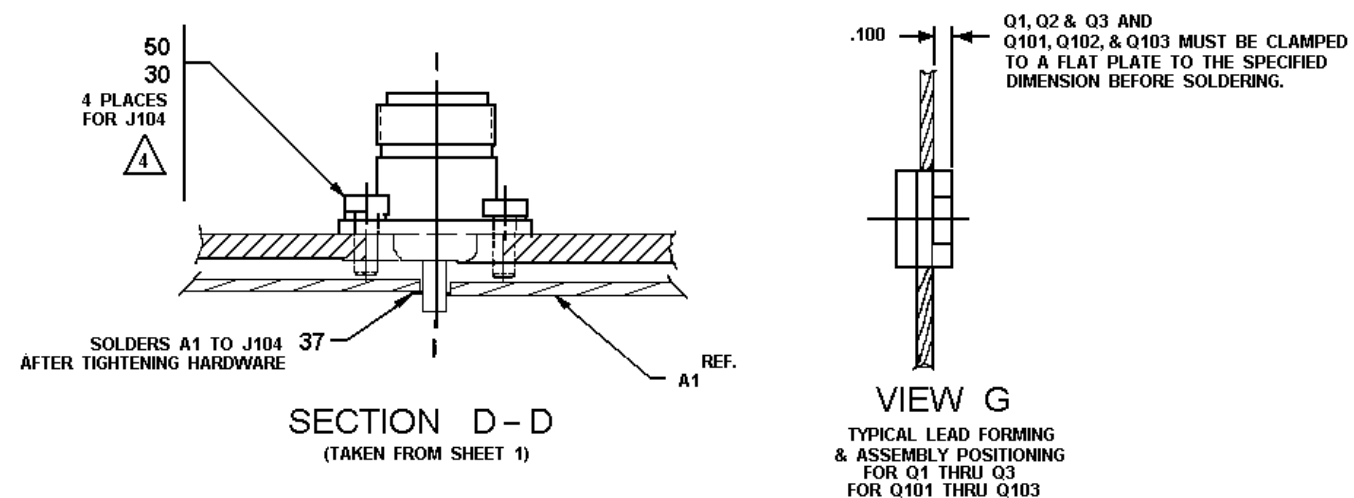
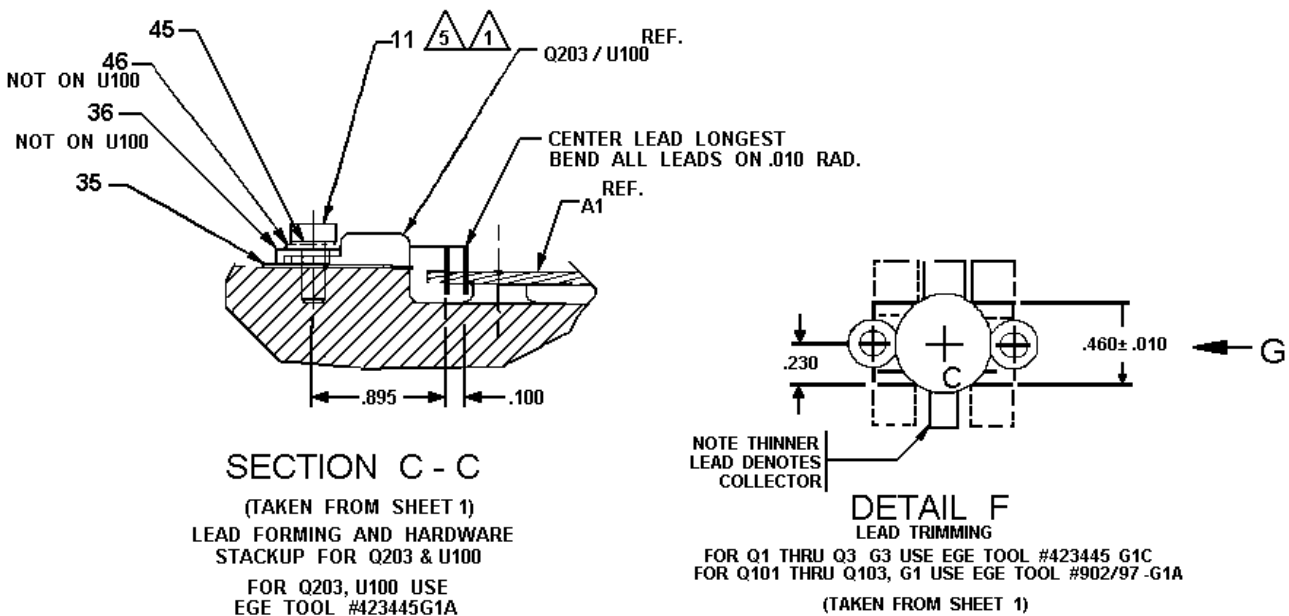
| Terminal | Function |
|----------|----------------------------|
| 1 | Ground and thermal contact |
| 2 | Vcc1 |
| 3 | Ground |
| 4 | RF |
| 5 | Power control |
| 6 | RF _{OUT} and Vcc2 |
| 7 | Ground and thermal contact |
| 8 | Ground and thermal contact |



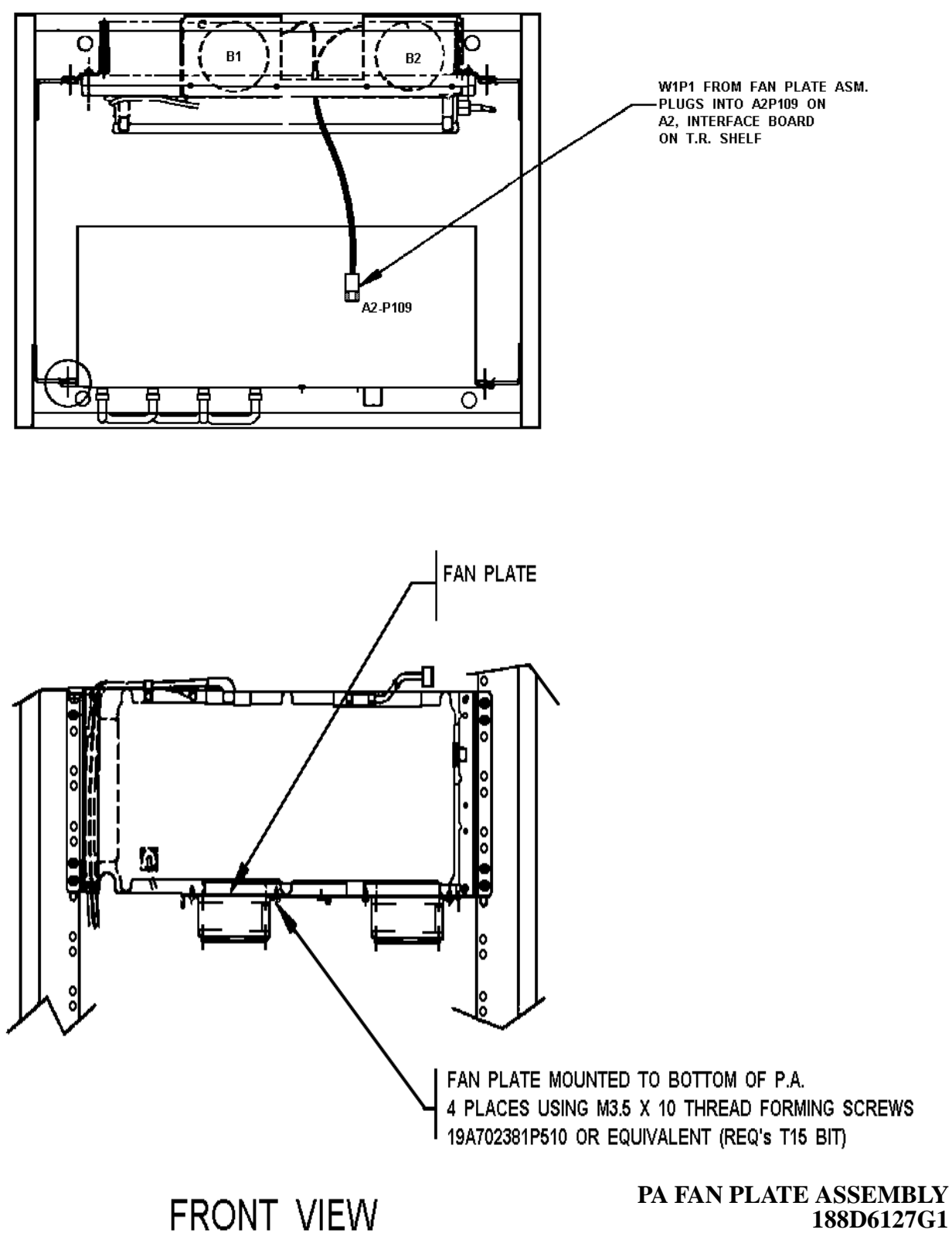
U101
RYT1016155/1



(19D902797, Sh. 4, Rev. 8)



POWER AMPLIFIER ASSEMBLY
19D902797G5
(19D902797, Sh. 2, Rev. 7)



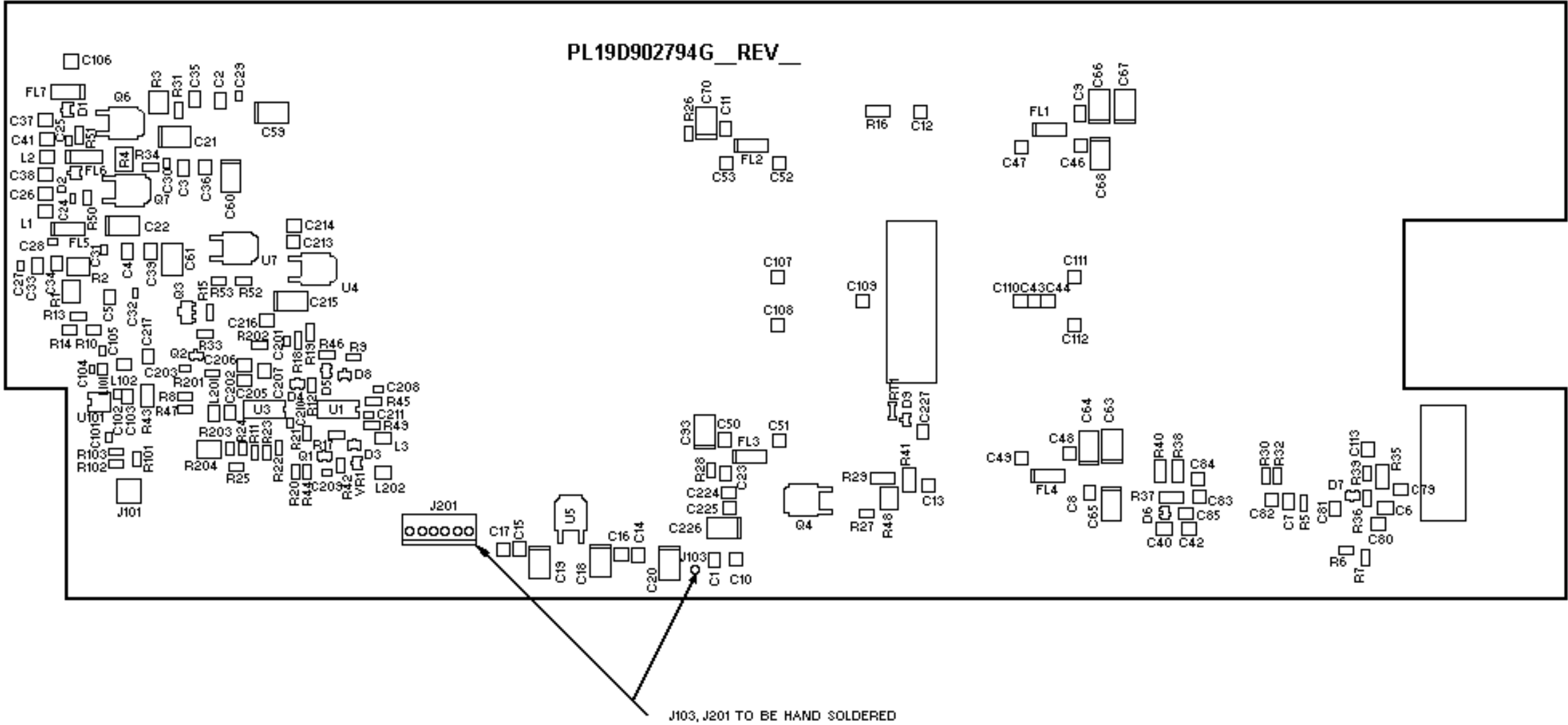
POWER AMPLIFIER
19D902797G5

| SYMBOL | PART NO. | DESCRIPTION |
|--------------|----------------|---|
| A1 | | Power Amplifier Board 19D902794G5 |
| | | ----- ATTENUATORS ----- |
| AT1 | REPUA01501/1 | Attenuation: 20dB + or - 1 dB 50 ohms. |
| | | ----- CAPACITORS ----- |
| C1 | 19A116708P2 | Feedthru: 0.01 uF + or - 0% 500 VDCW; sim to Eric 327-050 -XW0103P. |
| C1 thru C9 | 19A702052P26 | Ceramic: 0.1uF + or - 10%, 50 VDCW. |
| C10 | 344A3126P38 | Porcelain: 100 pF + or - 5%, 500 VDCW; sim to 101JT500X. |
| C11 | 19A702052P26 | Ceramic: 0.1uF + or - 10%, 50 VDCW. |
| C12 and C13 | 344A3126P62 | Porcelain: 1000 pF + or - 5%, 50 VDCW; sim to 102JT500X. |
| C14 and C15 | 19A702052P26 | Ceramic: 0.1uF + or - 10%, 50 VDCW. |
| C15 and C17 | 344A3126P38 | Porcelain: 100 pF + or - 5%, 500 VDCW; sim to 101JT500X. |
| C18 thru C22 | RJE5843358/15E | Tantalum: 15 uF + or - 10%, 35 VDCW |
| C23 | 19A702052P26 | Ceramic: 0.1uF + or - 10%, 50 VDCW. |
| C24 and C25 | 19A702052P5 | Ceramic: 1000 pF + or -10%, 50 VDCW. |
| C26 | 19A705108P25 | Mica Chip: 33 pF + or - 5%, 500 VDCW; temp coef 0 + 50 PPM/C. |
| C27 thru C32 | 19A702052P5 | Ceramic: 1000 pF + or -10%, 50 VDCW. |
| C33 thru C39 | 19A705108P25 | Mica Chip: 33 pF + or - 5%, 500 VDCW; temp coef 0 + 50 PPM/C. |
| C40 | 19A702052P26 | Ceramic: 0.1uF + or - 10%, 50 VDCW. |
| C41 | 19A705108P25 | Mica Chip: 33 pF + or - 5%, 500 VDCW; temp coef 0 + 50 PPM/C. |
| C42 | 19A702052P26 | Ceramic: 0.1uF + or - 10%, 50 VDCW. |
| C43 | 344A3126P2 | Porcelain: 2.2 pF + or - 0.5 pF, 500 VDCW; sim to 2R2CT500X. |
| C44 | 344A3126P203 | Porcelain: 1.2uF + or - 0.25 pF, 500 VDCW; sim to 1R2CT500X. |
| C46 thru C53 | 344A3126P38 | Porcelain: 100 pF + or - 5%, 500 VDCW; sim to 101JT500X. |
| C59 and C60 | RJE5843358/15E | Tantalum: 15 uF + or - 10%, 35 VDCW |
| C61 | 19A705205P18 | Tantalum: 4.7uF + or - 20%, 35VDCW |
| C63 thru C68 | RJE5843358/15E | Tantalum: 15 uF + or - 10%, 35 VDCW |
| C7 | RJE5843358/15E | Tantalum: 15 uF + or - 10%, 35 VDCW |
| C79 thru C81 | 19A705108P25 | Mica Chip: 33 pF + or - 5%, 500 VDCW; temp coef 0 + 50 PPM/C. |
| C82 thru C85 | 344A3126P38 | Porcelain: 100 pF + or - 5%, 500 VDCW; sim to 101JT500X. |
| C93 | RJE5843358/15E | Tantalum: 15 uF + or - 10%, 35 VDCW |
| C10 and C102 | 19A702236P36 | Ceramic: 27 pF + or - 5%, 50 VDCW; temp coef 0 + or -30 PPM/C. |
| C103 | 19A702052P26 | Ceramic: 0.1uF + or - 10%, 50 VDCW |
| C104 | 19A702236P10 | Ceramic: 2.2 pF + or -2.5 pF, 50 VDCW; temp or -30 PPM/C. |
| C105 | 19A702236P36 | Ceramic: 27 pF + or - 5%, 50 VDCW; temp coef 0 + or -30 PPM/C. |

| SYMBOL | PART NO. | DESCRIPTION |
|----------------|----------------|--|
| C106 thru C108 | 344A3126P38 | Porcelain: 100 pF + or - 5%, 500 VDCW; sim to 101JT500X. |
| C109 | 344A3126P1 | Porcelain: 3.3 pF + or - 0.25 pF, 500 VDCW; sim to 3R3CT500X. |
| C110 | 344A3126P203 | Porcelain: 3.3 pF + or - 0.25 pF, 500 VDCW; sim to 3R3CT500. |
| C111 and C112 | 344A3126P38 | Porcelain: 100 pF + or - 5%, 500 VDCW; sim to 101JT500X. |
| C113 | 19A705108P25 | Mica Chip: 33 pF + or - 5%, 500 VDCW; temp coef 0 + 50 PPM/C. |
| C201 | 19A702061P37 | Ceramic: 33 pF + or - 5%, 50 VDCW; temp coef 0 + or -30 PPM/C. |
| C202 | 19A702052P26 | Ceramic: 0.1uF + or - 10%, 50 VDCW. |
| C203 | 19A702061P37 | Ceramic: 33 pF + or - 5%, 50 VDCW; temp coef 0 + or -30 PPM/C. |
| C205 thru C207 | 19A702052P26 | Ceramic: 0.1uF + or - 10%, 50 VDCW. |
| C208 thru C211 | 19A702061P37 | Ceramic: 33 pF + or - 5%, 50 VDCW; temp coef 0 + or -30 PPM/C. |
| C213 | 344A3126P38 | Porcelain: 100 pF + or - 5%, 500 VDCW; sim to 101JT500X. |
| C214 | 19A702052P26 | Ceramic: 0.1uF + or - 10%, 50 VDCW. |
| C215 | RJE5843358/15E | Tantalum: 15 uF + or - 10%, 35 VDCW |
| C216 | 344A3126P38 | Porcelain: 100 pF + or - 5%, 500 VDCW; sim to 101JT500X. |
| C217 | 19A702052P26 | Ceramic: 0.1uF + or - 10%, 50 VDCW. |
| C224 | 19A702052P26 | Ceramic: 0.1uF + or - 10%, 50 VDCW. |
| C225 | 344A3126P38 | Porcelain: 100 pF + or - 5%, 500 VDCW; sim to 101JT500X. |
| C226 | RJE5843358/15E | Tantalum: 15 uF + or - 10%, 35 VDCW |
| C227 | 19A702052P26 | Ceramic: 0.1uF + or - 10%, 50 VDCW |
| | | ----- DIODES ----- |
| D1 thru D5 | 19A700053P3 | Silicon: 2 Diodes in Series, Common Cathode; sim to M5A470L. |
| D6 thru D8 | 19A705377P4 | Silicon, Hot Carrier: sim to HSMS-2802. |
| D9 | HKZ12303/1 | Diode, silicon. |
| | | ----- FILTERS ----- |
| FL1 thru FL7 | REG70420/2 | Ferrite, bead. |
| FL10 | RTNUA50101/1 | Low Pass: (Used in 850-900 MHz). |
| | | ----- JACKS ----- |
| J101 | 19A705512P1 | Connector, RF SMB Series: sim to AMP No. 221111-1. |
| J101 | RNT403185/02 | Connection, RF; SMD 50 ohms. |
| J103 | 19A134263P1 | Contact, electrical: sim to Selectro 229-1092-00-0-590. |
| J104 | 7777145P5 | Receptacle: sim to Amphenol 82-97. |
| J201 | 19A704852P32 | Printed wire, two part: 6 contacts, sim to Molex 22-29-2061. |
| | | ----- INDUCTORS ----- |
| L1 thru L3 | 19A705470P13 | Coil: 0.10 uH + or - 20%. |
| L101 | 344A3676P6P2 | Coil, Fixed; RF S.M. |
| L10 | 19A705470P9 | Coil, Fixed: 47 nH; sim to Toko 380NB-47nH. |
| L201 | 19A705470P13 | Coil: 0.10 uH + or - 20%. |
| L202 | | |
| | | ----- TRANSISTORS ----- |
| Q1 and Q2 | 19A700076P2 | Silicon, NPN: sim to MMBT3904, low profile. |

| SYMBOL | PART NO. | DESCRIPTION |
|--------------|---------------|--|
| Q3 | 19A134577P2 | Silicon, PNP: sim to Phillips BCX51-16. |
| Q4 | RYN121634/1 | Silicon, Power: SMD. |
| Q5 | RYN1216013/1 | Power: 150W. |
| Q6 and Q7 | RYN121634/1 | Silicon, SMD. |
| | | ----- RESISTORS ----- |
| R1 thru R4 | REL31624/5 | Potentiometer: 5K, 10T SMD. |
| R5 thru R7 | 19B800607P103 | Metal film: 10K ohms + or - 5%, 1/8 w. |
| R8 | 19B800607P681 | Metal film: 680 ohms + or - 5%, 1/8 w. |
| R9 | 19B800607P472 | Metal film: 4.7K ohms + or - 5%, 1/8 w. |
| R10 | 19B800807P270 | Metal film: 27 ohms + or - 5%, 1/8 w. |
| R11 and R12 | 19B800607P103 | Metal film: 10K ohms + or - 5%, 1/8 w. |
| R13 | 19B800607P270 | Metal film: 27 ohms + or - 5%, 1/8 w. |
| R14 | 19B800607P330 | Metal film: 33 ohms + or - 5%, 1/8 w. |
| R15 | 19B800607P103 | Metal film: 10K ohms + or - 5%, 1/8 w. |
| R16 | 19D801466P101 | Metal film: 100 ohms + or - 5%, 1/2w. |
| R17 | 19B800607P103 | Metal film: 10K ohms + or - 5%, 1/8 w. |
| R18 | 19B800607P822 | Metal film: 8.2K ohms + or - 5%, 1/8 w. |
| R19 thru R21 | 19B800607P103 | Metal film: 10K ohms + or - 5%, 1/8 w. |
| R22 | 19B800607P472 | Metal film: 4.7K ohms + or - 5%, 1/8 w. |
| R23 thru R25 | 19B800607P103 | Metal film: 10K ohms + or - 5%, 1/8 w. |
| R26 | 19B800607P220 | Metal film: 22 ohms + or - 5%, 1/8 w. |
| R27 | 19B800607P222 | Metal film: 2.2K ohms + or - 5%, 1/8 w. |
| R28 | 19B800607P220 | Metal film: 22 ohms + or - 5%, 1/8 w. |
| R29 | 19D801466P101 | Metal film: 100 ohms + or - 5%, 1/2w. |
| R30 | 19B800607P510 | Metal film: 51 ohms + or - 5%, 1/8 w. |
| R31 | 19B800607P472 | Metal film: 4.7K ohms + or - 5%, 1/8 w. |
| R32 | 19B800607P510 | Metal film: 51 ohms + or - 5%, 1/8 w. |
| R33 | 19B800607P103 | Metal film: 10K ohms + or - 5%, 1/8 w. |
| R34 | 19B800607P472 | Metal film: 4.7K ohms + or - 5%, 1/8 w. |
| R35 | 19B801466P750 | Metal film: 75 ohms + or - 5%, 1/2w. |
| R36 | 19B800607P750 | Metal film: 75 ohms + or - 5%, 1/8 w. |
| R37 and R38 | 19B801466P330 | Metal film: 33 ohm + or - 5%, 1/2 w. |
| R39 | 19B800607P101 | Metal film: 100 ohms + or - 5%, 1/8 w. |
| R40 | 19B801466P330 | Metal film: 33 ohms + or - 5%, 1/2 w. |
| R41 | 19B801466P270 | Metal film: 27 ohms + or - 5%, 1/2 w. |
| R42 | 19B800607P472 | Metal film: 4.7K ohms + or - 5%, 1/8 w. |
| R43 | 19B801466P330 | Metal film: 33 ohm + or - 5%, 1/2 w. |
| R44 | 19B800607P102 | Metal film: 1K ohms + or - 5%, 1/8 w. |
| R45 | 19A702931P285 | Metal film: 7.5 K ohms + or -1%, 200 VDCW, 1/8w. |
| R46 | 19A702931P333 | Metal film: 21.5K ohms + or -1%, 200 VDCW, 1/8w. |
| R47 | 19B800607P151 | Metal film: 150 ohms + or - 5%, 1/8 w. |
| R48 | REL316214/5 | Potentiometer: 5K, 10T SMD. |
| R49 | 19B800607P103 | Metal film: 10K ohms + or - 5%, 1/8 w. |
| R50 and R51 | 19B800607P101 | Metal film: 100 ohms + or - 5%, 1/8 w. |
| R52 | 19A702931P258 | Metal film: 3920 ohms + or -1%, 200 VDCW, 1/8 w. |

| SYMBOL | PART NO. | DESCRIPTION |
|-----------|---------------|--|
| R53 | 19A702931P137 | Metal film: 237 ohms + or - 5%. 1/8w. |
| R101 | 19B800607P330 | Metal film: 33 ohms + or - 5%. 1/8w. |
| R102 | 19B800607P270 | Metal film: 27 ohms + or - 5%. 1/8w. |
| R103 | 19B800607P330 | Metal film: 33 ohms + or - 5%. 1/8w. |
| R201 | 19B800607P102 | Metal film: 1K ohms + or - 5%. 1/8w. |
| R202 | 19B800607P103 | Metal film: 10K ohms + or - 5%. 1/8w. |
| R203 | 19B800607P473 | Metal film: 47K ohms + or - 5%. 1/8w. |
| R204 | REL316215/5 | Potentiometer: 5K, 10T SMD. |
| | | ----- THERMISTOR ----- |
| RT1 | 19A705813P2 | Thermistor: sim to AL03006-58.2K-97-0100. |
| | | ----- INTEGRATED CIRCUITS ----- |
| U1 | 19A701789P4 | Linear: Quad Op Amp: sim to LM224D. |
| U2 | RYT9016074/1 | Power : RF. |
| U3 | 19A701789P4 | Linear: Quad Op Amp: sim to LM224D. |
| U4 and U5 | 19A704971P10 | Voltage Regulator, 8V: sim to MC8M08CDT. |
| U6 | UNK10243/01 | Circulator: 150W. |
| U7 | RYT1136080/1 | Volt Regulator. |
| U101 | RYT1016155/1 | MMIC. |
| | | ----- VOLTAGE REGULATORS ----- |
| VR1 | 19A700063P102 | Silicon: 5.1 Volt Zener; sim to BZX84-C5V1. |
| | | ----- CABLES ----- |
| W1 | 19B803978P1 | Cable RF. |
| W4 | 19B801695G11 | Cable. |
| | | ----- MISCELLANEOUS ----- |
| 5 | 19A702381P510 | Screw,thread forming: TORX DRIVE No. M3.5-0.6 x 10. |
| 6 | 7139898P3 | Nut, hex, brass: No. 1/4-28. |
| 7 | 19D902420P7 | Heatsink. |
| 9 | 19A702339P510 | Screw. |
| 11 | 19A702364P510 | Machine screw. |
| 14 | 19B209268P113 | Terminal, solderless: sim to AMP 2-34835-4. |
| | 19A115959P2 | Wire stranded. |
| | 19B209268P116 | Solderless terminal. |
| 16 | 19A700136P7 | Insulated sleeving. |
| 21 | 19A701863P27 | Clip, loop. |
| 22 | 19A701312P5 | Flatwasher: M3.5. |
| 28 | 19A702364P316 | Machine Screw:Pan Head, Steel. (Used in G5, G10). |
| 29 | 19A700034P4 | Nut, hex:No. M3x0.5MM. (Used in G5, G10). |
| 30 | 19A700032P5 | Lockwasher,internal tooth:No. 3MM. (Used in G5 and G10). |
| 37 | 19A134455P3 | Washer, flat. |
| 38 | 19B801659G4 | Cover. |
| 41 | 19A700033P6 | Lockwasher, external tooth, M3.5. |
| 45 | N405P5B6 | Lockwasher. |
| 46 | 19A701312P4 | Flatwasher: 3.2 ID. |
| 50 | 19A702381P408 | Tap screw, TORX Drive, M3.0.5x8. |
| 63 | 19B803982P1 | Plate. |
| 65 | 19D902420P7 | Heatsink. |
| 70 | 19B804034P1 | Plate, spacer. |
| 75 | N404P25 | Lockwasher. |
| W10 | 19B801937P1 | Power cable. |
| W13 | 19B801739P1 | Cable, Control. |



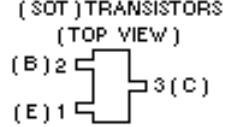
LEAD IDENTIFICATION FOR
U4, U5, U7



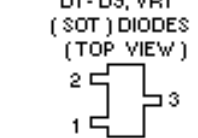
LEAD IDENTIFICATION FOR
Q4, Q6, Q7



LEAD IDENTIFICATION FOR
Q1, Q2



LEAD IDENTIFICATION FOR
D1 - D3, VR1

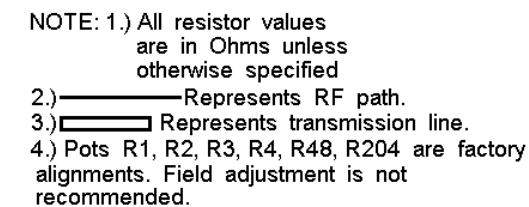


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Q3

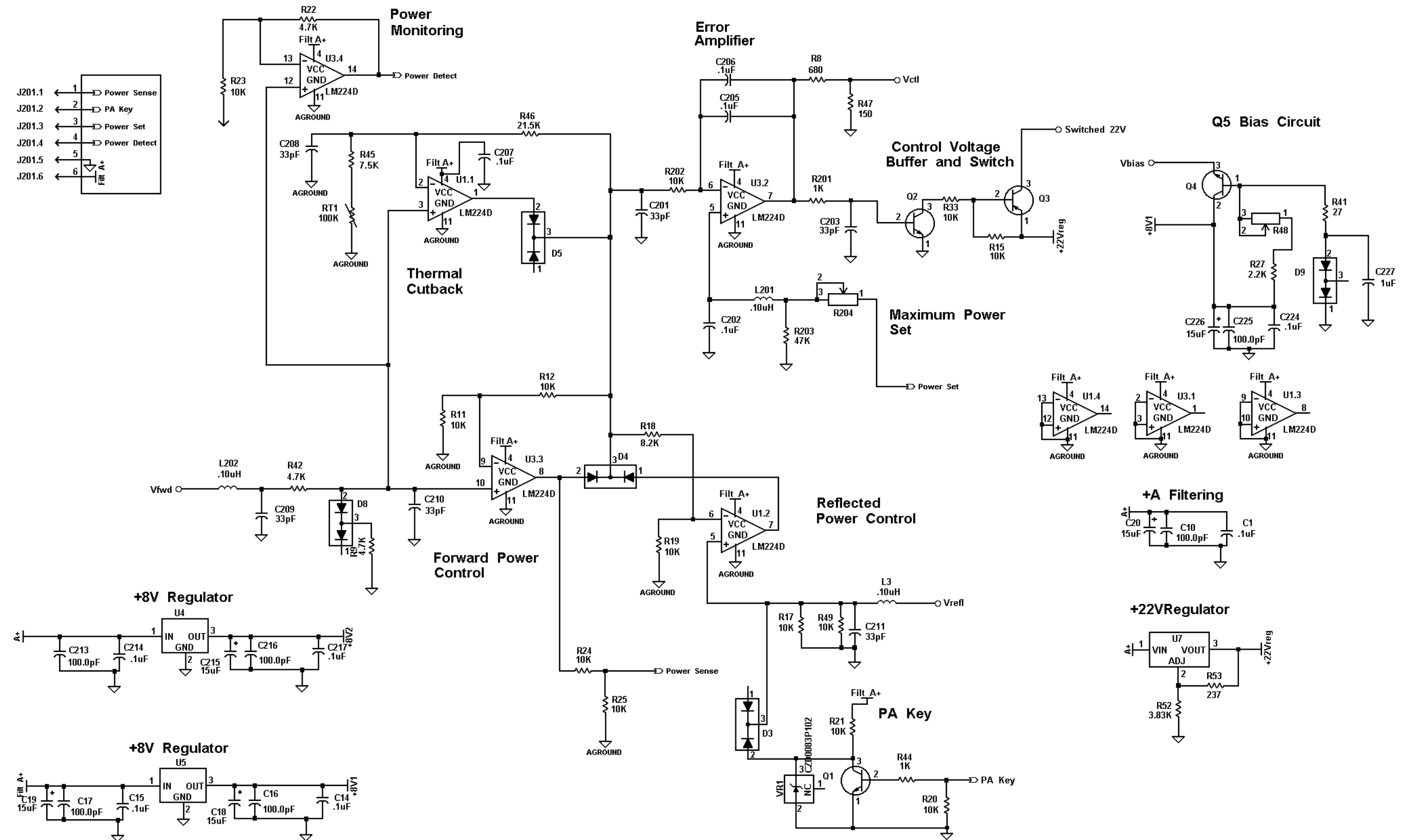


**POWER AMPLIFIER BOARD A1
19D902794G5**

(19D902794 Sh. 3, Rev. 9)



(188D5792, Sh. 1, Rev. 2)



POWER AMPLIFIER BOARD A1
19D902794G5

(188D5792, Sh.2, Rev. 2)