PTPA-200A
UHF POWER AMPLIFIER
OPERATION AND MAINTENANCE
MANUAL

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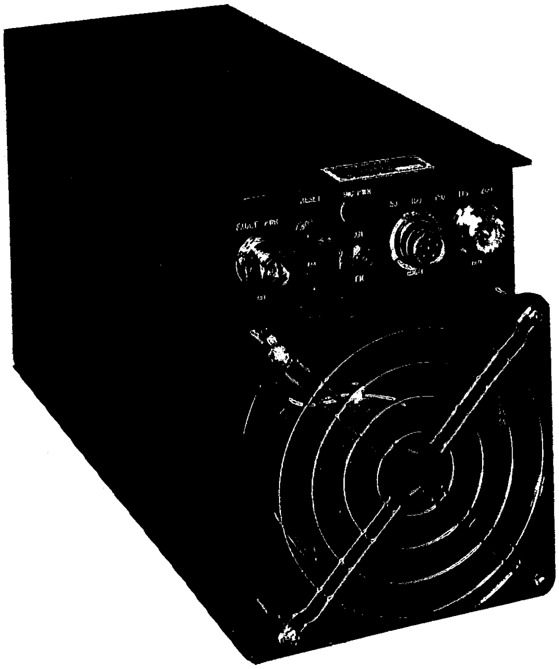

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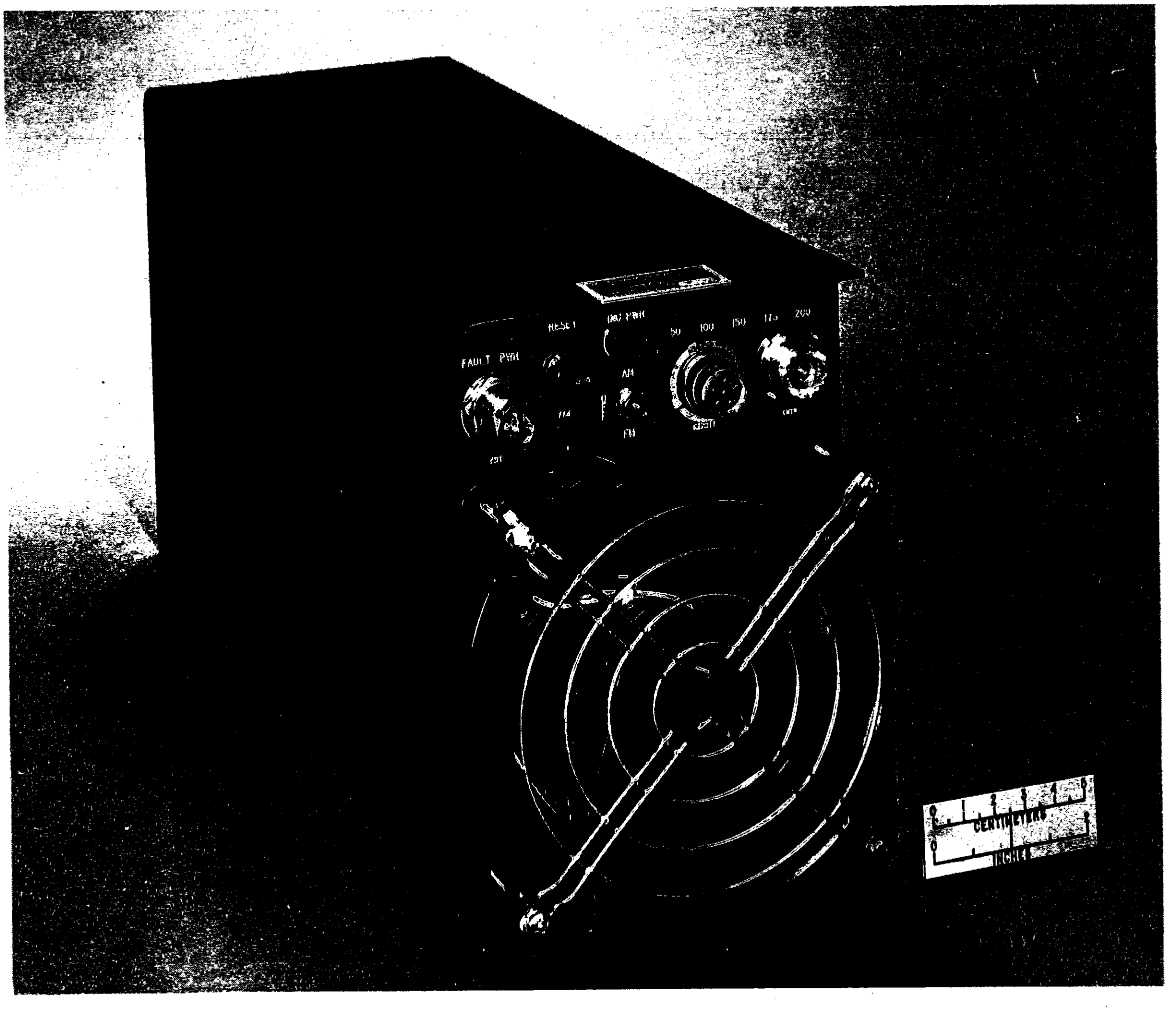
SECTION 1
DESCRIPTION

1-1 SYSTEM DESCRIPTION

1-2 The PTPA-200A is an RF-power-amplifier system, hereafter called the Power Amplifier, containing all circuits needed to provide automatically activated output power amplification in a UHF transmit/receive system. The Power Amplifier is shown in Figure 1-1.



1-3 The Power-Amplifier contains three RF amplifier stages which typically will amplify 1.5 watt input to an output of 200 watts.

1-4 In addition to the RF amplifiers, the Power-Amplifier contains circuitry to control T/R changeover, power-output, and a number of detection and control circuits to allow operation under adverse conditions while protecting itself against destructive conditions.

1-5 The Power Amplifier will operate over the frequency range of 225MHz to 400 MHz. The unit is fully broadbanded and never needs tuning (by operators or service personnel).

1-6 The Power Amplifier will function in either "carrier operated" mode or under "key line" control. The carrier detect circuit has enough delay designed into it to hold the unit in the transmit conditions with an AM signal during normal negative amplitude excursions.

1-7 The Power-Amplifier contains two output power leveling loops which, after the input power is above minimum level, will adjust the overall gain of the RF amplifier chain to maintain a constant output level. The AM power leveling loop maintains the average carrier level at one-fourth the level of the FM loop and has a time-constant long enough to reduce modulation stripping to less than 1dB at 300 Hz.

1-8 The FM ALC is a fast response loop which protects the amplifier in the case of excess amplitude modulation or sudden mismatch.

1-9 By using the key-line, the Power Amplifier can be used as a linear-amplifier with about 23dB of power gain.

1-10 The power indicating Led's give an indication of power output at intervals of 50,100,150,175, and 200 watts and vary intensity proportionally with the power between these points. Their fast response gives a visual indication of the presence of amplitude type modulation of the signal.

1-11 The fault indication lamp is red in color (all the other lamps are green) and indicates two types of fault conditions.

1-12 Automatic reset fault conditions are indicated by a flashing lamp. These faults are usually of a temporary operator controllable type and the fault condition, when removed, will allow normal operation on the next receive-to-transmit transition. These faults would be;

(a) High or Low input supply voltage. Input voltage must be greater than 20 volts and less than 33 volts.

(b) High input RF power. Input power must be less than 25 watts.

(c) High internal unit temperature.

1-13 Non-Automatic reset faults are indicated by a steady fault light. These faults usually require some attention to the installation or internal circuitry.

1-14 Sensing circuits are included to detect the failure of one of the dual output amplifiers and reduce power to allow continued operation with the remaining output amplifier module.

1-15 In the faulted or off state, the Power amplifier automatically goes into a bypass mode allowing normal operation of the rest of the system.

1-16 A Remote Control Connector is located on the front panel. The functions available from this connector are power ON/OFF, AM/FM control, power output adjustment, key line control and power output indication.

1-17 The operating parameters of the Power Amplifier are listed in Table 1-1. The environmental characteristics are listed in Table 1-2, and the input-output connections are listed in Table 1-3.

TABLE 1-1 OPERATING PARAMETERS

Function	Characteristics
Prime Power Input	28VDC nominal, 28 amps 22 VDC minimum, 32 VDC maximum
Frequency Range	225-400 MHz
RF Input Power	1.5 to 25 watts with FM, FSK PSK, or AM
RF Output Power	200 Watts, ±1dB with FM, FSK, or PSK 50 Watts carrier, 200 Watts peak with 100% AM
RF Output Power Range	Front Panel or Remote adjustable from 50 watts carrier to 200 watts
Load VSWR	Maximum of 2:1 for full power output

TABLE 1-2 ENVIRONMENTAL CHARACTERISTICS

Function	Characteristics
Size	
Height	7.00 inches
Width	4.95
Depth	14.12
Weight	23 lbs.
Operating Temperatures	-20°C to +55°C (including sun loading)
Cooling	Air Cooled with integral blower
Water	Splash proof and rain proof

TABLE 1-3 INPUT/OUTPUT CONNECTIONS AND LEVELS

Connector	Pin	Function	Levels
J1		RF Input	1.5 to 25 Watts
J2		RF Output	50 to 200 Watts
J3		Remote	
	A	Ground	
	B	Power On/Off Control	On = 0 to 0.5V @ -10Ma Off = 100K ohm to ground
	C	AM/FM Control	AM = 0 to 0.3V at 1 Ma FM = 5K ohm to ground
	D	Power Output Control	Maximum power with open circuit
	E	Output Power	10µA into 20K for 200 Watts
	F	Key	Open Circuit for Automatic operation < 0.8 VDC for transmit > 2.2 VDC for receive
P1	A & B	+28 VDC input	
	C & D	-28 VDC input	

SECTION 2

OPERATION

2-1 GENERAL

2-2 Information for operation of the PTPA-200A is included in this section. This information includes a description of input signal requirements for automatic operation as well as information regarding use of the key line for manual operation.

2-3 CONTROLS AND INDICATORS

2-4 All operating controls are located at the front of the unit above the cooling fan. Control and indicator functions are described in Table 2-1. Locations are shown in Figure 2-1.

2-5 OPERATIONAL CHECKOUT

2-6 General. The unit can be used in the automatic mode once a suitable power-source has been connected to it as described in Section 3 and the proper type and power-level RF driving signal source is available. A system interconnect diagram is contained in Figure 2-2.

2-7 The operating instructions in the following paragraphs will place the unit in operation to amplify signals from the transceiver to the antenna while allowing normal receiver operation. With the power amplifier switched off, the unit represents a straight through connection and will allow normal operation of the transmit/receive system.

TABLE 2-1

CONTROLS AND INDICATIONS

Control/Indication	Type	Function
Circuit Breaker	Toggle	35 Amp Breaker
AM/OFF/FM	3 position switch	ON/OFF & Mode
Power Control	Single Turn Control	Adjusts Output Power
Fault Light	Red LED	No light-no faults Flashing Light-reference Para. 1-11. Steady Light-Reference Para. 1-12.
Power Light	Green LED	Light indicates DC voltage applied.
50,100,150,175,200 Lights	Green LED'S	Lights indicate output power level.

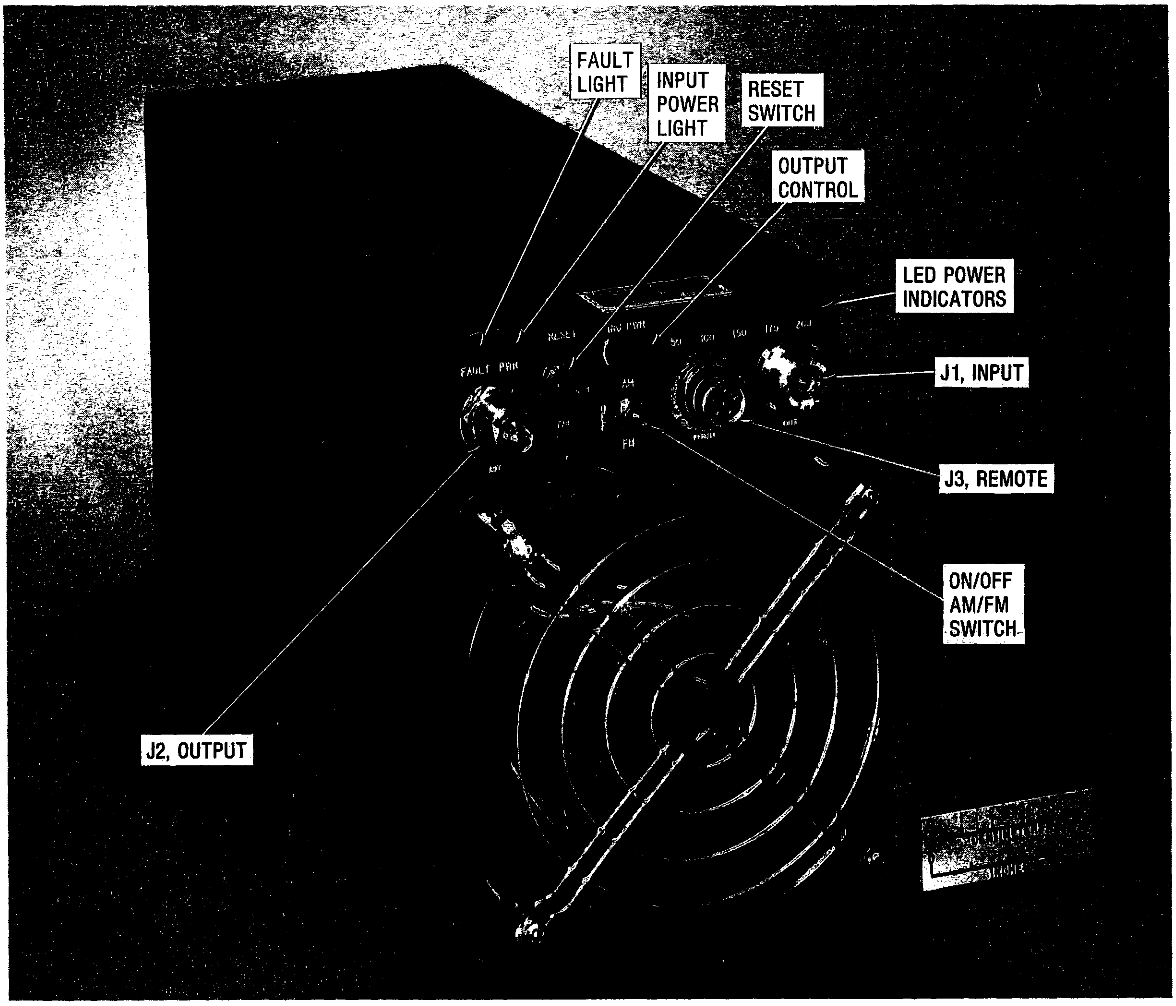
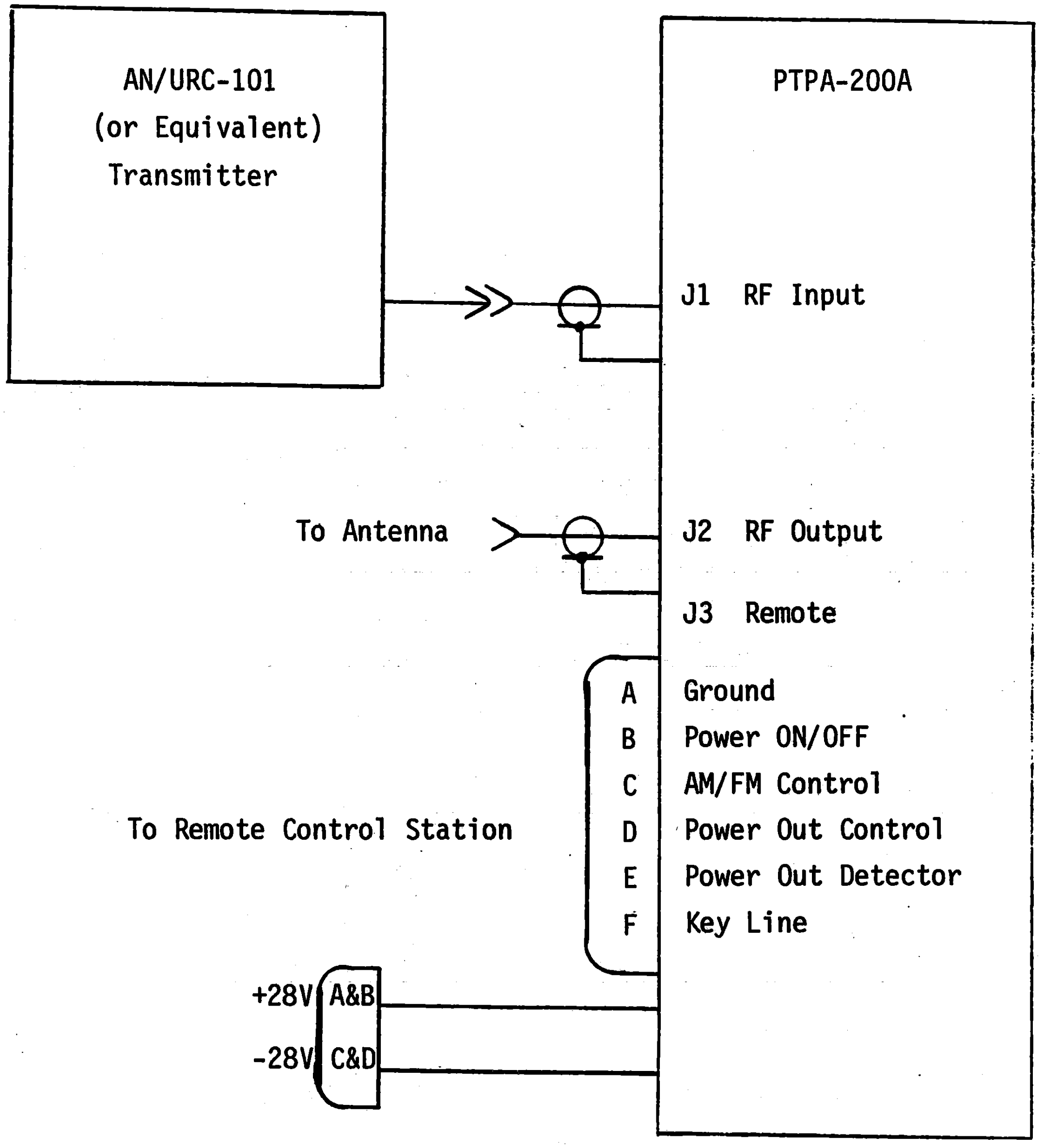


Figure 2-1. CONTROL AND INDICATOR LOCATIONS



SYSTEM INTERCONNECT DIAGRAM

Figure 2-2

2-8 TURN ON PROCEDURE

2-9 Refer to Table 2-1 for the functional description of the controls and indicators and Figure 2-1 for their locations to perform the following steps.

(a) Verify that the power amplifier is connected for operation in accordance with Section 3 and that the source of RF is of the proper type, frequency, and power-level.

(b) With no RF power being delivered to the Power Amplifier, switch on the circuit breaker/switch button.

(c) Set the AM/OFF/FM switch to correspond to the mode of the RF source.

(d) Verify that the green PWR LED is lit, indicating that power is being supplied to the Power Amplifier circuits.

(e) No indication should be noted from the fault LED. If the fault light is on (steady or flashing) refer to the Fault Indication Operator Notes at the end of Section 4.

(f) Turn the power control CW to the stop.

(g) Applying RF to the XMTR input should cause the indicator lamp(s) to indicate an output power level.

(h) If automatically leveled output is desired from the power-amplifier, adjust the power control to obtain the desired carrier power level in the AM or FM mode. For SSB, DSB, CW or Pulse, where a leveled output is not meaningful, the control should be turned completely CW. The ALC circuits in the Power Amplifier should not be used to "clip" or "limit" the output in these modes.

2-10 KEY LINE CONTROLLED OPERATION

2-11 Key-Line operation is necessary for operation in SSB, DSB, CW, or Pulse operation to prevent loss of output signal during changeover from receive to transmit and to avoid excessive toggling of the changeover relays.

2-12 Faster turn-around is also possible using the key-line circuit. The activation and deactivation time-constants needed for carrier control of the power-amplifier are overridden by the key-line signal.

2-13 REMOTE CONTROLLED OPERATION

2-14 Remote controlled operation is allowed with a suitable remote control unit. To set the system up for remote operation, the following setting should be made on the Power-Amplifier.

(1) Circuit Breaker = ON (up)
(2) AM/OFF/FM = OFF (Center Position)
(3) Power Control = CW (maximum power)

Attaching the front-panel remote connector will now allow full remote control of the amplifier.

2-15 To return the amplifier to local control, remove the front-panel remote plug.

SECTION 3

INSTALLATION

3-1 GENERAL

3-2 This section contains information necessary for installing the Power Amplifier in a typical system.

3-3 The Power-Amplifier is designed for both fixed and mobile installation.

3-4 The unit should be held securely in place in any mobile installation as an unsecured unit may cause damage to itself and surrounding equipment and personnel. Mounting holes are provided at the front and back of the Power Amplifier for this purpose.

3-5 Dimensions of the unit and location and size of the mounting holes are shown in Figure 3-1.

3-6 A shock mounted platform for a vehicular or aircraft installation consisting of this Power Amplifier, a AN/URC-101 radio transceiver and its associated power filter and distribution box is available from the supplier. This installation is shown in Figure 3-2.

3-7 The Power Amplifier normally is supplied with an MW 10M (M) A for power connection. This plug is to be connected as follows:

- A and B are positive
- C and D are negative and case ground.

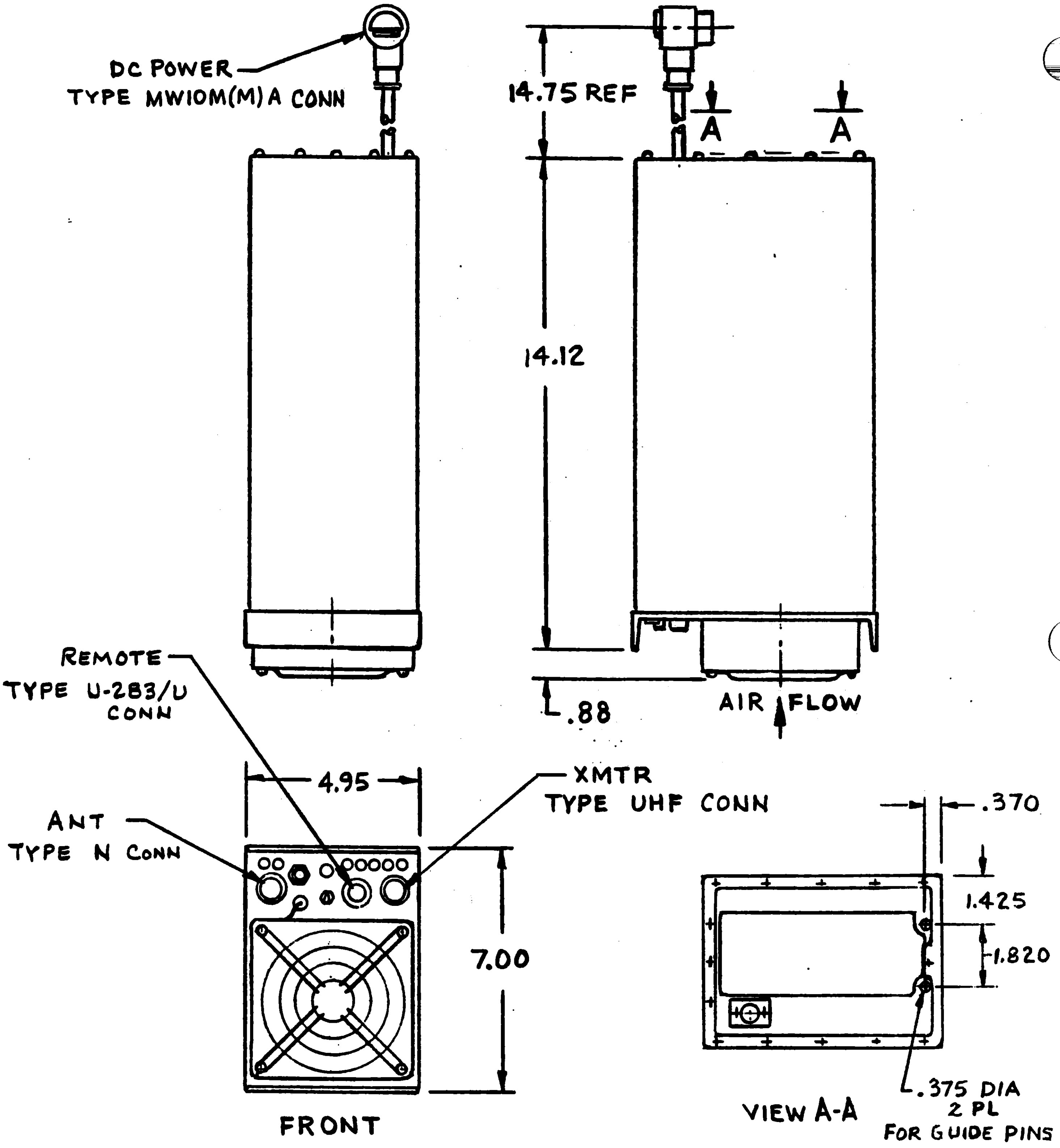


FIGURE 3-1
POWER AMPLIFIER
OUTLINE DRAWING

3-8 The amplifier contains a shunt power-diode which will conduct and trip the circuit-breaker if a reversed voltage connection is made. This diode will minimize damage to the unit but the high current available from a power source capable of supplying the Power Amplifier could cause enough damage to require servicing of the unit and this diode should not be relied on instead of care in connecting the unit.

In power-on standby mode, current to the power amplifier should be less than 100 MA and the power lamp should light. If there is any doubt about the connection a 28V source limited to less than 1 amp should be used to initially check the unit in the power on standby mode.

3-9 Due to the high current (up to 30 amps) drawn by the unit at maximum power, attention must be given to the power lines bringing power to the unit:

(a) A two wire cable should contain no less than 14 gauge wire.

(b) A Four wire cable should have at least 16 gauge conductors.

(c) Length should be kept to a minimum and good electrical connections must be made to the power source.

(d) The combination of cable length and conductor gauge should be such that less than a 2 volt drop occurs from the power-source to the unit connection under the conditions of maximum power transmission.

CAUTION

Due to the high RF power produced by the Power-Amplifier, it is important that the type and placement of the antenna be such to prevent both direct electrical contact or sustained close proximity operation by personnel.

SECTION 4

PERFORMANCE TESTING

4-1 INTRODUCTION

4-2 The scope of this section is to allow field performance evaluation of the operation of the Power Amplifier. This testing should be performed on a yearly basis or when degraded operating performance of the unit is suspected. Although this is not an indepth testing of all internal circuits, it represents a good overall check of the unit without requiring disassembly.

4-3 TEST EQUIPMENT REQUIRED

The test equipment listed in Table 4-1, or its equivalent, is required to test the Power Amplifier.

TABLE 4-1. TEST EQUIPMENT LIST

Description	Capability
Power Supply	20 to 34 VDC at 30 amps
Power Attenuator	30dB at 300 Watts
Voltmeter	0 to 50 VDC
Watt-Meter	1 mw to 3 watts
RF Power Source	variable to 5 watts 225 to 400 MHz

4-4 Testing of the unit requires accurately knowing both the Power out of and the voltage into the unit. Simply reading the power using the nameplate attenuation values of the equipment and neglecting the losses of the coaxial cable(s) can lead to errors in excess of 2dB. At 200 watts this could lead to an error of 75 watts or more in the indicated power. Only use a power meter with a specified accuracy of better than 0.5dB and perform an accurate determination of the actual loss of the attenuator and any interconnecting coaxial cables used between the power-amplifier output connector and the power detector at 225, 325, and 400 MHz. The results of these measurements should be used to determine the output power of the power amplifier. The voltage to the unit can be affected by long cables and the actual voltage to the unit will be less under high current conditions than that at the power source. Input voltage determination should be made as electrically close to the unit as possible.

4-5 With the Power Amplifier connected for operation into the attenuator load, the following conditions shall apply:

a. V_{in} = 28 VDC
b. Mode = FM
c. Power Control = maximum (CW).
d. Pin = 5W.
e. Key-line = open

4-6 The output power at 225, 325, and 400 MHz shall be between 160 watts and 225 watts.

4-7 Supply current shall be less than 30 amps.

4-8 Turning the power-control to minimum (CCW) shall cause the output to be reduced by 6dB ±1dB.

4-9 The following conditions shall apply for the AM testing:

a. V_{in} = 28 VDC
b. Mode = AM
c. Power Control = maximum (CW)
d. Pin = 1.5 W
e. Key-line = open

4-10 The output power shall be 50W ±13W.

4-11 Supply current shall be less than 20 amps.

4-12 Setting the power control to minimum shall reduce the output power by 3dB ±1dB.

4-13 Reduce the input power to minimum and slowly increase it until the unit actuates. The unit shall actuate at less than 1 W of input power.

4-14 Increase input power to 1.5 watts and apply 2.2V to the key-line. This should cause the unit to go into bypass.

4-15 Use the following conditions:

a. V_{in} = 28 VDC
b. Mode = FM
c. Power Control = maximum (CW)
d. Pin = 5W at 325 MHz
e. Key-line grounded (0V)

4-16 All power indicating LED's shall be lit. Slowly decreasing the input power shall cause the LED's to smoothly extinguish in a high to low progression. The unit shall not go into bypass with the input power at minimum.

4-17 Increase the input power to 5W and raise the voltage to 32 volts. The unit should continue to function and P_{out} should not change by more than 10W.

4-18 Decrease the input voltage to 20 volts. The unit should continue to operate but P_{out} shall decrease by at least 50W.

4-19 If the fan has not run at any time during these tests, return the input voltage to 28 volts and maintain full power output for 3 minutes or, until the fan operates. If air temperatures are much below 25°C, it may take longer than 3 minutes for the fan to operate. If the fan fails to operate, the following test should be performed:

a. Unplug the fan at the power amplifier front panel.
b. Connect a source of +28VDC capable of at least 0.5 amps to the disconnected lead (negative return goes to the Power Amplifier chassis).
c. If the fan fails to operate, the fan is defective and should be replaced.
d. If the fan operates, the Power Amplifier is defective and requires disassembly and repair.

4-20 With the amplifier switched off, the output power (produced by the 5W generator) should be noted. A barrel connector should be substituted for the amplifier and the output power noted. There should be less than 1.5dB difference in these readings.

4-21 A final test of the AM operation of the unit should be made using a transceiver such as the AN/URC-101 in low-power AM mode and monitoring the output on a receiver. The audio should be understandable with the Power Amplifier off or on (make sure that the signal is sufficiently attenuated so that overload of the receiver does not occur when the Power Amplifier is switched on). Operating the Transmitter/Amplifier into the attenuator with no direct connection to the receiver in the same room should provide a very adequate signal level for this check.

4-22 If the unit fails these tests, the Operator Troubleshooting Table 6-1 should be referred to for possible usage errors.

4-23 If no usage errors can be determined, the Power Amplifier requires disassembly and repair.

SECTION 5

5-1 FUNCTIONAL DESCRIPTION

This chapter provides a functional description of the PTPA-200A Amplifier.

An overall description of the major assembly systems is presented which is directed to the Simplified Block Diagram of figure 5-1.

A more detailed description of the functional block diagram of figure 5-2 is then presented.

5-2 OVERALL FUNCTIONAL DESCRIPTION

The overall functional nature of the amplifier can best be seen in the Simplified Block Diagram of figure 5-1.

The RF signal to be amplifier is applied to the XMTR input jack. The signal level should be in the 1 to 25 watt power range and 225 to 400 MHz frequency range.

In automatic T/R mode, whenever these input requirements are met, or when the key-line input is forced to a logic low level, the bypass relay energizes and the RF signal is applied to the voltage-controlled attenuator (VCA) on the A1 assembly. The VCA is the control element in a feedback loop which determines the output power level. The attenuation of the VCA is varied by the automatic-level control (ALC).

The output of the attenuator is supplied to a two-stage driver/amplifier the output of which is split into two equal amplitude signals which differ in phase by 90^{0}.

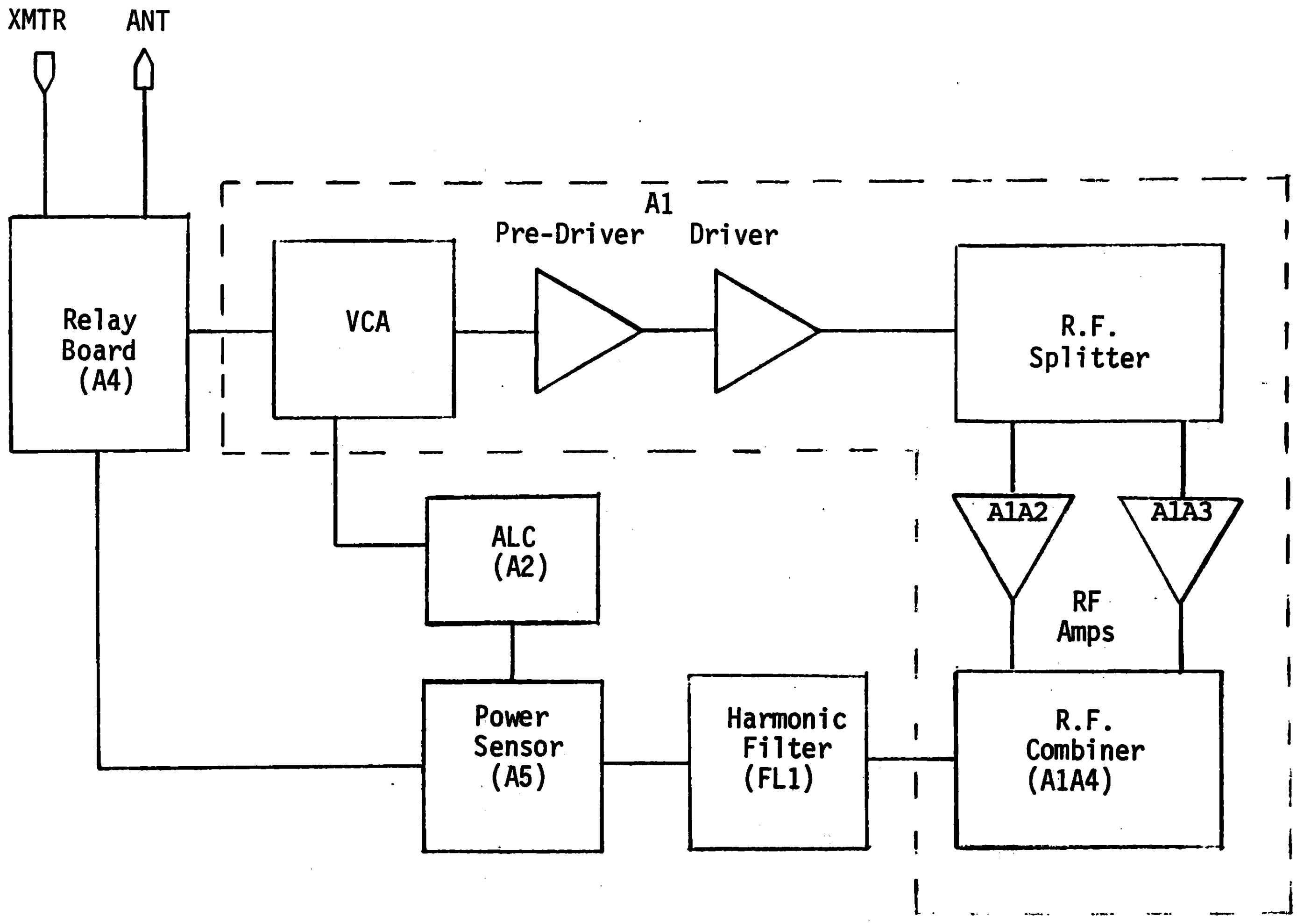


Figure 5-1. SIMPLIFIED BLOCK DIAGRAM

These two signals are amplified separately in A2 and A3 and then recombined in the Power Coupler (A4) by a 90^0 combiner which brings the two signals back into phase with each other.

The total output power is applied to a low-pass filter (FL1) to remove unwanted harmonics. The filtered signal is applied to a power sensor (A5) which senses the amount of forward and reverse power passing through the sensor. These signals are used by the ALC to monitor the output power level.

The RF is routed through the bypass relay (K1) to the antenna output connector.

5-3 FUNCTIONAL BLOCK DIAGRAM DESCRIPTION

The following description pertains to the Functional Block Diagram of Figure 5-2.

5-4 Circuit Breaker

The front-panel mounted circuit breaker is of the thermal trip-free type. All power to all circuits in the power-amplifier is routed through this device. The current rating of the breaker is 35 amps and the design is such that in the event the toggle is inhibited from reaching the "off" position, excessive current drawn by the unit will cause the breaker to open the path to minimize internal or external damage but the breaker will automatically reset after a short period of time. This condition would lead to cycling of the power off and on.

5-5 Transient Filter

This low-pass filter consists of a custom (in-house fabricated) 10 micro-henry series inductor shunted by a 10mfd film type capacitor. This combination of components is needed to reduce the level of spikes on the DC input line to a level which will not damage internal circuits. A secondary winding wound on the inductor core is connected to a power resistor in order to de-Q this input circuit. Without this, ripple in a vehicular system could be multiplied at circuit resonance to a damaging level. The input capacitor was selected to be able to withstand the large circulating currents which would occur in the event of a fault in the vehicular generator.

5-6 Power-On Lamp Ckt

This circuit consists of an LED and resistor connected to the 28V input to the ALC and control circuits of the power amplifier.

5-7 High/Low Voltage Sense

This circuit senses the input voltage to the amplifier and provides a logic control signal to the amp on/off control. This signal is active for an input of greater than 32 volts and less than 20 volts and prevents (or discontinues) amplifier operation for these out-of-voltage range conditions.

5-8 Voltage Limiters

The 3 series-pass type Voltage Limiters protect the voltage sensitive RF power-devices as well as other voltage sensitive components from damage due to excessive input voltage. The transistors in these circuits can safely hold the output level to 3 volts for inputs as high as 120 volts for short durations and safely hold off 100 volts indefinately.

For voltages of 20 to 30 volts, the limiters act as saturated switches with less than 1 volt drop. For voltages of 30 to 32 volts, the limiters act as series pass voltage regulators, maintaining the output to 30 volts. For an input voltage condition of greater than 32 volts, the limiters are inhibited from operation and the output is very nearly zero volts.

5-9 15V @ 100 mA Regulator

This circuit is a single series-pass emitter follower type of voltage regulator. This regulator provides 13 to 15 volts output whenever the power is switched on and powers operational amplifiers, the 5V logic voltage regulator and 2.5V reference generator. Because this circuit is not protected by a series limiter, it has been designed to withstand greater than 100 volts at its input. Tight line and load regulation is not required or attempted by this simple regulator.

5-10 5V @ 50mA Regulator

Power to this circuit is provided by the 15V regulator. This is a series pass regulator which uses a 2N2222 transistor as the pass element with an operational amplifier in the output control feed-back loop. The 2.5 volt reference is used by an amplifier circuit with an accurately controlled gain of 2 to provide the 5V output.

5-11 2.5 V REFERENCE

This circuit is powered by the 15V regulator and consist, primarily, of an MC1403 2.5V reference I.C. This circuit provides a highly accurate voltage for use throughout the unit for comparison and control.

5-12 5V @ 1.5 A Bias

Power to this circuit is provided by one of the switched series limiters. The circuit operation is the same as the low-current 5V logic supply, but, because of the higher current output requirement, a heat-sunk power device is used for the series pass element.

5-13 Temperature Controlled Fan Switch

This is a solid-state switch circuit which uses a thermistor mounted in the main R.F. amp heat-sink to determine when a temperature has been reached which requires the fan to be running. The circuit activates the fan motor when a temperature of about 60°C has been reached and has about 5°C of hysteresis (fan shuts off at about 55°C).

5-14 R.F. Level Decode

The circuit uses a filtered average output level from the fwd-power sense circuit to determine the amount of power being provided to the 50Ω output port. This level is compared to fixed D.C. levels and signals are provided to the Led drivers which are a function of the output power. The drive is a linearly increasing voltage which begins providing drive when the previous power-level lamp has reached its maximum intensity (when output power is equal to the level indicated by that lamp) and reaches a maximum when its indicated power-level has been reached. In the case of the lowest power lamp, the lamp begins to receive drive when the output power is equal to one-half the level indicated. With this system, proportional power level increases or decreases can be seen by the operator.

5-15 Lamp Drivers

The lamp drivers are 2N2222 transistors. Maximum current drive to the Led's is limited by a combination of the highest drive level delivered from the power-level decode circuit (3V) and an emitter resistor (130Ω).

5-16 Heat Sink Temperature To Power Output Computer

This circuit uses a thermistor mounted thermally close to the output amplifiers.

The output from this circuit has no effect on the output power level of the amplifier until a heat-sink temperature of approximately 85°C is reached. At this temperature a signal from the circuit causes the output of the amplifier to be reduced. The amount of reduction would cause the output to be linearly decreased to zero output for a heat-sink temperature of 100°C. Other circuits would actually switch the amplifier to bypass before zero output is reached. The net effect of this circuit is to not have any effect on the amplifier output until a heat-sink temperature of 85°C is reached and then to decrease the output power enough to prevent a further significant increase in heat-sink temperature, allowing continued operation at reduced power.

5-17 Input Voltage to Power Output Computer

This circuit is needed to prevent improper amplifier operation by the power-amplifier under the condition of reduced input voltage. The output available from a power-amplifier is a function of the output load and supply voltage. The power-amplifiers have been designed to produce the required output power at a nominal input voltage. Below some voltage, attempting to maintain this level would result in excessive distortion and it is the job of this circuit to adjust the maximum output power from the amplifier to prevent this condition. The power reduction is roughly inversely proportional to the square of the supply voltage reduction. The output power is proportional to the square of the power reference voltage. For this reason, power reduction can be accomplished by a linear power-reference versus input voltage level relationship. This circuit provides a constant level output down to 27 volts and reduces to a minimum for an input voltage of 21 volts.

5-18 Reference Power Level Computer

This circuit combines the inputs from the Heat-Sink Temperature to Power-Out Computer, Input Voltage to Power-Out Computer, Reduced Power Circuit, and Front Panel Power Control to produce a power reference level which is used by the ALC loops to control the output power level. With the exception of the Reduced Power Circuit, the input "requesting" the lowest output power-level will dominate over the other two inputs. In this way, the protection circuits or front-panel control will set the maximum output power level in response to the greatest reduced power protection demand or front panel control, ignoring the other two inputs which would have allowed a higher output power. The Reduced Power Circuit reduces power to one-quarter the level set by the dominating input. This circuit is activated in the case of the loss of one of the Power Amplifier modules and is used to make the operating conditions (power-out required) of the remaining Power Amplifier Module approximately the same as before the failure.

5-19 PA #1 & PA #2 RF Sense

This circuitry consists of the R.F. detector at each PA board and a signal processing circuit. The signal processing consists of a fast attack slow release circuit which prevents negative peaks during AM from falsly triggering a PA failure indication. The time constants involved were selected such that, under the normal condition of symmetrical modulation, the most negative excursion of the output of this circuit would be the same, or greater than that of the unmodulated carrier at frequencies down to 10Hz.

5-20 Reduce Power Latch

This circuit represents memory such that once a failure in a Power Amp module has been detected, the only way to return power to the full-power level is to reset this latch by switching the unit off and on.

5-21 Reduce Power Circuit

This circuit causes the power-reference voltage to be cut in half (reducing required output power to one quarter). This reduction is in addition to any proprtional reduction which has occurred due to low-voltage or high temperature. This method allows the remaining power-amplifier to continue to operate at the same level as before the failure of the other power-amp. Power lost to the isolation resistance is half the total power from the power amp therefore leaving one fourth the previous level for delivery to the output.

5-22 PA Fail Sense

Uses logic to determine if one of the power-amplifiers has failed.

5-23 T/R Relays

Two double-pole throw relays are used to transfer the single path from straight through (input connector to output connector), to Amp-In (input to PA in, output to PA out). Timing to these relays and the voltage-controlled attenuator drive circuits is such that the relays will never be called upon to switch more than 25 watts "hot".

5-24 Voltage Controlled Attenuator

This is a PIN-Diode type of D.C. controlled R.F. attenuator. This attenuator varies from less than 1dB insertion loss at Vin = 0 to better than 25dB at Vin = 8V. This unit can dissipate up to 25 watts safely (the maximum input R.F. Power allowed).

5-25 Drivers

The drivers consist of two stages of broad-band (225-400 MHz) gain which amplify the input from about 1 watt to 50 watts, hogh enough to drive the power amplifiers.

5-26 PA #1 & PA #2

The power amplifiers are two identical units capable of amplifying an input of 25 watts to about 125 watts. A pair of power transistors is used on each PA and a split-amplify-recombine approach is used which is similar to the method used on the two PA's to achieve more power output than could be obtained from a single device. The amplifiers are fully broad-banded and will cover the 225-400MHz frequency range without requiring tuning by the operator or service personnel.

5-27 Combiner

This device combines the output of each of the power-amplifiers. The method used allows one of the power-amps to fail without completely disrupting the output from the remaining power-amp. An isolation load resistance associated with this circuit absorbs R.F. power, which is the difference in power out of the two P.A.'s. For this reason, in the event of a loss of power out of one P.A., half of the power from the remaining P.A. would be consumed by this load resistor. In order to maintain the power out of the remaining amplifier at the same level it was before the failure, total output power from the circuit is reduced to one-fourth power.

5-28 Harmonic Filter

This is of the low pass type with a cutoff frequency of just over 400 MHz. All harmonics from the 225-400 MHz signal are out-of-band for this filter.

5-29 Power Detector

The amplifier output is passed through the power detector which senses the forward and reverse power level. The signals from this detector are used by the ALC to hold the output at the required level.

5-30 Fwd./Rev. Combiner

This circuit is designed to deliver a buffered voltage related to the forward output power for a load match of 2:1 or better and to the reverse power for any mismatch of 2:1 or worse. This circuit accomplishes this transition smoothly without detectable switching by "oring" the forward and reverse power signals together after the forward voltage has been attenuated by two-thirds with respect to the reverse-power signal.
In this way, as long as the reverse voltage is less than one-third that of the forward voltage (a better than 2:1 load mismatch) the forward voltage will control the power loop; if the reverse voltage becomes greater than on-third the forward voltage, the reverse power signal controls the power loop. In the case of a complete mismatch, the total maximum power developed (and dissipated) in the power amplifiers is one-ninth as much as in a matched condition.

5-31 A.M. Loop Amp and L.P. Filter

This circuit develops the high open loop gain necessary to ensure good control of the output power-level. It is also necessary for this section to provide sufficiently low open-loop frequency response to prevent significant reduction in the percentage of A.M. modulation in the closed loop condition. It was also necessary to ensure good stability of this loop and prevent a peaked frequency response. In order to ensure less than 1dB modulation reduction at a frequency of 300 Hz and a non-peaked response, a second-order function using this circuit to provide the dominant poles and a closed loop W_n of 100 Hz and zeta = o.7 was developed.

5-32 F.M. Loop Amp

This amplifier is similar to the AM loop amplifier and filter but has not been designed to prevent A.M. reduction since such type of modulation is undesirable in FM. The circuit time constants were set to allow as fast an attack time as possible in keeping with a good (45^{0}) phase-margin for good loop stability. It is this loop which is called upon in the case of a sudden mismatch (such as a shorted or broken antenna) to rapidly reduce the power-amplifier output to prevent damage to the R.F. power transistors.

5-33 Quarter Power Attenuator

This circuit reduces the power-reference voltage level delivered to the AM loop to one-half that for the FM loop. This results in the AM loop maintain a carrier output power (when active) of one-quarter the level of the FM level.

5-34 V.C.A. Amp and Driver

This circuit combines the outputs of the A.M. Loop Amp and Low Pass Filter, FM Loop-Amp, and VCA Clamp and Delay circuits, and amplifies the dominant control level to a power-level sufficient to drive the V.C.A.. The combining of these signals is done such that the control level which controls the VCA is the one which requires the greatest amount of attenuation in the output level. Using this scheme allows both the AM and FM loops to be functioning in the AM mode. Since the reference level delivered to the AM loop corresponds to one-fourth the output power of the FM loop, the AM loop controls the output level. In the case of a sudden mismatch or over-modulation, the FM loop with its fast attack time acts to protect the output devices. This configuration also allows the use of a clamp circuit to force the VCA to maximum attenuation during T/R relay change over.

5-35 VCA Clamp and Delay

By reducing the amount of R.F. output during the transition time of the output T/R relay, the relay is prevented from having to switch high (200W) levels which would substantially reduce its lifetime. At the start of a transition to transmit, a pulse is generated to cause the VCA to clamp to its maximum attenuation. This pulse lasts for 15 msec, long enough to allow the relay to operate and settle before allowing the RF power to climb to its proper level. At the time a transition to receive or amplifier bypass is initiated, the VCA circuit is forced again to maximum attenuation and held while the relay is switching and power is being removed from the drivers and power amps.

5-36 AM Loop Defeat

This circuit is controlled by the front-panel AM/FM switch. The changeover from the AM mode to the FM mode is accomplished by simply defeating the AM-ALC loops ability to drive the attenuator. When this occurs, the fast-responding quadruple-power level FM loop takes control of the output power leveling.

5-37 R.F. In Sense

This circuit is made to respond to an input of 1 watt to indicate to the T/R detect circuitry that R.F. is present from the driving unit. This circuit has a fast-attach slow-release type of response like the other R.F. sense processing circuits to eliminate indicated R.F. loss during normal negative modulation excursions due to amplitude modulation frequencies as low as 10 Hz.

5-38 T/R Detect

This circuit allows the use of R.F. controlled power-amp activation or the use of an external key-line control. With no connection to the key-line, this circuit detects the "floating" input and allows control of the T/R function to be performed whenever an input of at least 1 watt is received at the input from the transmitter. Loss of this signal for a period longer than normal negative modulations causes the T/$\overline{R}$ function to return to receive. If the key-line is forced to less than 0.5 volts, the T/R circuit will force the unit (barring a lockout fault) into the transmit mode unconditionally. If the key-line is forced to be above 2.2 volts, the amplifier will stay in the by-pass mode, regardless of the presence of R.F. at the input. This allows more rapid turn-around if desired; remote control of amplifier in/out or TTL or CMOS logic control; and use of pulsed or CW modes of operation.

5-39 Lock-Out Latch #1

This circuit prevents the unit from transferring into the operating mode when it is activated by high input RF, a tripped heat sink thermostat, or high or low input D-C voltage. If actuated during a transmit cycle, this circuit will remain in the lock-out mode until the end of the transmission even if the condition which caused the lockout clears before then. This scheme prevents toggling of the power amp in and out during transmission. Either transferring to receive or switching the unit off and on will clear the latch if the fault condition has been cleared. An output from this circuit is sent to the fault indicator, lamp circuit which causes the lamp to flash, indicating to the operator that an automatic-resetting fault condition has been detected which will prevent operation of the power amp.

5-40 Lock-out Latch #2

This latch is activated by conditions which normally indicate a major operational fault in the Power-Amplifier requiring some repair of the unit to correct. This latch can be set by indications of ALC loop failures or gross failure of the R.F. amplifier. After tripping and forcing the amplifier into the bypass mode, the fault light remains on steadily until a normal receive condition occurs.

5-41 Error Check Delay

This circuit delays the operation of latch #2 for a period of about 100 msec after initiation of a receive to transmit sequence. This goves the ALC and the RF detectors time to stabilize before checking for an abnormal condition.

5-42 Amp On/Off

This circuit checks the lockout-latches and, if both are cleared, upon receiving a transmit signal from the T/R control circuit supplies active signals to the Error check delay circuit, series limiter on/off circuits and drive to the relays.

5-43 Hi R.F. Detect

This circuit detects an input power exceeding 25 watts and sets lockout latch #1. This circuit is needed to prevent damage to the VCA and Pre-driver in the case of excessive input power.

5-44 Thermostat Trip Sense

This circuit wire or's the heat sink thermostats together such that the tripping of either thermostat will cause lockout-latch #1 to be activated. This circuit is in addition to the power controlling heat sink temperature detecting circuit and acts as a safety valve guarding against transistor damage if the other circuit fails to prevent excessively high heat sink temperatures in the vicinity of the power amplifier transistors.

5-45 Power On Reset

This circuit provides a reset to the latches whenever power is applied to the unit. This resets any lock-out or low power mode and allows the unit to start in a no-fault condition.

5-46 Loop Error Detect

This is one of the circuits used to prevent damage to the power amplifiers in the case of a failure in the ALC. The circuit looks for the case where the detected output power is greater than the reference power at a point where any such error should have been tracked out by the closed loop. This condition would occur if the FM loop were unable to maintain the output at a low enough level to conform to that set by the reference level.

5-47 Excessive RF Power Detect

This circuit detects the situation that output power of the amplifier is in excess of 250 watts, a condition never encountered in a properly operating amplifier and ALC loop.

5-48 Overdriven VCA Detect

This circuit is activated whenever VCA drive voltage exceeds 9 volts indicating the end of the usable range of the VCA. This condition would only occur for a situation where the VCA was unable to reduce the output level to that required by the loop for proper amplifier operation.

5-49 No RF Out For R.F. In Detect

This circuit detects a condition where the output of the power- amplifier at less than 10 watts for 1 watt or more at the input. Such a condition indicates a major fault in the R.F. amplifier and activates lock-out latch #2.

5-50 Fault Lamp Driver

This circuit provides the necessary drive to the fault lamp either pulsing the lamp or maintaining a continuous output as called upon to do by the lock-out circuits.

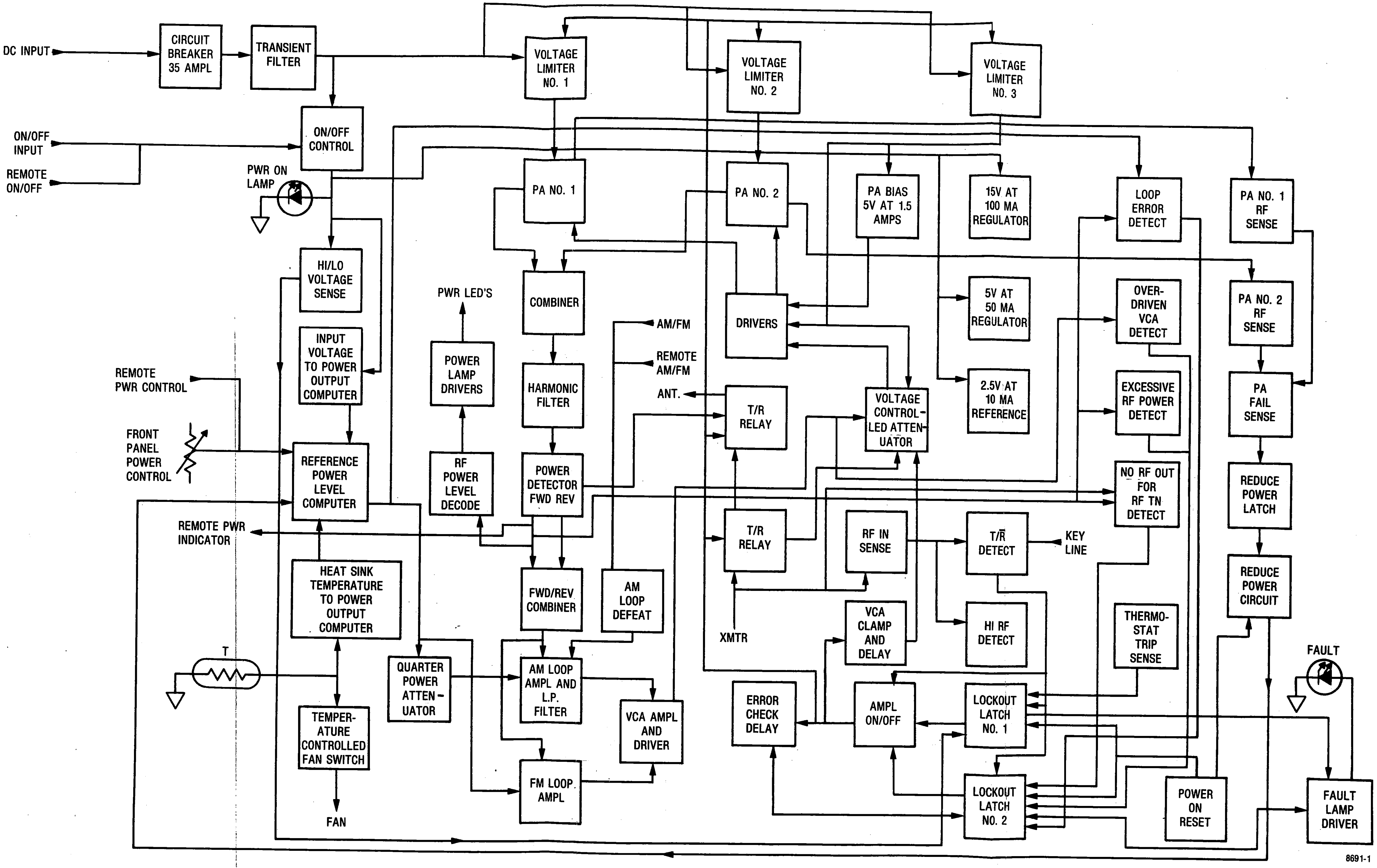


Figure 5-2. Functional Block Diagram

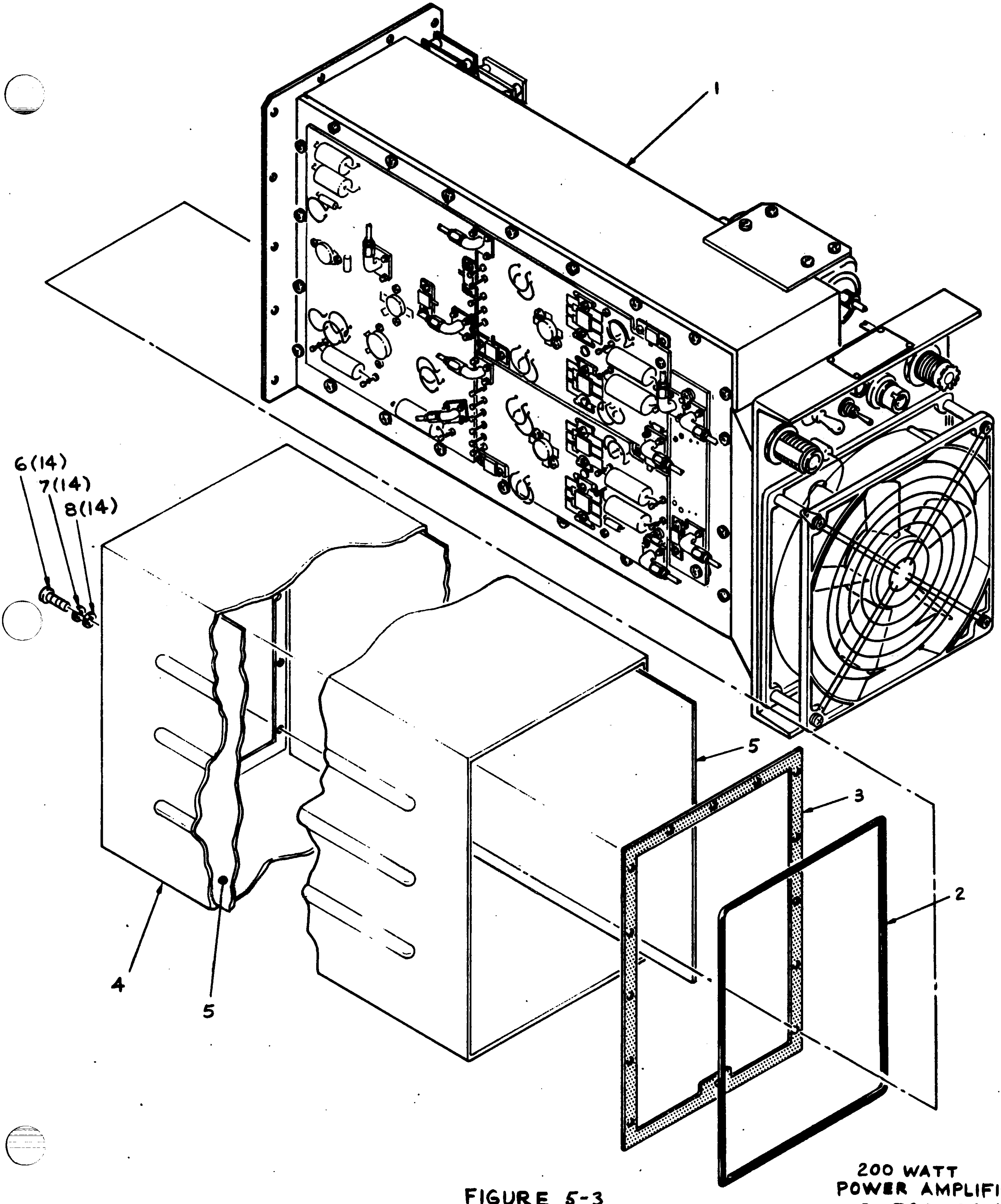
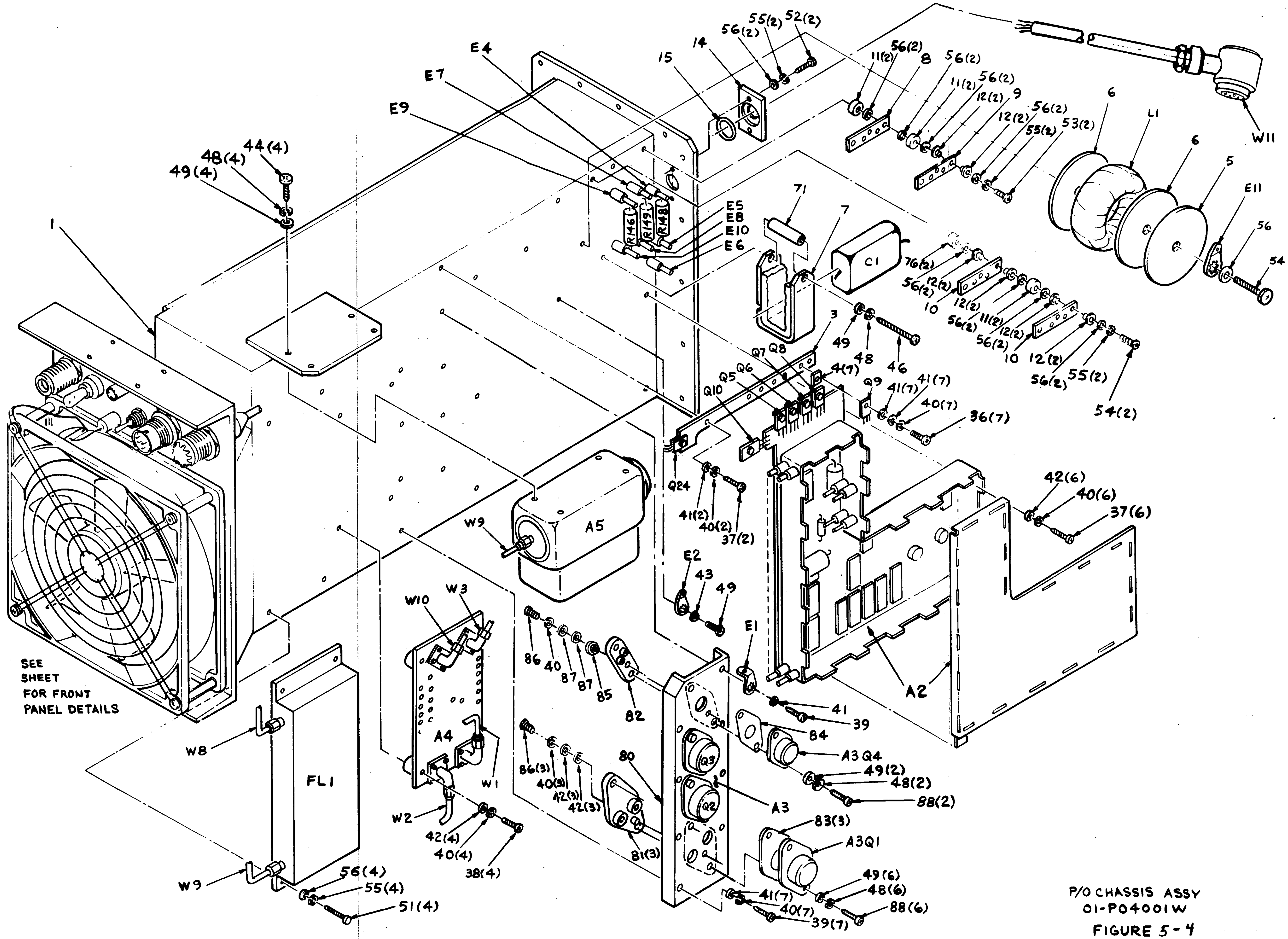


FIGURE 5-3

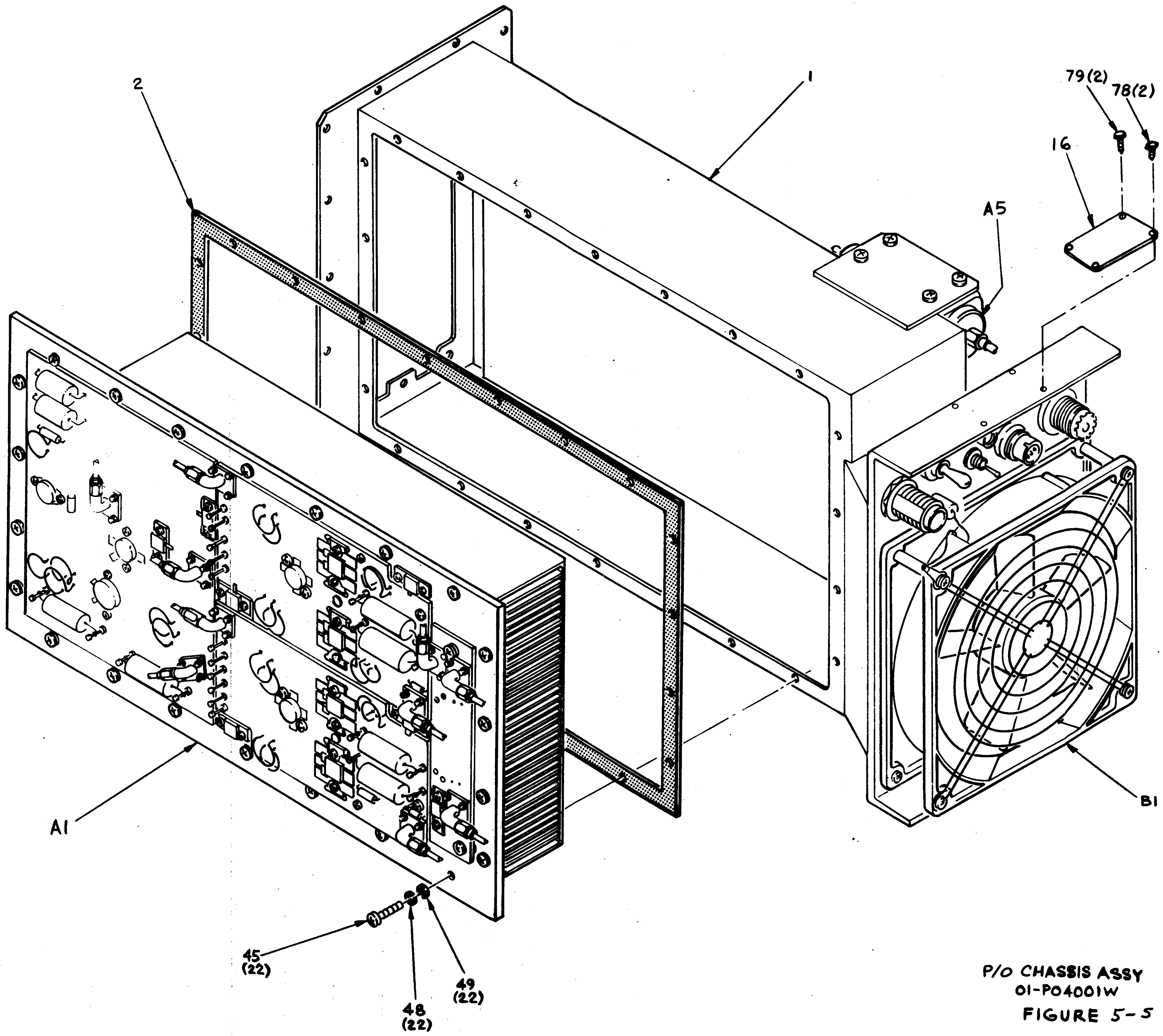
PARTS LIST

FIND NO.	QTY REQD	CODE IDENT	PART NUMBER	NOMENCLATURE
001	1		01-P04001W002	Chassis/Front Panel Assy
002	1		32-P04007W001	Gasket-Front Panel
003	1		32-P04008W001	Gasket-Rear Panel
004	1		15-P04012W001	Cover, Housing
005	2		64-P06348W001	Panel, INS-Housing
006	14		MS51957-29	Screw, PH .1380-32x.438
007	14		MS35338-136	Washer, Lock .136
008	14		NAS62006	Washer, Flat .138



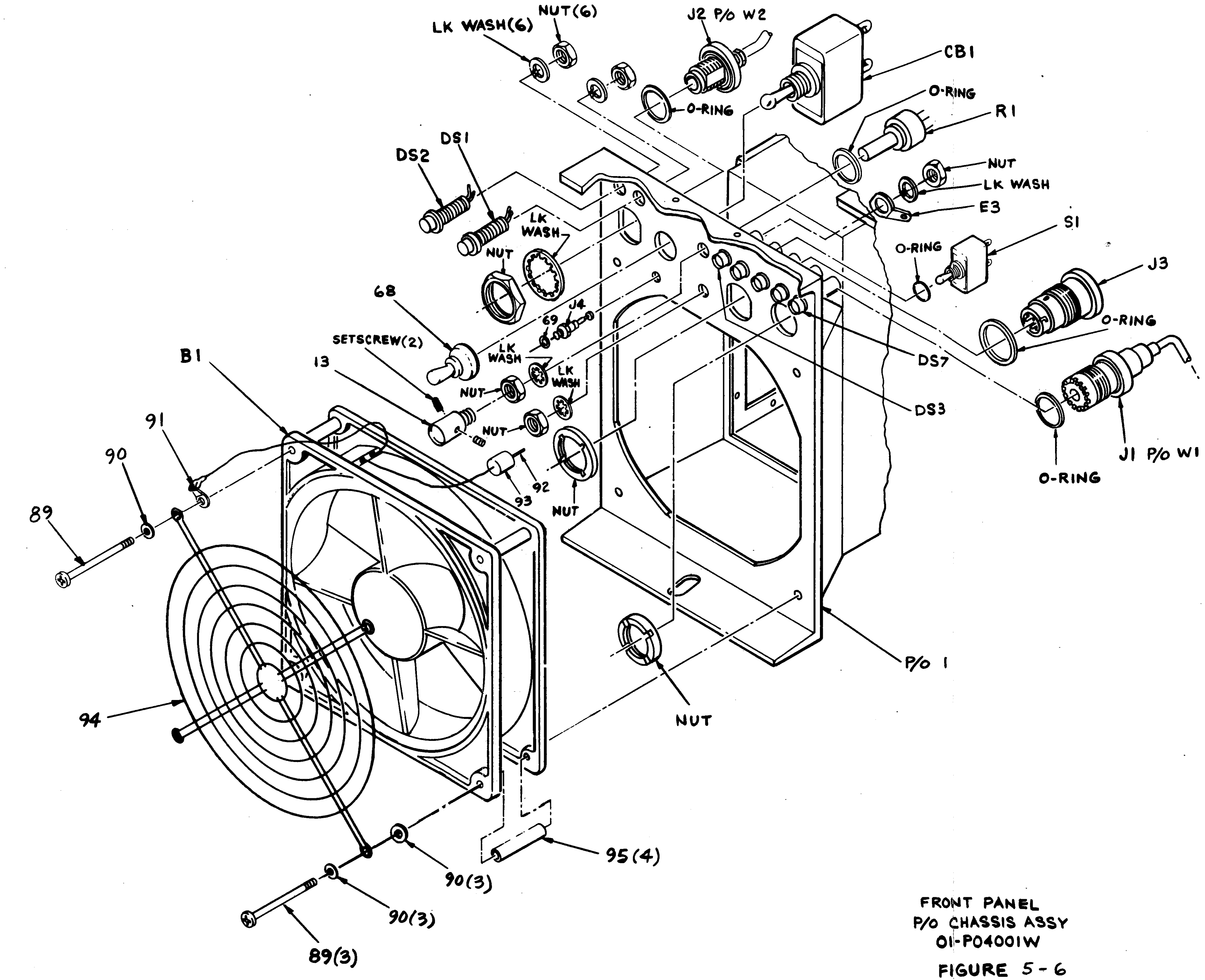
SEE SHEET FOR FRONT PANEL DETAILS

P/O CHASSIS ASSY
01-P04001W
FIGURE 5-4



P/O CHASSIS ASSY
01-P04001W
FIGURE 5-5

8373-2



FRONT PANEL
P/O CHASSIS ASSY
01-P04001W
FIGURE 5-6

8373-3

PARTS LIST

ND NO.	QTY REQD	CODE IDENT	PART NUMBER	NOMENCLATURE
001	1		27-P04006W001	Chassis Plenum/Front Pnl.
002	1		32-P04009W001	Gasket, RF Assy
003	1		64-P04035W001	Plate, Transistor Mtg.
004	7		14-P14440A007	Insulator Plate Case 77
005	1		04-P06315W001	Washer, Inductor (Alum)
006	2		04-P06315W002	Washer, Inductor (Foam)
007	1		42-P06340W001	Clamp, Capacitor
008	1		39-P06334W002	Bus Bar (A)
009	1		39-P06334W001	Bus Bar (B)
010	2		39-P06335W001	Bus Bar (C, D)
011	6		43-15147A35	Spacer #8 x .188
012	12		14-14133A05	Insulator .375 x .190
013	1		C1022-2A-LT/BLU	Knob W/Blue Insert
014	1		09-P04019W001	Holder, O-Ring
15	1		32-14079A09	Packing O-Ring
016	1		33-P04034W001	Nameplate
036	7		MS51957-14	Screw, PH .1120 -40 X .312
037	8		MS51957-15	Screw ,PH .1120 -40x .375
038	4		MS51957-19	Screw, PH .1120 -40x .750
039	8		MS51957-20	Screw, PH .1120 -40 x.875
040	26		MS35338-135	Washer, Lock .112
041	24		NAS620CAL	Washer, Flat .112
042	16		MS15795-803	Washer, Flat .125
043	1		MS51957-25	Screw, PH .1380 -32x ,188
044	4		MS51957-27	Screw, PH .1380 -32x.312
045	22		MS51957-29	Screw, PH .1380 -32x.438
046	1		MS51957-34	Screw, PH .1360 -32x1 .000
048	35		MS35338-136	Washer, Lock .138
049	36		NAS620C6	Washer, Flat .138
051	4		MS51957-42	Screw, PH .1640 -32x.312
052	2		MS51957-45	Screw, PH .1640 -32x.500
53	2		MS51957-48	Screw,PH .1640 -32x.875

PARTS LIST

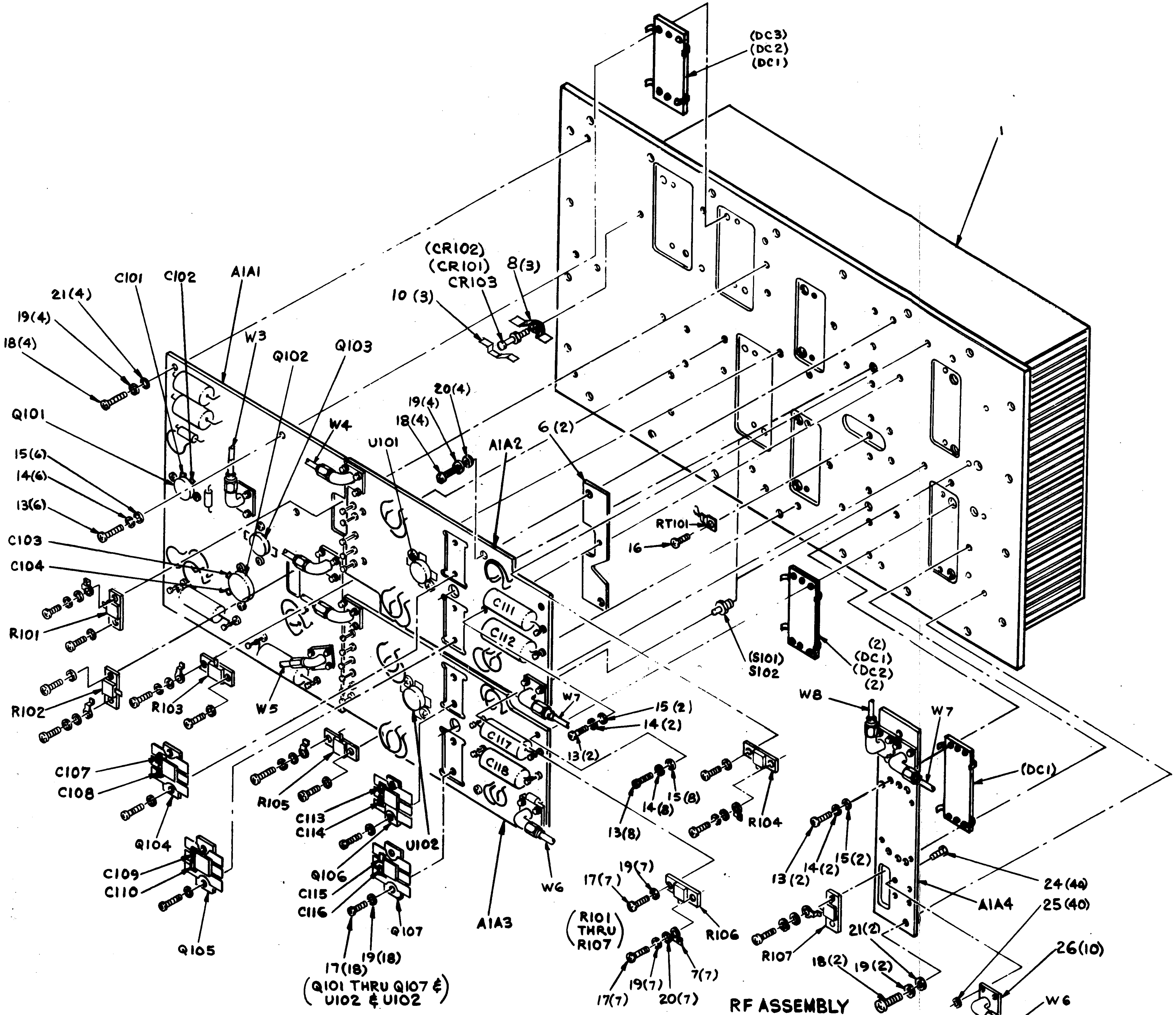
FIND NO.	QTY REQD	CODE IDENT	PART NUMBER	NOMENCLATURE
54	3		MS51957-49	Screw, PH .1640 -32x1.000
55	11		MS35338-137	Washer, Lock .164
56	23		MAS620C8	Washer, Flat .164
68	1		MFS-51053	Boot, Toggle
69	1		2-9N219-7	Packaging, O-Ring
71	1		43-15147A44	Spacer, Sleeve #8x.75
76	2		43-15147A36	Spacer, #8 x .250
78	2	45722	00x1/8	Screw, Drive Stainless Type U, Size 00
79	2	45722	00x3/16	Screw, Drive Stainless Type U Size 00
80	1		26-P04033W001	Heat Sink, Regulator
81	3	06776	MD-3452-G	Socket TO-3
82	1	06776	MD-66302-1G	Socket TO-66
83	3		14-15141A01	Insulator
84	1		14-15141A02	Insulator
85	1		5607-79	Washer, Shldr, Nylon #6
86	4		MS51957-16	Screw, PH .112-40x.438
87	2		MS15795-804	Washer, Flat .125
88	8		MS51957-30	Screw, PH .138-32x.500
89	4		MS51957-38	Screw, PH .138-32x2.00
90	7		MS15795-806	Washer, Flat .156
91	1		MS77070-2	Terminal #6 -.88L
92	1		28-P06329W001	Plug - Modified
93	1		43-P06331W001	Sleeve, Plug
94	1		9601-43	Finger Guard
95	AR		M23053/5-105-0	Insulation Sleeving .187 Blk
A001	1		01-P04004W001	R F Assembly A1
A002	1		01-P04030W001	ALC Assembly A2
A003	1		01-P06318W001	Regulator Assembly A3
A004	1		01-P04027W001	Relay Assembly A4

PARTS LIST

FIND NO.	QTY REQD	CODE IDENT	PART NUMBER	NOMENCLATURE
A005	1		25-P04011W001	Power Sensor A5
B001	1		59-P06330W001	Motor, Blower Modified B1
C001	1		ZD1A106	Capacitor 10 UF
CB001	1		7270-1-35	Circuit Breaker 35A
DS001	1		1903G	LED GRN
DS002	1		1903G	LED RED
DS003	1		1903G	LED GRN
DS004	1		1903G	LED GRN
DS005	1		1903G	LED GRN
DS006	1		1903G	LED GRN
S007	1		1903G	LED GRN
E001	1		MS77068-1	Terminal 4,.64L
E002	1		MS77068-2	Terminal 6,. 64L
E003	1		29-14155A02	Terminal Lug SLDR .256
E004	1		29-14070A63	Terminal
E005	1		29-14070A63	Terminal
E006	1		29-14070A63	Terminal
E007	1		29-14071A63	Terminal
E008	1		29-14070A63	Terminal
E009	1		29-14070A63	Terminal
E010	1		29-14070A63	Terminal
E011	1		MS77068-3	Terminal Sldr Lk 8,.64L
FL001	1		25-P04010W001	Filter, RF
J003	1		GC283	Receptacle 6 pin
004	1		28-P06328W001	Jack, Tip Modified
L001	1		TF4488	Choke

PARTS LIST

IND NO.	QTY REQD	CODE IDENT	PART NUMBER	NOMENCLATURE
001	1		MJ11015	Transistor
002	1		MJ11015	Transistor
003	1		MJ11015	Transistor
004	1		2N6315	Transistor
005	1		MJE341	Transistor
006	1		MJE341	Transistor
007	1		MJE341	Transistor
008	1		MJE341	Transistor
009	1		MJE341	Transistor
010	1		MJE253	Transistor
024	1		MJE253	Transistor
001	1	01121	GP1T048P253RA	Resistor, Variable 25K
146	1		RCR42G122JS	Resistor, 1200-5-2
148	1		RCR32G121JS	Resistor 120-5-1
149	1		RCR42G102JS	Resistor 1000 -5-2
001	1		MTE-206P	Switch Toggle 2 Pole/3 Pos.
001	1		30-P06306W001	RF Cable Assy w1
002			30-P06307W001	RF Cable Assy w2
003	1		30-P06308W001	RF Cable Assy w3
004			30-P06309W001	RF Cable Assy w4
005	1		30-P06310W001	RF Cable Assy w5
006	1		30-P06311W001	RF Cable Assy w6
007	1		30-P06311W002	RF Cable Assy w7
008	1		30-P06312W001	RF Cable Assy w8
009	1		30-P06313W001	RF Cable Assy w9
010	1		30-P06314W001	RF Cable Assy W10
011	1		30-P06305W001	Power Cord Assy W11



RF ASSEMBLY
01-P04004W
FIGURE 5-7

8373-4

PARTS LIST

FIND NO.	QTY REQD	CODE IDENT	PART NUMBER	NOMENCLATURE
001	1		26-P04005W001	Heat Exchanger
006	2		26-P04025W001	Heat Sink, RF Amplifier
007	7		39-P04026W001	Strap, Resistor
008	3		39-P06341W001	Strap, Diode
010	3		01-P04004W010	Strap Alloy 110 Copper .005 THK x.100 Wide
013	18		MS51957-5	Screw .0860-56x.375
014	18		MS35338-134	Washer, Lock .086
015	18		NAS620C2	Washer, Flat .086
016	1		MS51957-12	Screw .1120-40x.188
017	32		MS51957-13	Screw .1120-40x.250
018	10		MS51957-15	Screw .1120-40x.375
019	46		MS35338-135	Washer, Lock .112
020	17		NAS620C4L	Washer, Flat .112
021	6		MS15795-803	Washer, Flat .125
024	40		MS51957-3	Screw .08-56x.250
025	40		MS21042L02	Locknut .086-56
026	10	95077	2960-4019	Connector, SMA RT Angle
A1A1	1		01-P04013W001	Driver/VCA Assy A1A1
A1A2	1		01-P04021W001	RF Ampl Assy A1A2/A1A3
A1A3	1		01-P04021W001	RF Ampl Assy A1A2/A1A3
A1A4	1		01-P04016W001	RF Combiner Assy A1A4
C101		29990	ATC1008B470JP500(x)	Capacitor 47PF-5-500
C102		29990	ATC10CB470JP500(x)	Capacitor 47PF-5-500
C103	1	29990	ATC100B750JP500(x)	Capacitor 75PF-5-500
C104	1	29990	ATC100B750JP500(x)	Capacitor 75PF-5-500
C107	1	29990	ATC100B680JP500(x)	Capacitor 68PF-5-500
C108	1	29990	ATC100B680JP500(x)	Capacitor 68PF-5-500
C109	1	29990	ATC100B680JP500(x)	Capacitor 68PF-5-500
C110	1	29990	ATC100B680JP500(x)	Capacitor 68PF-5-500
C111	1		M39018/01-0633	Capacitor 47UF-10+30-40
C112	1		M39018/01-0633	Capacitor 47UF-10+30-40

PARTS LIST

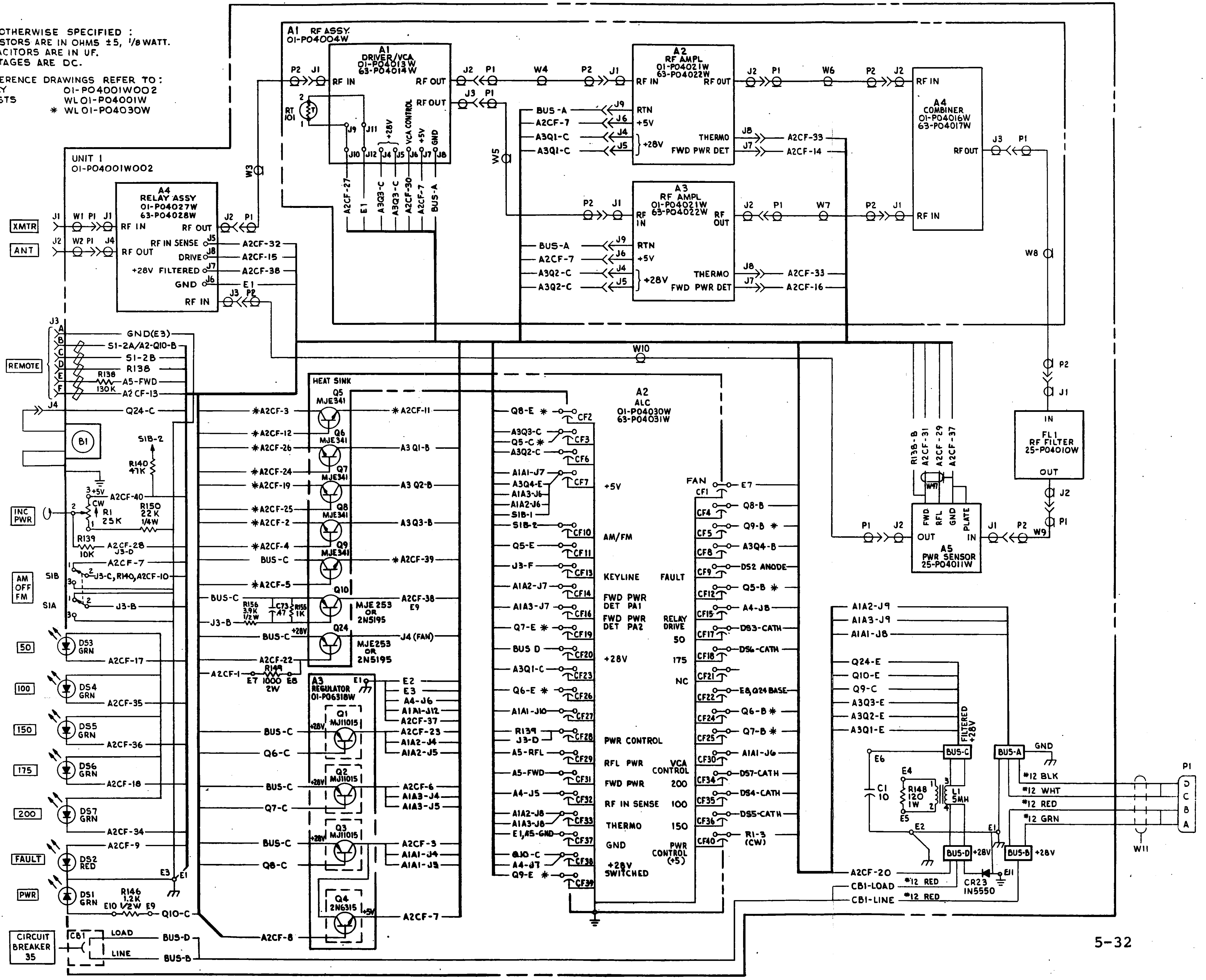
FIND NO.	QTY REQD	CODE IDENT	PART NUMBER	NOMENCLATURE
C113	1	29990	ATC100B680JP500(x)	Capacitor 68PF-5-500
C114	1	29990	ATC100B680JP500(x)	Capacitor 68PF-5-500
C115	1	29990	ATC100B680JP500(x)	Capacitor 68PF-5-500
C116	1	29990	ATC100B680JP500(x)	Capacitor 68PF-5-500
C117	1		M39018/01-0633	Capacitor 47UF-10+30-40
C118	1		M39018/01-0633	Capacitor 47UF-10+30-40
CR101	1	12969	UM7101C	Diode, Pin
CR102	1	12969	UM7101C	Diode, Pin
CR103	1	12969	UM7101C	Diode, Pin
Q101	1		SRF2597	Transistor
Q102	1		2N6439	Transistor
Q103	1	50155	ZO-28F	Bias Device
Q104	1		48-P06325W002	Transistor, Matched Quad w/Q105, Q106, Q107
Q105	1		48-P06325W002	Transistor, Matched Quad w/Q104, Q106, Q107
Q106	1		48-P06325W002	Transistor, Matched Quad w/Q104, Q105, Q107
Q107	1		48-P06325W002	Transistor, Matched Quad w/Q104, Q105, Q106
101	1	50155	TA150-50	Termination 50 ohm
102	1	50155	TA150-50	Termination 50 ohm
103	1	50155	TA150-50	Termination 50 ohm
104	1	50155	TA150-50	Termination 50 ohm
105	1	50155	TA150-50	Termination
R106	1	50155	TA150-50	Termination
R107	1	50155	TA150-50	Termination
T101	1		SS25/T-41U1A401	Thermistor

PARTS LIST

FIND NO.	QTY REQD	CODE IDENT	PART NUMBER	NOMENCLATURE
S101	1		M24236/19-CND	Switch, Thermostat
S102	1		M24236/19-CND	Switch, Thermostat
U101	1		MBN101	Bysistor
U102	1		MBN101	Bysistor

NOTES:

1. UNLESS OTHERWISE SPECIFIED :
   ALL RESISTORS ARE IN OHMS ±5, 1/8 WATT.
   ALL CAPACITORS ARE IN UF.
   ALL VOLTAGES ARE DC.
2. FOR REFERENCE DRAWINGS REFER TO:
   ASSEMBLY 01-P04001W002
   WIRE LISTS WL01-P04001W
   * WL01-P04030W



SECTION 6

6-1 SYSTEM TROUBLESHOOTING AND MAINTENANCE

6-2 The information at the beginning of this section is presented to allow an operator to determine if an apparent problem is caused by system deficiencies or by improper use of the power-amplifier. This information appears in table 6-1 and sections 6-3 to 6-9. Information in sections 6-10 to 6-21 pertain to performance evaluations to be made at a properly equipped service depot.

6-3. OPERATOR TROUBLESHOOTING

6-4 LOW OUTPUT POWER CAUSES

6-5 Low output power can be caused by the following:

(a) Low input RF (3 watts are required to assure a 200 watt output power range)

(b) Wrong frequency of input RF (frequency of RF source should be in the range of 225 to 400 MHz)

(c) High VSWR caused by open, shorted or wrong antenna.

(d) Low input voltage (input voltage should be greater than 26 VDC to assure a specified output in the 200 W range in FM, 50W range in AM).

(e) In the event of a loss of one of the dual output amplifiers, power is reduced to one-quarter. Turning the unit off and on will reset the memory circuit and allow another test for this condition to occur.

(f) High internal unit temperature. No significant power reduction should occur for any operation at ambient air temperature up to 55^{o}C (131^{o}F) as long as (1) the cooling fan is plugged in and functioning properly (2) the heat-sink fins are clear of dirt & debris, and (3) the units air intake or outlets are not obstructed.

6-6 FLASHING FAULT LIGHT CAUSES

The following conditions lead to a flashing fault indication. These faults are considered soft failures in that they are often temporary or under control of the operator and will clear automatically once the condition causing the problem is eliminated.

(a) High or Low input voltage. Input voltage should be greater than 20 VDC and less than 33VDC.

(b) High RF drive level. RF input should be less than 25 watts.

(c) High Power Amplifier Temperature. This is a safety valve circuit and should reset automatically as the internal temperature drops.

6-7 FLASHING FAULT RESETTING

If the cause of a flashing fault is eliminated, the indicator lamp will stop flashing immediately, but, if the fault occurred during a transmission (causing the amplifier to go into the bypass mode) the power-amplifier will remain in bypass until system receive state has occurred. This is necessary to prevent toggling of the Power Amplifier during a transmission.

6-8 STEADY FAULT LIGHT CAUSES

A steady fault light indication usually indicates a malfunction has occurred which requires some servicing of the unit. The following conditions can cause a steady fault condition:

(a) No RF out for RF in and otherwise proper conditions for Proper Amplifier Operation.

(b) ALC loop error.

(c) Excessive output power detected.

(d) Overdriven VCA

6-9 Conditions could exist which are under control of the operator that could cause a steady fault. These conditions are enumerated in the Operator Troubleshooting Table 6-1.

If one of these malfunctions occurs during a transmission, the unit will automatically switch to bypass and the fault lamp will remain on through the rest of the transmission. A transition to receive or standby state will extinguish the lamp and reset the fault detection circuit.

Table 6-1

OPERATOR TROUBLESHOOTING

SYMPTOM	CAUSE	CURE
Will not operate.	Low input power.	Increase input power
	High output VSWR.	Check/Correct Antenna.
Single flash of fault light with no continued PA operation.	Power Source voltage drooping.	Provide larger cable conductors. Start engine or power-generator. Replace defective power - source
	Marginally high input power.	Reduce input power.
Flashing fault light.	Low or High input voltage.	Start engine or generator. Adjust power source to 20-33V (28V nominal)

SYMPTOM	CAUSE	CURE
Flashing fault light (cont'd).	High input RF power.	Reduce input power to less than 25 watts.
	Overheat thermostat tripped.	Wait for unit to cool. Check fan plug fan rotation or blocked or clogged cooling duct.
Steady fault light.	Reversed Xmtr and Antenna connections.	Change Xmtr & Antenna connections.
	High power cable resistance.	Increase gauge and/or reduce length of cable.
	Out of band operation.	PA range = 225 to 400 MHz.
	Power output too low.	High VSWR, high temperature, low voltage or low front panel power setting causing a power output of less than 15 watts Increase power output level.

SYMPTOM	CAUSE	CURE
Steady fault light (cont'd)	Power Output to power input ratio too low	Output power should be at least 6dB greater than input power. Reduce input power or increase output power.

6-10 PERFORMANCE TESTING

6-11 Test equipment required for proper performance testing is presented in Table 6-2.

TABLE 6-2

TEST EQUIPMENT REQUIRED

DESCRIPTION	RECOMMENDED MODEL	SUPPLIER
Power Supply 19-33 volts @ 35 amps	SWA-28K	Power Mate
AMMETER - 35 amp		
RF GENERATOR - 225 to 400 MHz; AM/CW; 0 to 50 watt	473	Ailtech
LOAD/ATTENUATOR 30dB; 300 watt	8329	BIRD
POWER METER - 0 to 3 watt	HP 436A	Hewlett-Packard
MODULATION ANALYZER AM; 225 to 400 MHz	82AD	Boonton
SPECTRUM ANALYZER 100 KHz to 1 GHz	141T;8554B;8552B	Hewlett-Packard
AUDIO OSCILLATOR 300 Hz and 1 KHz	HP200CD	Hewlett-Packard
DISTORTION ANALYZER	HP333A	Hewlett-Packard
DIGITAL MULTIMETER	HP3465A	Hewlett-Packard

6-12 PERFORMANCE EVALUATION

6-13 The PTPA-200A power amplifier should be configured as in figure 6-1.

Caution: It is important to use accurately calibrated equipment and measurement techniques when making power measurements. An error of ±1dB can amount to a nearly 100 watt variation in apparent output.

6-14 OUTPUT POWER AND EFFICIENCY MEASUREMENTS

The following conditions should be used to measure the maximum power output and maximum input current requirement of the amplifier.

a) Vin = 28V ±0.2V; Remote Control disconnected; RF Generator set at minimum output.

b) Switch amplifier on to FM and adjust PWR control fully CW (maximum power)

c) Adjust RF Generator to 325 MHz and 5 watts.

d) P_{out} should be 159 watts to 252 watts.

e) I_{in} should be 30 amps maximum.

f) Manually sweep the signal generator from 225 to 400 MHz while observing output power and input current.

g) No surges or dips of greater than 1dB should occur over any 5 MHz range.

h) Current should never exceed 30 amps and power output should be in the range of 159 watts to 252 watts.

If the current or power exceeds its maximum allowable specification (252 watts, 30 amps), testing should be discontinued and troubleshooting implemented immediately.

6-15 ALC Range Testing

Set the signal generator to 325 MHz and reduce the level to minimum.

a) Adjust the front-panel power control to minimum.
b) Adjust the RF generator output level to 20 watts.
c) Output from the amplifier should be between 32 & 79 watts and no faulting should occur.
d) Reduce the input RF power to 5 watts and increase the front panel power-control to maximum (CW).
e) Switch the unit to AM and slowly decrease the front-panel power setting until the unit faults or minimum power is obtained.
f) Power should have been reduceable to less than 25 watts without a fault occurring.

6-16 Output Power vs. Input Voltage Tests

a) Switch the unit to FM, RF input to 5 watts and reduce the power supply voltage to 22 volts.
b) The power out of the amplifier should be between 75 watts and 150 watts.

6-17 Fan Operation

a) With 5 watts of RF into the unit in FM mode and 28VDC input, the fan shall automatically operate in less than 5 minutes for an ambient temperature above 15°C (60°F).
b) No reduction of power or faulting of the unit should occur before the fan operates.

6-18 AM Distortion Measurement

a) Switch the unit to off and apply a modulated RF signal with the following characteristics:
   - RF level = 1.5 watts (Carrier)
   - Modulation frequency = 1 KHz
   - Modulation = 80%

b) Using the Modulation Analyzer and Distortion-Analyzer, measure the distortion level with the amplifier off (bypass mode).

c) Distortion should be less than 2.5% in order to make valid added distortion measurements (Note actual distortion level).

d) Switch amplifier on to AM with power control at maximum (CW) and measure distortion.

e) Distortion shall not have increased more than 10%.

6-19 AM Stripping Measurement

a) Adjust the modulated 1.5 watts RF input modulation frequency to 300 Hz.

b) With the amplifier off, adjust the modulation level to 30%.

c) Switch the amplifier on and measure the modulation level.

d) Modulation shall not have decreased to less than 25%.

6-20 Harmonics and Spurious Response Measurements

a) With the RF generator set-up as follows:
- F = 225 MHz
- Power = 5 watts (CW)

b) Observe the output of the RF generator (Power amps off) on a spectrum analyzer covering 100 KHz to 1 GHz

c) Harmonics must be at least 40dB down from the 225 MHz carrier level and spurious responses must be down at least 65dB.

d) With the amplifier on FM and the power-control at maximum, harmonics and spurious responses should be down at least 45dB.

6-21 Remote Control Testing

a) Connect a remote control to the unit and set the following controls:

- Power Amplifier
  AM/OFF/FM = OFF
  Power = Max (CW)
- Remote Control
  AM/OFF/FM = OFF
  Power = Max (CW)
  Key = Open Circuit

b) The unit should be off

c) Switch remote control to FM and apply 5 watts of RF at 325 MHz.

d) Amplifier output should be between 159 and 252 watts.

e) Decreasing power control to minimum should reduce output power to between 32 and 79 watts.

f) Increase power-control to maximum; reduce RF input to 1.5 watts and switch remote control to AM.

g) Output power should be between 32 and 79 watts.

h) Short the key-line input to ground; switch the Remote Control to FM and increase the RF input to 5 watts.

i) Slowly decrease the input RF level while observing the power indicator.

j) There should be a reduction of power observed on the Remote-Control power indicator and on the external power meter as the drive level is decreased to zero.

k) The amplifier should remain in the transmit mode without switching to bypass.

l) Apply 2.2 volts to the key-line input and increase the RF input power to 5 watts.

m) The amplifier should have switched to bypass and remained in bypass mode as long as the 2.2 volts is applied to the key-line input.

SECTION 7
DRIVER/VCA
A1A1

** IMPORTANT NOTE **

Chip capacitor type and placement are critical in this circuit. Failure to use the proper type, or to position the replacement device within 1/20 inch of the original position will result in poor or destructive performance.

7-1 PURPOSE AND GENERAL DESCRIPTION

7-2 The DRIVER/VCA contains a two stage broad-band power-amplifier and a voltage controlled attenuator as shown in Figure 7-1. The primary function of this module is to amplify the input signal to the proper level to drive the Power-Amplifier modules to the desired output.

7-3 Both RF stages have a fixed gain. It is the function of the Voltage Controlled Attenuator to adjust the level of the input signal down to what is needed for the proper overall system gain.

7-4 DETAILED DESCRIPTION

7-5 The following paragraphs provide a detailed description of the circuit operation in this module. The description refers to the Driver/VCA schematic in figure 7-2.

7-6 VOLTAGE CONTROLLED ATTENUATOR

This circuit receives the input RF from the Relay Assembly (A4). When the unit is in transmit mode, this input is connected through a relay to the Front-Panel Xmtr connector. This circuit can accept input levels as high as 25 watts without damage.

7-7 The attenuation is obtained by using PIN diodes (CR101 to CR103). The RF impedance of these diodes is controlled by the amount of DC through them. Increasing the current decreases the impedance. These diodes work in conjunction with a Quadrature Coupler (DC-2).

7-8 This coupler splits the input RF into two equal amplitude components which differ in phase by 90 degrees. The shunt diodes CR101 and CR102 have little effect on the signal when there is no current flowing through them. The signal is recombined in an identical Quadrature Coupler, DC-3. The RF output is obtained at the "IN" terminal on this coupler and passed through C31. Diode CR103 has little effect with no bias applied and the signal is coupled through C33 to the input of the amplifier chain.

7-9 When enough voltage is applied to the VCA Control line (J6), all three diodes will conduct and shunt some of the RF to ground. This attenuates the signal and shows some proportion to the voltage level at J6. In this way, the output level of the RF can be controlled by a DC signal.

7-10 L1 to L3 and C29, C30 and C37 form an RF filter to keep the high RF off the control line. R8, R9, R12, R13 and CR4 control the attenuation rate of the diodes relative to each other. C27, C31 and C33 block the control voltage from the input or output.

7-11 The attenuator can be made to vary from less than 3 dB to more than 25 dB by varying the control voltage.

7-12 PRE-DRIVER - The signal from the VCA is transformed in impedance by W1, C1, C2, C3, C101 and C102 to the proper level to drive the base of Q101. The collector output of this device is impedance transformed by C9, W2, C10, W4, W3, C12, C13, C14, C103 and C104 and supplied to the base of the driver transistor, Q102.

7-13 The gain of this stage is about 10 dB across the 225 MHz to 400 MHz band. The maximum output is about 10 watts. The stage is operated in class AB and has good linearity for Amplitude Modulation modes.

7-14 Bias in this stage is controlled by the Byistor, Q103, which exhibits very good thermal tracking. The bias is normally in the range of 5 ma to 25 ma. R2 may be changed if needed to bring the bias into this range. Increasing the resistance increases the bias.

7-15 The RF chokes in this stage are of the strip-line type and are not discrete components. C6, C7 and C8 are bypass capacitors.

7-16 DRIVER - This circuit accepts the signal from the Pre-Driver, amplifies it and splits the output into two equal amplitude signals for use by the two PA modules.

7-17 The collector of Q102 is converted to a 50 ohm impedance by C105, C106, C22, C23, C24, C25, C26, W5 and W6 and applied to the "IN" port of Quadrature Coupler DC-1. Two equal amplitude signals differing in phase by 90 degrees are output to J2 and J3. C17, C18, C21 and C38 are bypass capacitors.

7-18 The gain of this stage is about 10 dB across the 225 MHz to 400 MHz range and the maximum output level is about 50 watts. The stage is biased in the class AB region and exhibits good linearity for Amplitude Modulation modes.

7-19 Bias is provided by the Byistor Q103, and good thermal stability is obtained. The bias should be in the 7 ma to 35 ma range. R4 can be changed to raise or lower the bias point. Increasing the resistance will increase the bias.

7-20 Byistor Q103 is a special kind of device which is attached to the heat-sink close to the power transistors and has good thermal tracking to the transistor junctions. This helps keep the bias to the transistors in the proper range over the operating temperature range of the devices. This device draws about 500 ma from the 5 volt bias supply. This current is controlled mainly by R6. C34, C35 and C36 are bypass capacitors which keep the RF from modulating the bias point.

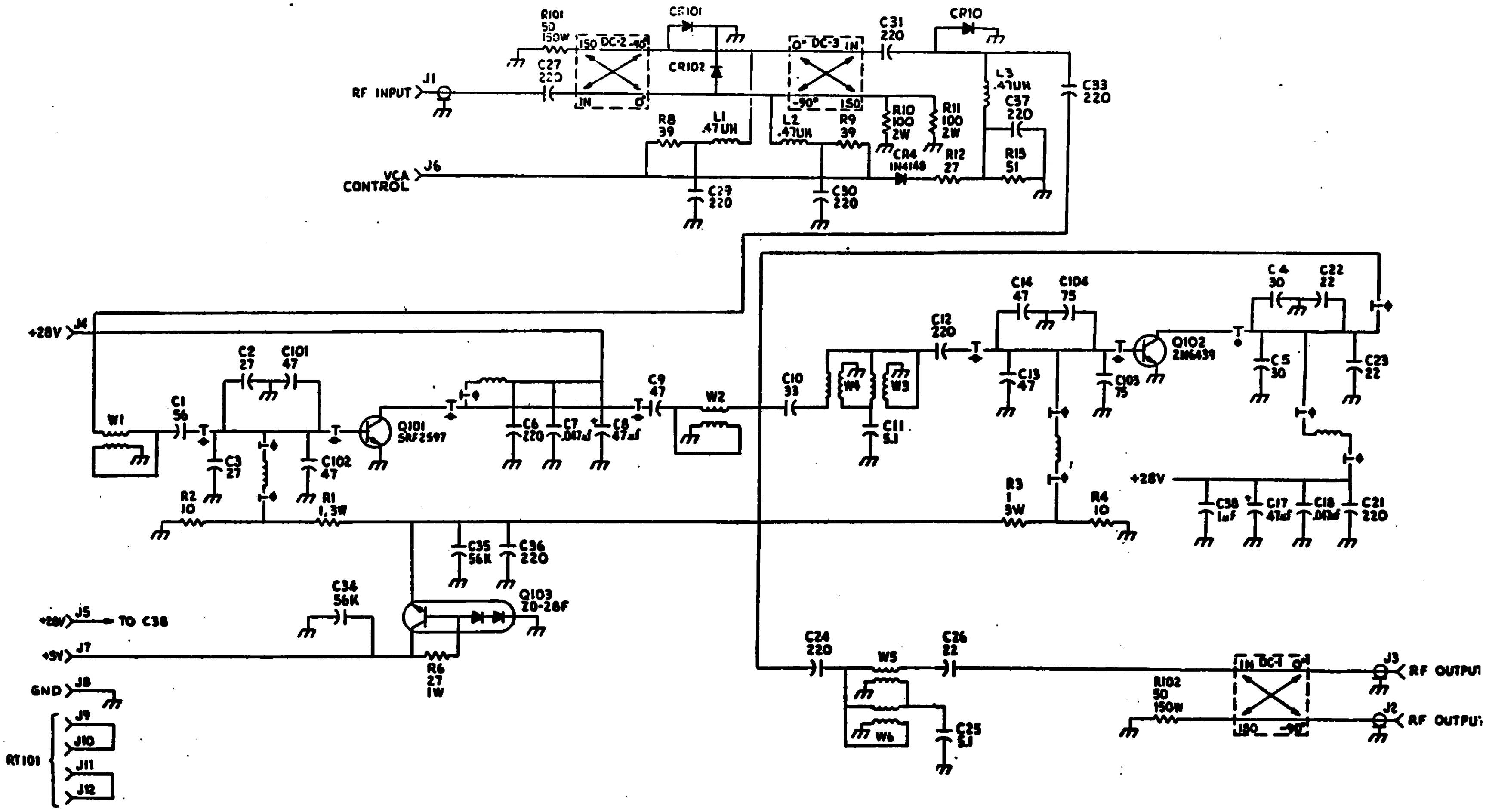


Figure 7-1. DRIVER/VCA (A1A1) CIRCUIT SCHEMATIC

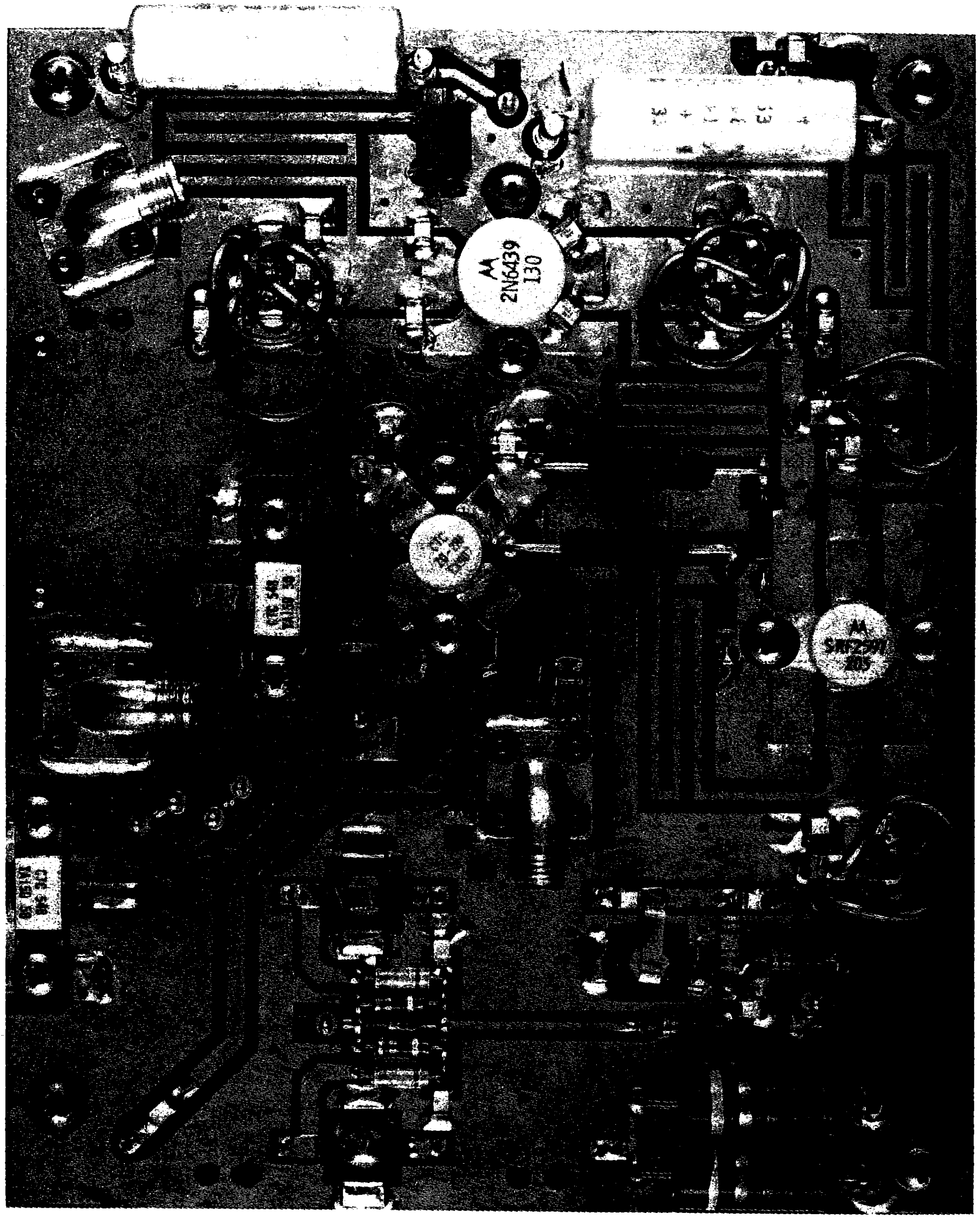


Figure 7-2. DRIVER/VCA (A1A1)

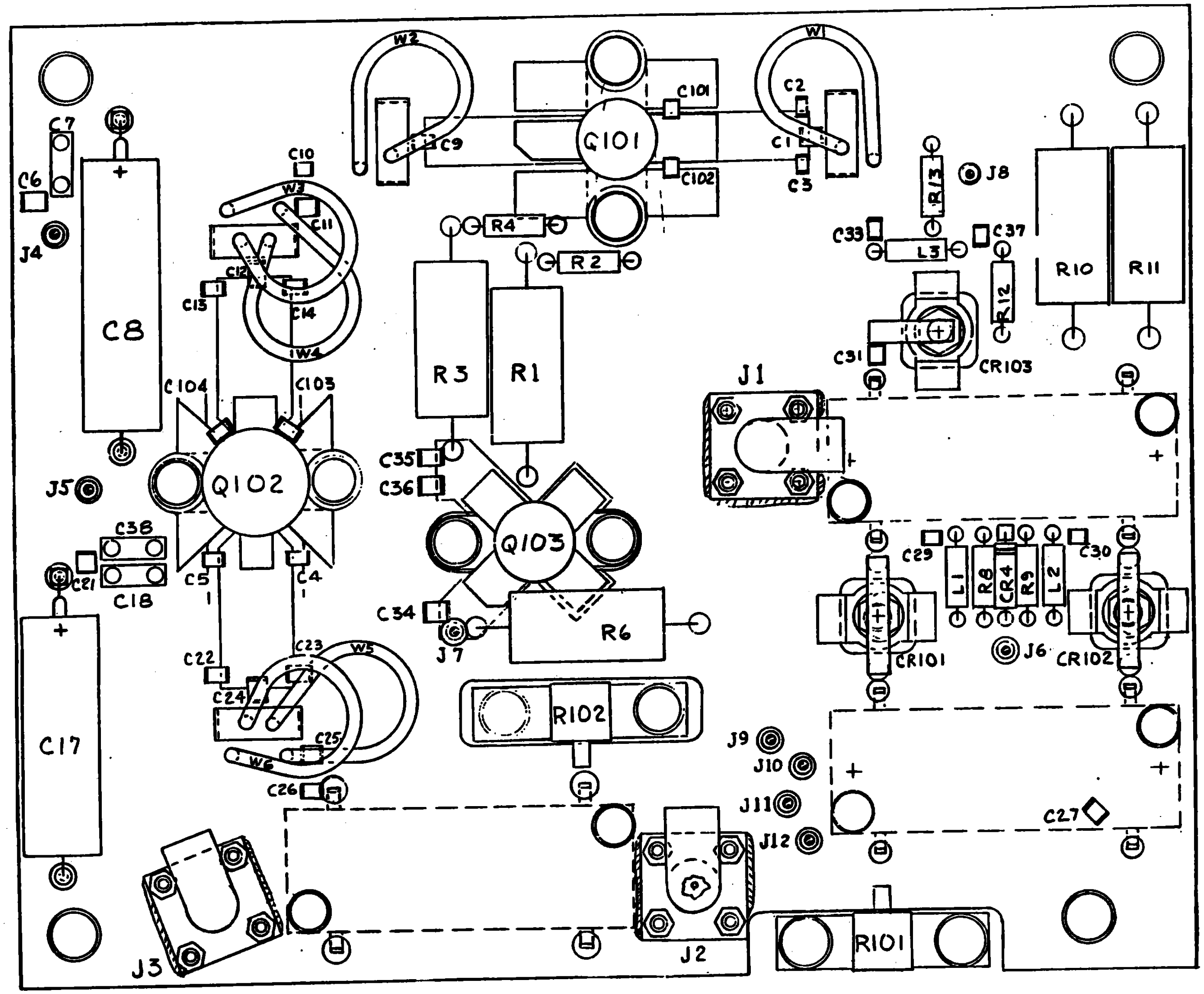


Figure 7-3. DRIVER/VCA (A1A1) COMPONENT LAYOUT

PARTS LIST

FIND NO.	QTY REQD	CODE IDENT	PART NUMBER	NOMENCLATURE
001	1	94990	84-P04015W001	Driver/VCA Assy PWB
002	4	94990	43-P06332W002	Spacer .095
003	4		2035-A1	Terminal
004	12		MS51957-3	Screw, PH .0860-56x.250
005	12		MS1042L02	Locknut .086-56
006	4	94990	07-P04024W001	Bridge
C001	1		ATC100B560JP500(x)	Capacitor 56PF-5-500
C002	1		ATC100B270JP500(x)	Capacitor 27PF-5-500
C003	1		ATC100B270JP500(x)	Capacitor 27PF-5-500
C004	1		ATC100B300JP500(x)	Capacitor 30PF-5-500
C005	1		ATC100B300JP500(x)	Capacitor 30PF-5-500
C006	1		ATC100B221JP200(x)	Capacitor 220PF-5-200
C007	1		M39014/02-1345	Capacitor .047UF-10-100
C008	1		M39018/01-0633	Capacitor 47UF-10+30-40
C009	1	29990	ATC100B470JP500(x)	Capacitor 47PF-5-500
C010	1	29990	ATC100B330JP500(x)	Capacitor 33PF-5-500
C011	1	29990	ATC100A5R1DP50(x)	Capacitor 5.1PF-.5PF-50
C012	1	29990	ATC100B221JP200(x)	Capacitor 220PF-5-200
C013	1	29990	ATC100B470JP500(x)	Capacitor 47PF-5-500
C014	1	29990	ATC100B470JP500(x)	Capacitor 47PF-5-500
C017	1		M39018/01-0633	Capacitor 47UF-10+30-40
C018	1		M39014/02-1345	Capacitor .047UF-10-100
C021	1	29990	ATC100B221JP200(x)	Capacitor 220PF-5-200
C022	1	29990	ATC100B220JP500(x)	Capacitor 22PF-5-500
C023	1	29990	ATC100B220JP500 (x)	Capacitor 22PF-5-500
C024	1		ATC100B221JP200(x)	Capacitor 220PF-5-200
C025	1	29990	ATC100A5R1DP50(x)	Capacitor 5.1PF-.5PF-50
C026	1	29990	ATC100B220JP500(x)	Capacitor 22PF-5-500
C027	1	29990	ATC100B221JP200(x)	Capacitor 220PF-5-200
C029	1	29990	ATC100B221JP200(x)	Capacitor 220PF-5-200
C030	1	29990	ATC100B221JP200(x)	Capacitor 220PF-5-200
C031	1	29990	ATC100B221JP200(x)	Capacitor 220PF-5-200
C033	1	29990	ATC100B221JP200(x)	Capacitor 220PF-5-200

PARTS LIST

FIND NO.	QTY REQD	CODE IDENT	PART NUMBER	NOMENCLATURE
C034	1		CDR03Bx563AKSM	Capacitor .056UF-10-50
C035	1		CDR03Bx563AKSM	Capacitor Chip 56K-1-50
C036	1	29990	ATC100B221JP200(x)	Capacitor 220PF-5-200
C037	1.	29990	ATC100B221JP200(x)	Capacitor 220PF-5-200
C038	1		M39014/02-1419	Capacitor 1UF-10-50
CR004	1		JAN1N4148-1	Diode
DC001	1	31597	IR0260-3	Coupler 3DB 90Degree
DC002	1	31597	IR0260-3	Coupler 3DB 90Degree
DC003	1	31597	IR0260-3	Coupler 30B 90Degree
J001	1	95077	2960-4019	Connector, SMA
J002	1	95077	2960-4019	Connector, SMA
J003	1	95077	2960-4019	Connector, SMA
J004	1	00779	60599-3	Contact
J005	1	00779	60599-3	Contact
J006	1	00779	60599-3	Contact
J007	1	00779	60599-3	Contact
J008	1	00779	60599-3	Contact
J009	1	00779	60599-3	Contact
J010	1	00779	60599-3	Contact
J011	1	00779	60599-3	Contact
J012	1	00779	60599-3	Contact
L001	1		MS75083-9	Coil, RF .47UH
L002	1		MS75083-9	Coil, RF .47UH
L003	1		MS75083-9	Coil, RF .47UH
R001	1		RWR89S1R00FR	Resistor 1-1-3
R002	1		RCR07G100JS	Resistor 10-5-1/4
R003	1		RWR89S1R00FR	Resistor 1-1-3
R004	1		RCR07G100JS	Resistor 10-5-1/4
R006	1		RCR32G270JS	Resistor 27-5-1

PARTS LIST

FIND NO.	QTY REQD	CODE IDENT	PART NUMBER	NOMENCLATURE
R008	1		RCR07G390JS	Resistor 39-5-1/4
R009	1		RCR07G390JS	Resistor 39-5-1/4
R010	1		RCR42G101JS	Resistor 100-5-2
R011	1		RCR42G101JS	Resistor 100-5-2
R012	1		RCR07G270JS	Resistor 27-5-1/4
R013	1		RCR07G510JS	Resistor 51-5-1/4
W001	1	94990	30-P06323W001	Cable, Coax Right Low
W002	1	94990	30-P06321W001	Cable, Coax, Left Low
W003	1	94990	30-P06322W001	Cable, Coax Left Hi
W004	1	94990	30-P06321W001	Cable, Coax, Left Low
W005	1	94990	30-P06321W001	Cable, Coax, Left Low
W006	1	94990	30-P06324W001	Cable, Coax, Right Hi

SECTION 8
POWER AMPLIFIER MODULES
A1A2 & A1A3

** IMPORTANT NOTE **

Chip capacitor type and placement are critical in this circuit. Failure to use the proper type, or to position the replacement device within 1/20 inch of the original position will result in poor or destructive performance.

8-1 PURPOSE AND GENERAL DESCRIPTION

8-2 The final high-level RF power output is obtained from two identical Power Amplifier modules. The following description applies to both of these modules.

8-3 The input to these amplifiers is obtained from the Driver/VCA module A1A1. Two identical amplitude signals, 90 degrees out-of-phase with each other, are obtained from this module.

8-4 The outputs of these modules are recombined in the RF Combiner A1A4 (figure 8-2). This is a quadrature type combiner which adds the signals together in phase with each other. The phase relationship of the signals is very important in the overall efficiency of the Power Amp. The length of the coaxial-cables into and out of the amplifiers must be very nearly identical. When testing the amplifiers individually, the amplifier under test should not be connected to the input splitter or output combiner.

8-5 DETAILED DESCRIPTION

8-6 The following paragraphs provide a detailed circuit description of these modules. The circuit schematic is in figure 8-1.

8-7 The input RF to this module is split into two identical amplitude signals differing in phase by 90 degrees by DC1. These signals are amplified by two identical amplifier circuits on the module and recombined at their outputs.

8-8 Following one of these signals through its amplifier, the 50 ohm signal is transformed down to the proper impedance to drive the base of Q104 by W1, W2, C2, C3, C4, C5, C107 and C108. This matching network provides a good match across the 225 to 400 MHz frequency range.

8-9 The output impedance of Q104 is matched across the band to 50 ohms by C19, C20, C21, C22, C23, C24, W3, W4 C25 and C26. In addition to these discrete components, strip-line inductances on the printed wiring board are needed to achieve this broad-band match.

8-10 The 50 ohm outputs of each of the amplifiers are combined by Quadrature combiner DC2. This method greatly reduces interaction between the amplifiers.

8-11 The amplifiers are biased for class AB operation by a Byistor circuit. The Byistor, Q101, is mounted to the heat-sink close to the output transistors to obtained close thermal tracking. Bias to each of the transistors is in the range of 25 ma to 50 ma. R3 (and R7) can be changed to bring the bias into this range. C6, C7, C47 and C48 are bypass capacitors reducing modulation of the bias line by the RF signal.

8-12 A strip-line forward-power detector on each module is used to sense the RF power out of the module. CR1, a 1N5711, is used to rectify the RF. C27, C28, R8, and R9 serve as the post detection filter. R11 and C29 provide the proper broad-band signal detection needed.

8-13 The thermostat is mounted through a hole in the center of the module, between the RF power devices. This close proximity to the power-devices gives good response time in the case of excessive device temperature.

8-14 Strip-line inductors and by-pass capacitors are used to reduce RF on the power and signal lines. More than one capacitor is needed in some cases to achieve sufficient bypassing of the undesired AC signals. C111, C17, and C18 are an example of this technique. This number and these types of capacitors are needed for proper operation of the unit.

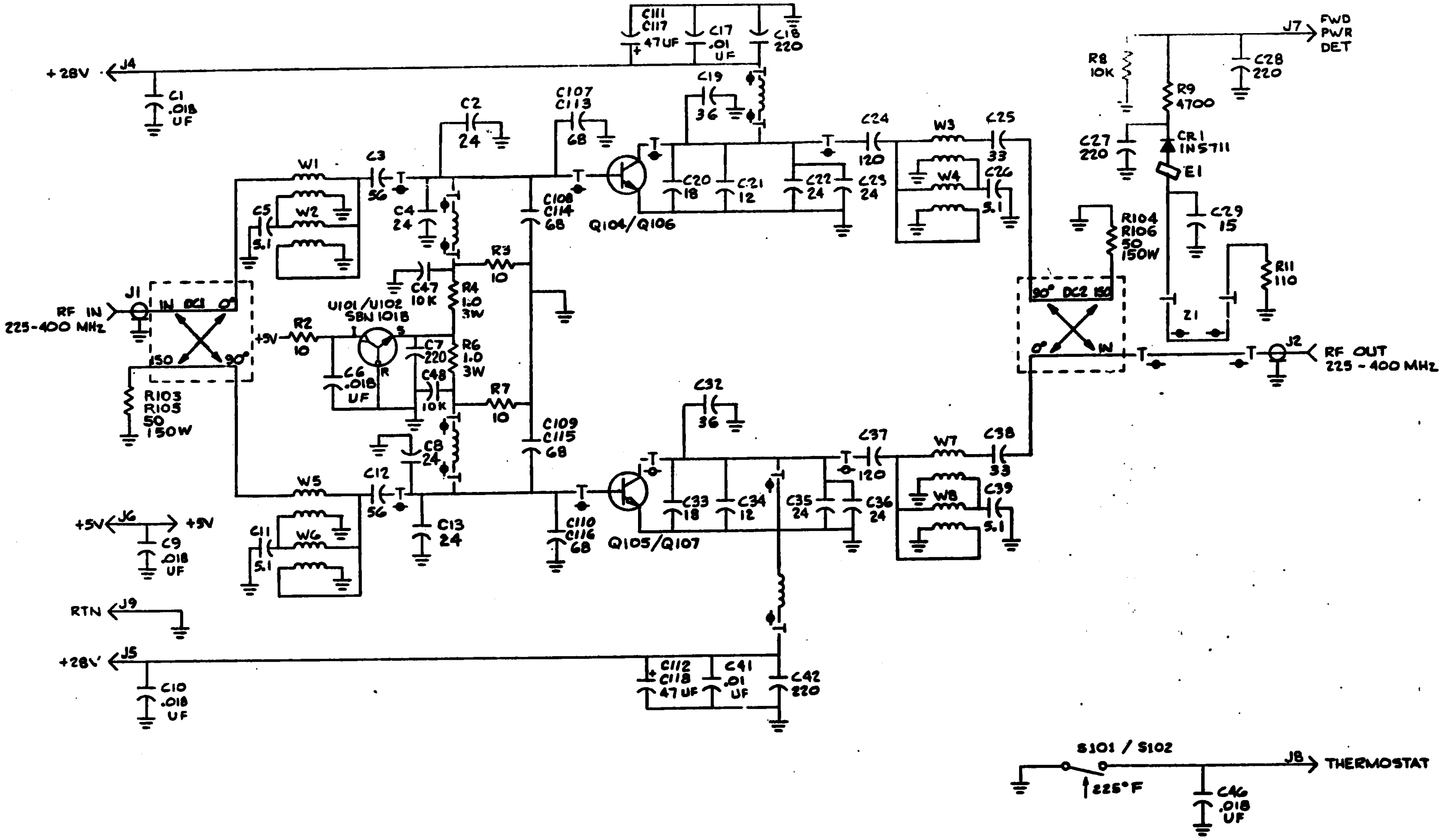


Figure 8-1. POWER AMPLIFIER
MODULE (A1A2 & A1A3)
SCHEMATIC DIAGRAM

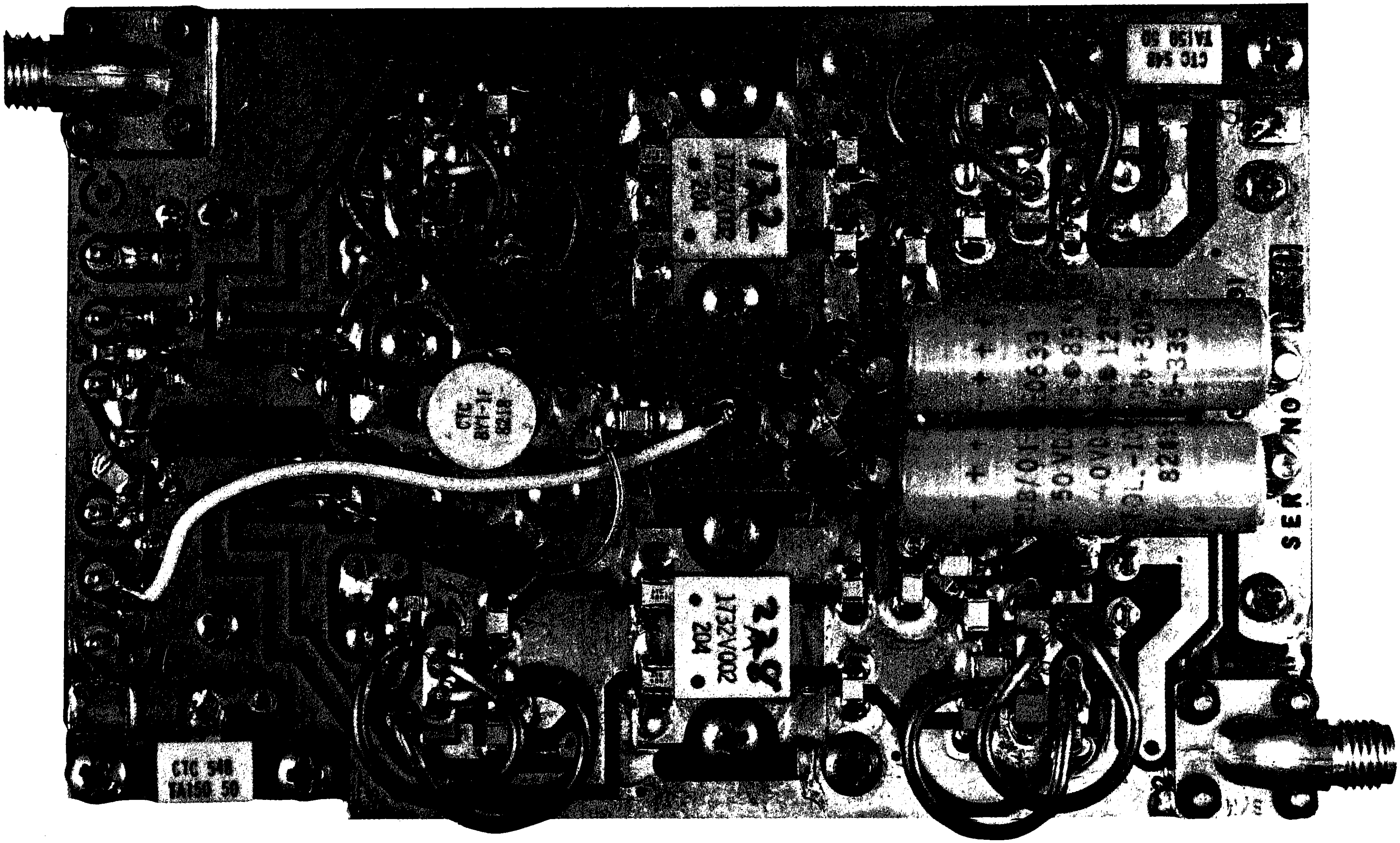


Figure 8-2. POWER AMPLIFIER
MODULE (A1A2 & A1A3)

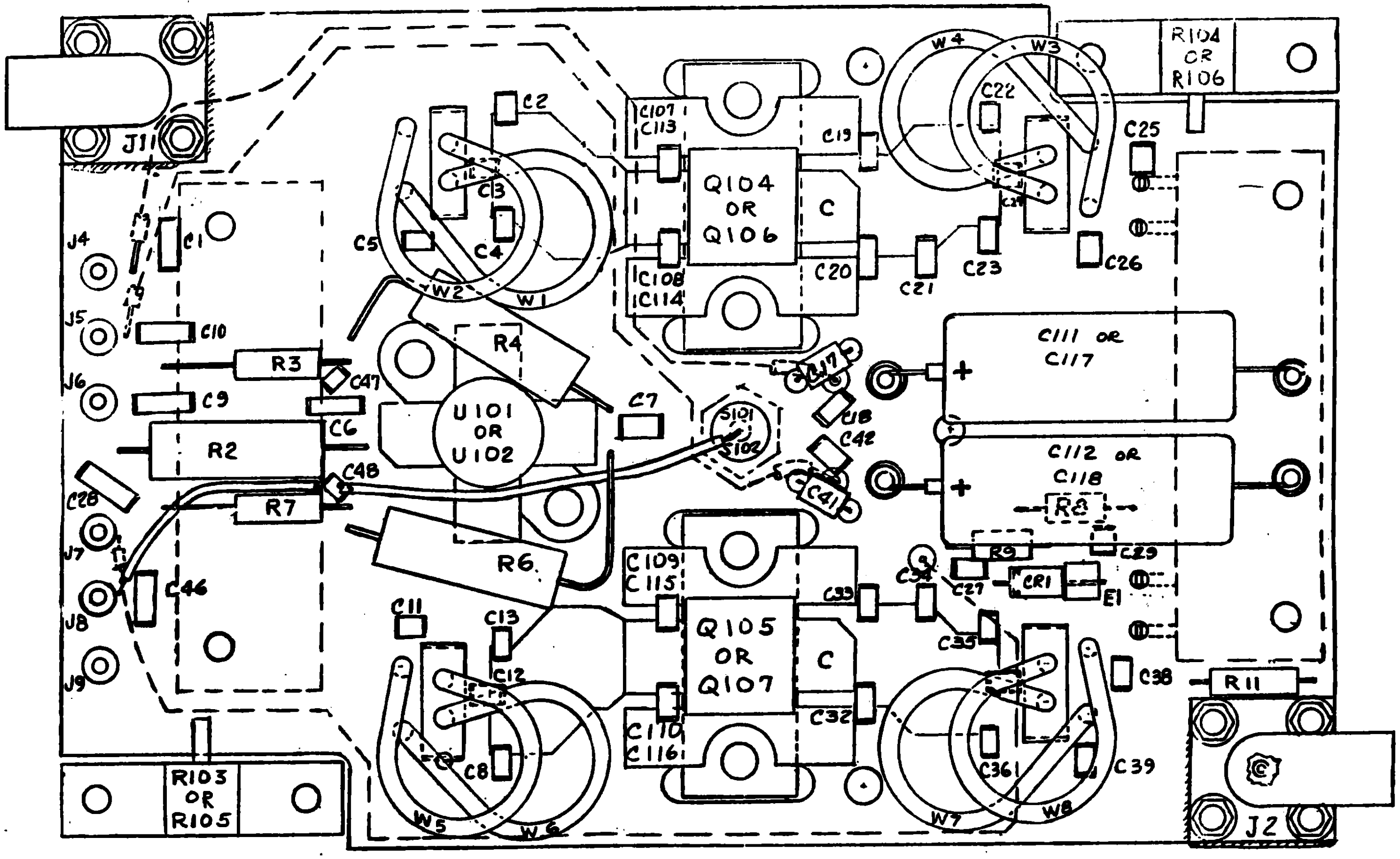


Figure 8- . POWER AMPLIFIER
MODULE (A1A2 & A1A3) COMPONENT LAYOUT

PARTS LIST

FIND NO.	QTY REQD	CODE IDENT	PART NUMBER	NOMENCLATURE
001	1	94990	84-P04023W001	RF Amplifier PWB
002	4	88245	2035-A1	Terminal
003	8		MS51957-3	Screw, PH .0860-56x.250
004	8		MS21042L02	Locknut .086-56
005	4	94990	07-P04024W001	Bridge
C001	1		CDR02Bx183AKSM	Capacitor .018UF-10-50
C002	1	29990	ATC100B240JP500(x)	Capacitor 24PF-5-500
C003	1	29990	ATC100B560JP500(x)	Capacitor 56PF-5-500
C004	1	29990	ATC100B240JP500(x)	Capacitor 24PF-5-500
C005	1	29990	ATC100A5R1DP50(x)	Capacitor 5.1PF-.5PF-50
C006	1		CDR02Bx183AKSM	Capacitor.018UF-10-50
C007	1	29990	ATC100B221JP200(x)	Capacitor 220PF-5-200
C008	1	29990	ATC100B240JP500(x)	Capacitor 24PF-5-500
C009	1		CDR02Bx183AKSM	Capacitor .018UF-10-50
C010	1		CDR02Bx183AKSM	Capacitor .018UF-10-50
C011	1	29990	ATC100A5R1DP50(x)	Capacitor 5.1PF-.5PF-50
C012	1	29990	ATC100B560JP500(x)	Capacitor 56PF-5-500
C013	1	29990	ATC100B240JP500(x)	Capacitor 24PF-5-500
C017	1		M39014/01-1575	Capacitor .01UF-10-100
C018	1	29990	ATC100B221JP200(x)	Capacitor 220PF-5-200
C019	1	29990	ATC100B360JB500(x)	Capacitor 36PF-5-500
C020	1	29990	ATC100B180JP500(x)	Capacitor 18PF-5-500
C021	1	29990	ATC100B120JP500(x)	Capacitor 12PF-5-500
C022	1	29990	ATC100B240JP500(x)	Capacitor 24PF-5-500
C023	1	29990	ATC100B240JP500(x)	Capacitor 24PF-5-500
C024	1	29990	ATC100B121JP300(x)	Capacitor 120PF-5-300
C025	1	29990	ATC100B330JP500(x)	Capacitor 33PF -5-500
C026	1	29990	ATC100A5R1DP50(x)	Capacitor 5.1PF-.5PF-50
C027	1	29990	ATC100B221JP200(x)	Capacitor 220PF-5-200
C028	1	29990	ATC100B221JP200(x)	Capacitor 220PF-5-200
C029	1	29990	ATC100A150JP50(x)	Capacitor 15PF-5-50

PARTS LIST

FIND NO.	QTY REQD	CODE IDENT	PART NUMBER	NOMENCLATURE
C032	1	29990	ATC100B360JP500(x)	Capacitor 36PF-5-500
C033	1	29990	ATC100B180JP500(x)	Capacitor 18PF-5-500
C034	1	29990	ATC100B120JP500(x)	Capacitor 12PF-5-500
C035	1	29990	ATC100B240JP500(x)	Capacitor 24PF-5-500
C036	1	29990	ATC100B240JP500(x)	Capacitor 24PF-5-500
C037	1	29990	ATC100B121JP300(x)	Capacitor 120PF-5-300
C038	1	29990	ATC100B330JP500(x)	Capacitor 33PF-5-500
C039	1	29990	ATC100A5R1DP50(x)	Capacitor 5.1PF-.5PF-50
C41	1		M39014/01-1575	Capacitor .01UF-10-100
C042	1	29990	ATC100B221JP200(x)	Capacitor 220PF-5-200
C046	1		CDR02BX183AKSM	Capacitor .018UF-10-50
C047	1		CDR02BX103BKSM	Capacitor .01UF-10-100
C048	1		CDR02BX103BKSM	Capacitor .01UF-10-100
CR001	1		JAN1N5711	Diode
DC001	1		10360-3	Coupler 90 Degree
DC002	1		10360-3	Coupler 90 Degree
E001	1		74-15169A01	Bead
J001	1	95077	2960-4019	Connector, SMA
J002	1	95077	2960-4019	Connector, SMA
J004	1	00779	60599-3	Contact
J005	1	00779	60599-3	Contact
J006	1	00779	60599-3	Contact
J007	1	00779	60599-3	Contact
J008	1	00779	60599-3	Contact
J009	1	00779	60599-3	Contact
R002	1		RWR89S10R0FR	Resistor 10-1-3

PARTS LIST

FIND NO.	QTY REQD	CODE IDENT	PART NUMBER	NOMENCLATURE
R003	1		RCR07G100JS	Resistor 10-5-1/4
R004	1		RWR89S1R00FR	Resistor 1-1-3
R006	1		RWR89S1R00FR	Resistor 1-1-3
R007			RCR07G100JS	Resistor 10-5-1/4
R008	1		RCR07G103JS	Resistor 10K-5-1/4
R009	1		RCR07G472JS	Resistor 4700-5-1/4
R011	1		RCR07G111JS	Resistor 110-5-1/4
W001	1	94990	30-P06323W001	Cable, Coax Right Low
W002	1	94990	30-P06324W001	Cable, Coax Right Hi
W003	1	94990	30-P06324W001	Cable, Coax Right Hi
W004	1	94990	30-P06323W001	Cable Coax Right Low
W005	1	94990	30-P06324W001	Cable Coax Right Hi
W006	1	94990	30-P06323W001	Cable, Coax Right Low
W007	1	94990	30-P06321W001	Cable, Coax Left Low
W008	1	94990	30-P06322W001	Cable, Coax Left Hi.

SECTION 9
CONTROL AND ALC MODULE
A2

9-1 PURPOSE AND GENERAL DESCRIPTION

9-2 The Power-Amplifer Control and ALC provides the operating signals required for the operation of the amplifier.
The primary fuction is to determine and control the output power level of the amplifier.
Additionally, this module provides and accepts signals to control T/R switching, power-indicators, fault indication, and fan control.

9-3 The following functional blocks contained in figure 5-2 are completely within this module:

HI/LO Voltage Sense
Input Voltage to Power Output Computer
Heat-Sink Temperature to Power Output Computer
Reference Power Level Computer
FWD/REV Combiner
AM Loop Amp and LP Filter
AM Loop Defeat
FM Loop Amp
VCA Amp and Driver
Quarter Power Attenuator
RF In Sense
T/R Detect
Hi RF Detect
VCA Clamp and Delay
Error Check Delay
Amp ON/OFF
Lock-Out Latch #1

Lock-out Latch #2
Power-On Reset
Thermostat Trip Sense
Overdriven VCA Detect
Excessive RF Power Detect
No RF Out for RF In Detect
Loop Error Detect
Reduce Power Circuit
Reduce Power Latch
PA Fail Sense
RF Power Level Decode
Power Lamp Driver
Fault Lamp Driver
5V @ 50 ma Regulator
2.5V @ 10 ma Reference

In addition, the low-level control circuits for the following are contained in this module:

Voltage Limiters (1, 2 & 3)
15V @ 100 ma Regulator
PA Bias (5V @ .15 amps)
Temperature Controlled Fan Switch

9-4 DETAILED DESCRIPTION

9-5 The following paragraphs provide a detailed description of the functions in this module. They describe circuits shown in the FUNCTIONAL BLOCK DIAGRAM, figure 5-2 and the SCHEMATIC DIAGRAMS 9-1 to 9-4.

9-6 HI/LO VOLTAGE SENSE - This circuit appears on sheet 2 of the A2 schematics. The active elements are two Voltage Comparitors in U3. The precision resistors R45, R46 and R47 form a voltage-divider with two outputs proportional to the filtered input DC voltage level. The precision 2.5V reference provides the comparison signal to the comparitors. The input level to pin 5 of U3 will be less than 2.5 volts if the input voltage is less than 20 volts. This condition will cause the output (pin 2) to go to a logic low level, signaling a low input voltage condition. In a similar manner, the input pin 6 will be greater than 2.5 volts for an input voltage greater than 32 volts, causing the output of the comparitor (pin 1) to go low and signal a high input voltage condition. The outputs of these comparitors are of the open-collector type allowing a wired-or connection. This signal is processed by digital logic to prevent operation of the amplifier and flash the fault-lamp for an out-of voltage-range condition.

9-7 VOLTAGE REGULATORS - The Voltage limiters appear on sheet 3 of the A2 schematics. There are three identical Voltage Regulators in the amplifier. Active elements of these circuits are:

PNP Power Darlington Transistors Q1, Q2 and Q3 mounted on the Power-Regulator Bridge

Power Tab Transistors Q6, Q7 and Q8

Three of the operational-amplifiers in U18

The following description about the regulator associated with Q1 applies to the other circuits with Q2 and Q3 also.

9-8 These Regulators are closed loop voltage-regulators which are allowed to go into saturation for an input voltage less than 30 volts. The operational amplifier compares the 2.5 volt reference with the output of the voltage-divider R126, and R127, which is a function of the output voltage. If this voltage is lower than the reference, the drive to Q6 is increased which turns Q1 on more to increase the voltage. The drives are decreased if the output voltage is too high. Resistors R124 and R123 limit the drive and provide good saturation of the transistors when the input voltage is too low to allow regulation of the output to 30 volts.

9-9 The dissipation of the Darlington Transistors increases rapidly as the input voltage increases above 31 volts. Excessive power dissipation in these devices is avoided by switching them off for voltages greater than about 32.5 volts. This switching is performed by applying a logic high level through diode CR14 to the inverting input of the op-amp. This level forces the output of the amplifier to minimum, eliminating drive to Q6 and Q1; shutting off the circuit.

9-10 15V @ 100 ma REGULATOR - This circuit appears on sheet 3 of the A2 schematics. The active elements are Q9 and CR19. Zener diode CR19 provides a 15 volt reference which is buffered by Emitter-Follower Q9 used to supply the needed current. Because this circuit supplies the power to turn-on the Voltage Regulators, it cannot be protected from high voltage by these circuits. This circuit was designed to tolerate input voltages as high as 100 volts without damage. Tight voltage control is not needed from this circuit and the design will allow a plus-or-minus 2 volt variation.

9-11 5V @ 50ma REGULATOR - This circuit appears on sheet 2 of the A2 schematics. Active elements include Q17 and an op-amp in U13. The configuration of this circuit is similar to a non-inverting op-amp circuit with a gain of two. The transistor Q17 buffers the output of the op-amp to allow more current to be obtained than the op-amp alone could supply. The gain of two accurately converts the 2.5 volt reference input to a 5 volt output. The gain is determined by precision resistors R66 and R67.

9-12 2.5V @ 10ma REFERENCE - This circuit appears on sheet 2 of the A2 schematics. The active element is U19, a precision voltage reference I.C. The accuracy and stability of the voltage obtained from this circuit eliminates the need for adjustment.

9-13 5v @ 1.5 amp BIAS - This circuit appears on sheet 3 of the A2 schematics. Active elements include Q4 and an op-amp from U4. This circuit works the same as the 5v @ 50 ma Regulator. Because this circuit must supply much more current than the other regulator, the output transistor Q4 is mounted on the Regulator Bridge heat-sink. The circuit gain of two is controlled by precision resistors R86 and R88. The 5 volt output is obtained by multiplying the 2.5 volt reference by this gain. This circuit is switched off when the amplifier is in standby by applying a logic high level through CR12 to the inverting input (pin 13) of U4. When this signal is present, the output of the op-amp and Q4 go to nearly 0 volts.

9-14 TEMPERATURE CONTROLLED FAN SWITCH - This circuit appears on sheet 3 of the A2 schematics. Active elements are Q23, Q24 and an op-amp in U18. Temperature sensing is done by a thermistor mounted on the RF amp heat-sink between the two power-amplifier modules. The thermistor is biased by current from the 5 volt source, through resistors R152 and R161 (on sheet 2). As the temperature of the heat-sink increases, the resistance of the thermistor decreases. This causes the voltage to pin 2 of U18 to decrease. R81 and R82 form a voltage-divider to provide a reference to the non-inverting input pin 3 of U18. When the thermistor voltage drops below this level (about 0.9v), the output of U18 goes high, turning on Q23 and Q24 to supply power to the fan. R83 provides hysteresis so that the fan will turn on at about 55 degrees centigrade and turn off when the heat sink temperature has dropped by about 7 degrees to 48 degrees centigrade.

9-15 RF LEVEL DECODE - This circuit appears on sheet 2 of the A2 schematics. Active elements include U16 and U17. The RF forward power sensor voltage is applied through R121 to input pin 12 of U16, a voltage-follower. The output of this op-amp is applied to the non-inverting inputs of a string of op-amps whose inverting inputs are derived from the string of resistors R154, R100, R101, R105, R109, R113, and R117. As the detected voltage increases, the op-amps become activated in sequence and their outputs increase from 0 volts to about 4 volts. Negative feedback is used at each inverting input to cause a smooth transition of the outputs from minimum to maximum.

9-16 LAMP DRIVERS - This circuit appears on sheet 2 of the A2 schematics. Active elements are Q12 to Q16. These transistors sink current from the front-panel LEDs in proportion to the voltage from the RF Level Decode op-amps. The current is equal to this voltage divided by the 130 ohm resistors between each transistor's emitter and ground.

9-17 HEAT-SINK TEMPERATURE TO POWER OUTPUT COMPUTER - This circuit appears on sheet 2 of the A2 schematics. The active element is an op-amp in U4. The heat-sink temperature signal is obtained from the voltage-divider R152, R161 and the thermistor mounted to the heat-sink. This voltage is applied to the non-inverting input pin 10 of U4. R59, R60 and R62 set the point at which the falling input (due to increasing heat-sink temperature) begins decreasing the output from a saturated level near 5 volts, and the rate at which it decreases. The reduction begins at about 0.35 volts and decreases to nearly 0 volts for an input of 0.2 volts. This means the output power will not be decreased for a heat-sink temperature below 85 degrees centigrade and would decrease (if allowed to) to 0 output at 100 degrees centigrade. In actuality, the output would decrease until a balance is reached where no further decrease is needed to maintain a non-destructive heat-sink temperature.

9-18 INPUT VOLTAGE TO POWER OUTPUT COMPUTER - This circuit appears on sheet 2 of the A2 schematics. The active element is an op-amp in U4. The input voltage to the amplifier is divided by R56 and R57 and applied to the non-inverting input (pin 3) of U4. Resistors R54 and R55 determine the point at which the output of the op-amp begins to drop out of saturation and the rate at which the decrease occurs. The circuit values used will begin power reduction for an input voltage of 27 volts and decrease linearly to a minimum at 20 volts.

9-19 REFERENCE POWER LEVEL COMPUTER - This circuit appears on sheet 2 of the A2 schematics. Active elements are Q22 and an op-amp in U4. When the Reduced Power circuit is not active, Q22 is on and the output Pin 7 voltage is about double the input to pin 5. The highest voltage into this input is set by the voltage applied to E28 (from the front-panel power control and remote control jack). This input voltage can be pulled down by the Heat-Sink Temperature to Power Output Computer through CR10 or by the Input Voltage to Power Out Computer by CR9. When the Reduce Power circuit is active, Q22 is off and the op-amp output is cut in half (reducing output power by a factor of four).

9-20 REDUCE POWER LATCH - This circuit appears on sheet 1 of the A2 schematics. Active elements are a flip-flop in U7 and gates in U8, U9 and U11. If a PA module fails, one of the inputs to the two-input NAND-gate (pins 8 and 9) will drop to a low logic level forcing the output (pin 10) high. This signal will be inverted by U11 and applied to input pin 8 of U9. In the absence of a standby signal at pin 2 or an Error Check Delay signal to pin 1, the output (pin 9) will go high, setting the flip-flop in U7. The output (pin 2) is applied through R65 to the base of Q22 to control the reduced power mode.

9-21 When this circuit becomes active, the output power is reduced to one-fourth of the power which would exist if this circuit were inactive.

9-22 PA FAIL SENSE - This circuit appears on sheets 1 and 2 of the A2 schematics. Active elements are diodes CR21 and CR22, and two voltage-comparitors in U2. Power sense circuits on the PA modules are connected to the inputs of the comparitors (pins 7 and 9) and compared to a voltage obtained from the 2.5 volt reference by voltage-divider R36 and R37. When the module is putting out more than about 10 watts, the detected signal will be higher than this and the outputs of the comparitors will be high. If one of the modules fails, one of the outputs will go low, signaling the failure of the module to the Reduce Power Latch circuit. Diodes CR21 and CR22 are driven by the RF Input Detect circuit to hold these inputs high in the absence of an input signal to prevent the false indication of a module failure.

9-23 T/R RELAYS DRIVE CIRCUIT - This circuit appears on sheet 1 of the A2 schematics. The active element in this circuit is Q21. Drive from the inverter output (U11 pin 2) is applied through R29 to the base of Q21. This forces the transistor into saturation and sinks current from the input voltage through the T/R relays, activating them.

9-24 FWD/REV COMBINER - This circuit appears on sheet 1 of the A2 schematics. Active elements are two op-amps in U5 and diodes CR1 and CR2. Voltage from the Forward Power sense circuit is applied through voltage-divider R4 and R5 to the input pin 5 of U5. Voltage from the Reverse Power Detector is applied through Voltage-divider R1 and R2 to input pin 3. The outputs of these circuits are connected through diodes CR1 and CR2 to the following stage and, also, back to the inverting inputs. This circuit causes the op-amp with the higher input voltage at its non-inverting input to take control of the output and have unity gain. The detector levels and the voltage-dividers create a condition where the output is under control of the Forward Power Detector for a VSWR of less than 2:1 and under control of the Reverse Power Detector for a VSWR of greater than 2:1.

9-25 AM LOOP AND LP FILTER - This circuit appears on sheet 1 of the A2 schematics. Active elements are two op-amps in U5, and Q18. This circuit compares the actual output power level to the desired level and adjusts drive to the VCA to make them equal. Most of the gain in this loop is provided by the integrator circuit using pins 9 and 10. Some additional gain and an inversion of the signal occurs in the inverting-amplifier using pins 12 and 13 as inputs.

The frequency response of this circuit is limited to prevent stripping of the modulation of an AM signal at audio frequencies. C3 and R7 have the most control over the frequency response and prevent stripping of more than a few percent at frequencies as low as 100 Hz.

9-26 FM LOOP AMP - This circuit appears on sheet 1 of the A2 schematic. The active elements are two op-amps in U13 and Q20. The output of the FWD/REV Combiner is compared to the desired signal by an op-amp in U13 at pins 12 and 13. The high gain of this stage provides most of the overall loop-gain. Some additional gain and a signal inversion is performed in the following stage (U13 pins 8,9 and 10).

There is no requirement to prevent amplitude modulation stripping by this loop. The speed of the loop is as fast as it can be and still maintain good stability. R9 and C4 add enough high-frequency roll-off to keep the loop from oscillating. This loop is called upon to reduce power in the case of a sudden mis-match and prevent damage to the PA modules. This is the reason why a fast response is needed.

9-27 QUARTER POWER ATTENUATOR - This circuit appears on sheet 1 of the A2 schematics. The current consists of the voltage-divider containing R8 and R10. This circuit reduces the desired voltage level to the AM loop to ½ that to the FM loop. This results in the AM loop adjusting the output level to ¼ the power level that would be set by the FM loop. The loop circuitry in the amplifier will allow control of the output level by the loop requiring the lower level. The AM Loop Defeat circuit allows control of the loop by the AM loop or higher power FM loop, as needed.

9-28 VCA AMP AND DRIVER - This circuit appears on sheet 1 of the A2 schematics. The op-amp outputs of the AM and FM loops are buffered by Q18 and Q20. Excessive voltage drive is prevented by zener diodes CR5 and CR6. The outputs of the circuits are diode-orred by CR20 and C7. This results in control of the attenuator by the loop requiring the highest amount of attenuation. Q5 buffers the output and provides the high current needed to drive the VCA.

9-29 VCA CLAMP AND DELAY - This circuit appears on sheet 1 of the A2 schematics. The active elements in this circuit are U12, CR8 and CR9. U12 is a 555 type timer which is activated by the transmit logic signal. This signal becomes active when a transition to transmit occurs. A pulse is produced which is passed through CR8 charging C57 and through CR4 to produce a 3 volt level at the input to the loop amplifiers. The loop amplifiers respond to this by increasing the attenuation to maximum.

9-30 AM LOOP DEFEAT CIRCUIT - This circuit appears on sheet 1 of the A2 schematics. The active element of this circuit is Q19. A voltage of 2 volts or more applied to E10 will cause a current to flow through R16 into the base of Q19, turning the transistor on. Under this condition, the base drive to Q18 is shunted to ground; effectively reducing the output of the AM loop path to zero. A voltage of less than 0.4 volts will not be sufficient to activate this circuit.

9-31 R.F. IN SENSE - This circuit appears on sheet 2 of the A2 schematics. The signal for this circuit is derived from J5 of the relay assembly A4 and is a function of the RF power applied to the input of the amplifier. This signal enters the ALC at E32 and is applied through R30 to input pin 5 of U2. This signal is compared to a DC level of about 0.6 volts derived from the 2.5 volt reference and voltage-divider resistors R33 and R34. The output of this voltage-comparitor switches high for an input signal above this DC level indicating the prescence of the required minimum amount of RF (about 1 watt). This signal is used by the T/R Detect circuit for automatic T/R control. Some positive feed-back is provided by R31. This prevents chattering of the T/R relays for a marginal input signal. With this feed-back, the input signal must be below about 3/4 watt for the circuit to indicate the loss of the input signal.

9-32 T/R DETECT - This circuit appears on sheet 3 of the A2 schematics. The circuit uses comparitors in U3 digital logic in U15 to determine whether key-line or automatic T/R mode is being used. Voltage-divider resistors R95, R96, and R97 provide reference voltage levels of 0.8 volts at pin 11 and 2.0 volts at pin 9 of U3. With no connection made to the front-panel key-line, the voltage level at the other inputs to these voltage-comparitors is determined by a voltage-divider, R93 and the 5 volt source. This 1.5 volt level results in the following states:

U3 PIN 13 = LOW
U3 PIN 14 = HIGH
U15 PIN 8 = LOW
U15 PIN 1 = HIGH
U15 PIN 10 = HIGH

Under these conditions, the output of the NAND-gate pin 3 of U15 is an inverse function of the input to pin 2 of U15 and the circuit output of pin 4 of U15 is an inverse function of this signal. The net result of these conditions is to make the overall circuit output a function of the signal from the R.F. In Sense.

In the case of an input signal of less than 0.8 volts being applied to the key-line input, the following logic states will occur:

U3 PIN 13 = HIGH
U3 PIN 14 = HIGH
U15 PIN 10 = LOW
U15 PIN 4 = HIGH

Because the circuit output pin 4 is unconditionally high for this condition, the amplifier will remain in the keyed condtion regardless of the state of the RF In Sense state. In the case of an input signal of more than 2.0 volts being applied to the key-line, the following logic states will occur:

U3 PIN 13 = LOW
U3 PIN 14 = LOW
U15 PIN 10 = HIGH
U15 PIN 3 = HIGH
U15 PIN 4 = LOW

Because the circuit output pin 4 of U15 is unconditionally low, the amplifier will be in the bypass or unkeyed mode regardless of the state of the RF In Sense signal.

9-33 LOCK-OUT LATCH #1 - This circuit appears on page 1 of the A2 schematics. The active element in this circuit is U6. In a T/R transition, pin 8 of U6 is driven high to cause the output pin 12 to go low and latch in a transmit mode. A high logic level to pin 10 of this flip-flop will inhibit this output and prevent latching during an R to T transition. This level will occur for any condition which would cause a logic low level at either pin 5 or pin 6 of NAND-gate U8. This level is in turn caused by a logic high at any of pins 9, 10, 11 or 12 of the NOR-gate U10. Conditions which could cause this state are:

A logic low level at the thermostat input E33

A logic high level from pin 13 of U7 (Lock-Out Latch #2)

A logic high level at U14 pin 13 (High RF Detect)

A logic low level at U3 pin 1 (Out of range input voltage)

9-34 LOCK-OUT LATCH #2 - This circuit appears on page 1 of the A2 schematics. The active element in this circuit is U7. This Flip-Flop serves as a memory element which is activated by a logic high level at pin 8. This pin is driven by the output pin 10 of U9, a NOR-Gate. This output is low as long as one of the following conditions exist:

The unit is in standby (U6 pin 12 high)
The error Check Delay is active (U12 pin 9 high)
No Fault condition detected (U9 pin 6 high)

The third condition will become active if one of the following is true:

Low RF Out for RF in Detect active (input pin 4 of U10)
Excessive RF Power Detect active (input pin 4 of U9)
Overdriven VCA Detect active (input pin 4 of U9)
Loop Error Detect active (input pin 4 of U9)

The latch is reset by a logic high level at pin 10 (of U7). This occurs for a standby condition (U11 pin 6 low) or Power On Reset active. When this latch is set, pin 13 (of U7) goes high which switches the amplifier to bypass mode using pin 12 of U10, and activates the Fault Lamp Driver for continuous output (through R145 to Q11).

9-35 ERROR CHECK DELAY - This circuit is located on sheet 1 of the A2 schematic. The active element of this circuit is U12. This I.C. generates a pulse in response to a logic low at pin 8. The length of the pulse is determined by R22 and C12 and is about 100 milli-seconds. The logic high level from pin 9 activates the AMP ON/OFF latch (pin 8 of U6) and inhibits setting of Lock-Out Latch #2 by driving pin 12 of U9 high for the duration of the pulse. This circuit prevents checking for errors until a settling time has been allowed for the R/T transition..

9-36 AMP ON/OFF - This circuit is located on sheet 1 of the A2 schematics. The active element in this circuit is U6. This latch is set by a pulse from the Error Check Delay Circuit and is reset by a logic high level from pin 4 of U8. This two input NAND-gate can be activated by two signals:

A logic low from the T/R Detect circuit (receive)
A logic low from U10 (fault)

The output pin 12 of U6 controls the relays, voltage to the amplifiers, VCA clamp, and Bias Supply.

9-37 HI RF DETECT - This circuit appears on sheet 2 of the A2 schematics. The active element is a Voltage-Comparitor in U14. The RF Sensed at the input to the amplifier by the relay board detector is connected through a voltage-divider R41 and R42 to pin 11 of U14. This voltage is compared to the 2.5 volt reference and, if it is greater than this, the output pin 13 will be too low.

This output is applied to pin 11 of U10 to prevent operation of the amplifier. This will prevent damage to the unit from input powers of greater than about 25 watts.

9-38 THERMOSTAT TRIP SENSE - This circuit is on sheet 1 of the A2 schematics. The active element is U11. The thermostats used in the amplifier are normally open. A temperature of 105 degrees centigrade or more will cause them to close, shorting their output to ground. Input pin 14 of U11 is held high by 5 volts through R49. If a thermostat trips, this input will be pulled low causing the output of the I.C. (pin 15) to go high, activating U10 to place the amplifier in the bypass-mode, and cause the Fault Lamp to flash. R147 and C11 filter RF and prevent falsing of the circuit.

9-39 POWER ON RESET - This circuit appears on sheet 1 of the A2 schematics. The active element is U11. When power is switched on, capacitor C14 begins charging through R25 toward Vcc. After the logic becomes functional, additional charging is provided through R157. As this charging is taking place, the output at pin 10 of U11 is high, resetting Lock-Out Latch #2 and the Reduce Power Circuit. When the voltage at pin 9 reaches Vcc/2, the output goes low, allowing normal setting of the latches to occur.

9-40 LOOP ERROR DETECT - This circuit is located on sheet 3 of the A2 schematics. The active elements are U13, U14, and U15. The desired power level voltage is applied through R71 to pin 5 of U13. This Voltage-Follower circuit prevents loading of this point by the circuit. The output of the follower is applied through R73 to U14 where it is compared to the voltage from the FWD/REV Combiner circuit. The level from the combiner should never significantly exceed the desired level for more than a few milli-seconds. The offset supplied to this comparitor by R72 will maintain a high logic level from pin 14 of U14 for all normal conditions. If the actual output level exceeds the desired enough to cause this output to go low, a failure in the loop control has occurred.

9-41 EXCESSIVE RF POWER DETECT - This circuit is located on sheet 3 of the A2 schematics. The active element is a Volatage-Comparitor in U14. The output of the FWD/REV Combiner circuit is connected through R80 to input pin 4 of U14 and compared to a reference voltage level supplied by resistors R89, R90 and R153. This level has been set at the factory to correspond to a level of about 250 watts. If the level at pin 4 exceeds the reference at pin 5, the output (pin 2) will go low. This signal is applied to a response shaping network at the input to pins 12 and 13 of U15. The output of this logic gate will set Lock-Out Latch #2 through U9. The purpose of the response shaping network is to prevent falsing of the error signal by normal, short term conditions.

9-42 OVERDRIVEN VCA DETECT - This circuit appears on sheet 3 of the A2 schematics. The active element is a voltage-comparitor in U14. The output voltage of the VCA driver is sampled at the emitter of Q5. This level is attenuated by R77 and R78 and applied to input pin 6 (of U14). This level is compared to the 2.5 volt reference and if it is greater, output pin 1 of U14 will go low. This level is applied to the waveform shaping circuit consisting of R76, C36 and CR11. The output of this circuit drives pins 12 and 13 of U15. The logic low level at this input will be inverted and applied to U9 and set Lock-Out Latch #2. This circuit will become active for voltage at the driver transistor greater than about 9 volts. This is near the saturation voltage of this circuit and indicates insufficient range is available for the required attenuator control. This condition could be caused by a bad PIN diode in the attenuator or by setting the output low (less than 25 watts) with a high input level (greater than 10 watts).

9-43 NO RF OUT FOR RF IN DETECT - Elements of this circuit appear on sheets 1 and 2 of the A2 schematics. The analog portion of the circuit uses voltage-comparitors in U2 to detect the presence of output and input signals. The digital logic part of this circuit uses U10. The presence of an input signal is determined by the same circuit used by the automatic T/R control. The circuit output from pin 2 of U2 is inverted by U11 and applied to input pin 3 of U10. The presence of output signal is determined by applying voltage from the RF Forward power detector to pin 11 of U2. This detected level is compared to a fixed value obtained from the 2.5 volt reference and voltage dividers R51 and R52. When the detected level exceeds about .25 volts, the output pin 13 (of U2) will go high. This level corresponds to about 10 watts out. U10 combines these signals so that if there is detected input power (pin 3 low), detected output (pin 4) must be high, indicating the presence of output or a fault signal (pin 1 of U10 high) will be generated.

9-44 FAULT LAMP DRIVER - This circuit appears on sheet 3 of the A2 schematics. The active element is U1. This circuit is activated by one of two possible signals. A logic low applied to pin 4 (from U8 pin 11) will cause the output pin 3 to alternate high and low at a rate controlled by R143, R144, and C56. This rate is set at about twice a second. A logic high signal applied to R145 will cause Q11 to conduct and pin 2 to drop to a logic low level. This will force output pin 3 to a steady high level. The output of this I.C. is applied through current limiting resistor R142 to the front-panel FAULT LED. If both signals occur at the same time, a "steady fault" is indicated.

NOTES:

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATIONS PREFIX WITH 1A2.
2. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE IN OHMS ± 5 PCT, 1/4 WATT.
   ALL CAPACITORS ARE IN UF.
   ALL VOLTAGES ARE IN DC.
3. FOR REFERENCE DRAWINGS REFER TO:
   01-P04030W ASSEMBLY
   12-P09164W TEST PROCEDURE

△4. PART OF REGULATOR ASSY., A3, 01-P06318W.

△5. PART MOUNTED ON CHASSIS ASSY., UNIT 1, 01-P04001W.

△6. PART MOUNTED OUTSIDE OF SHIELD.

△7. PART MOUNTED OF RF ASSEMBLY, A1.

TABLE 1

REF DES	DEVICE TYPE	E39 +15V	E40 +5V	E37 OR E22 (CF37) GROUND
U1	MC1555U			1
U2	LM139J		3	12
U3	LM139J	3		12
U4	LM124J	4		11
U5	LM124J	4		11
U6	MC14013		5, 14	6, 7, 9, 11
U7	MC14013		14	
U8	MC14011		14	7
U9	MC14025		14	7
U10	MC14002		14	7
U11	MC14049U		1	8
U12	MC3556L		10, 4, 14	7
U13	LM124J	4		11
U14	LM139J		3	12
U15	MC14011		14	7
U16	LM124J		4	11
U17	LM158J		8	4
U18	LM124J	4		11
U19	MC1403U	1		3

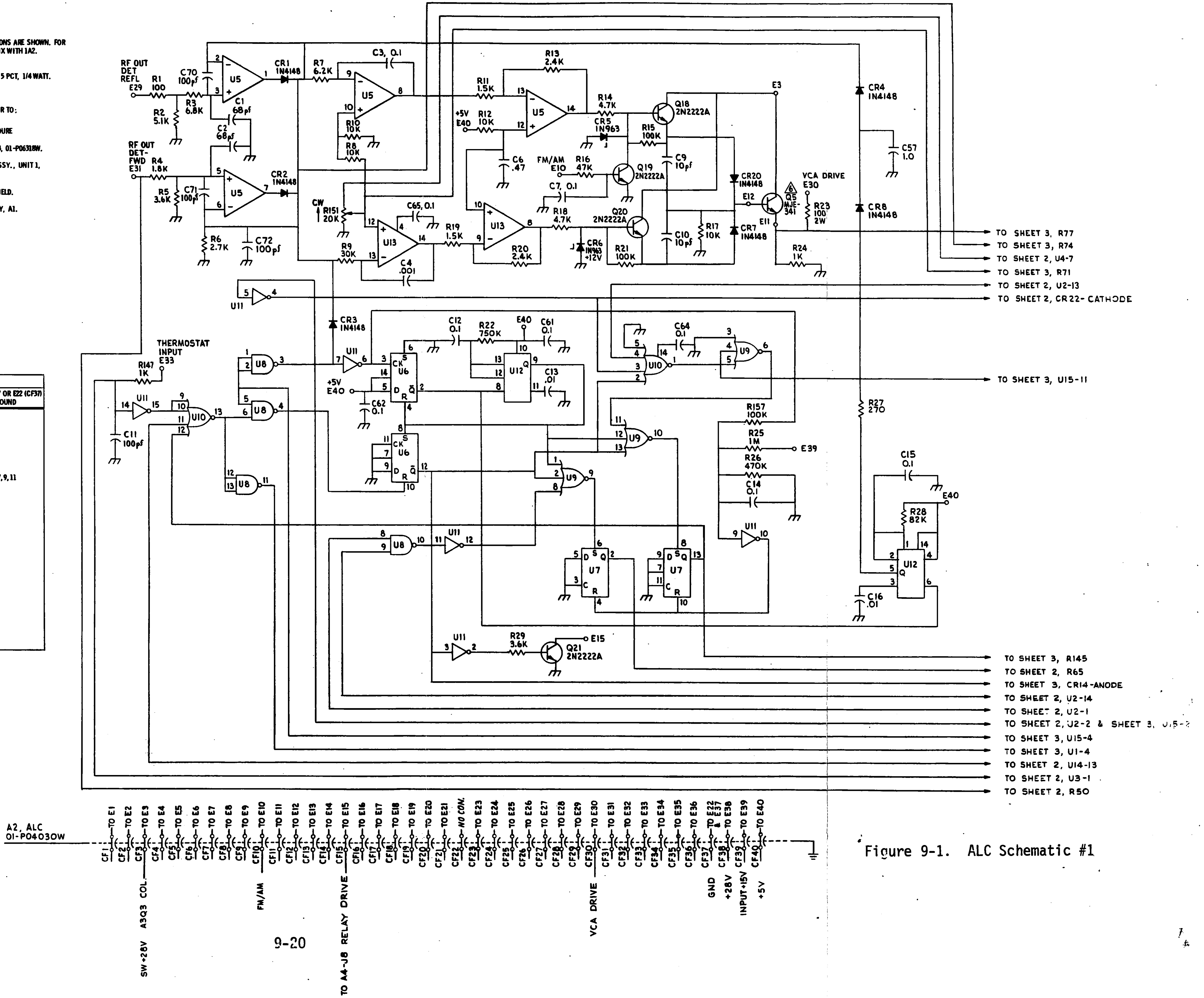


Figure 9-1. ALC Schematic #1

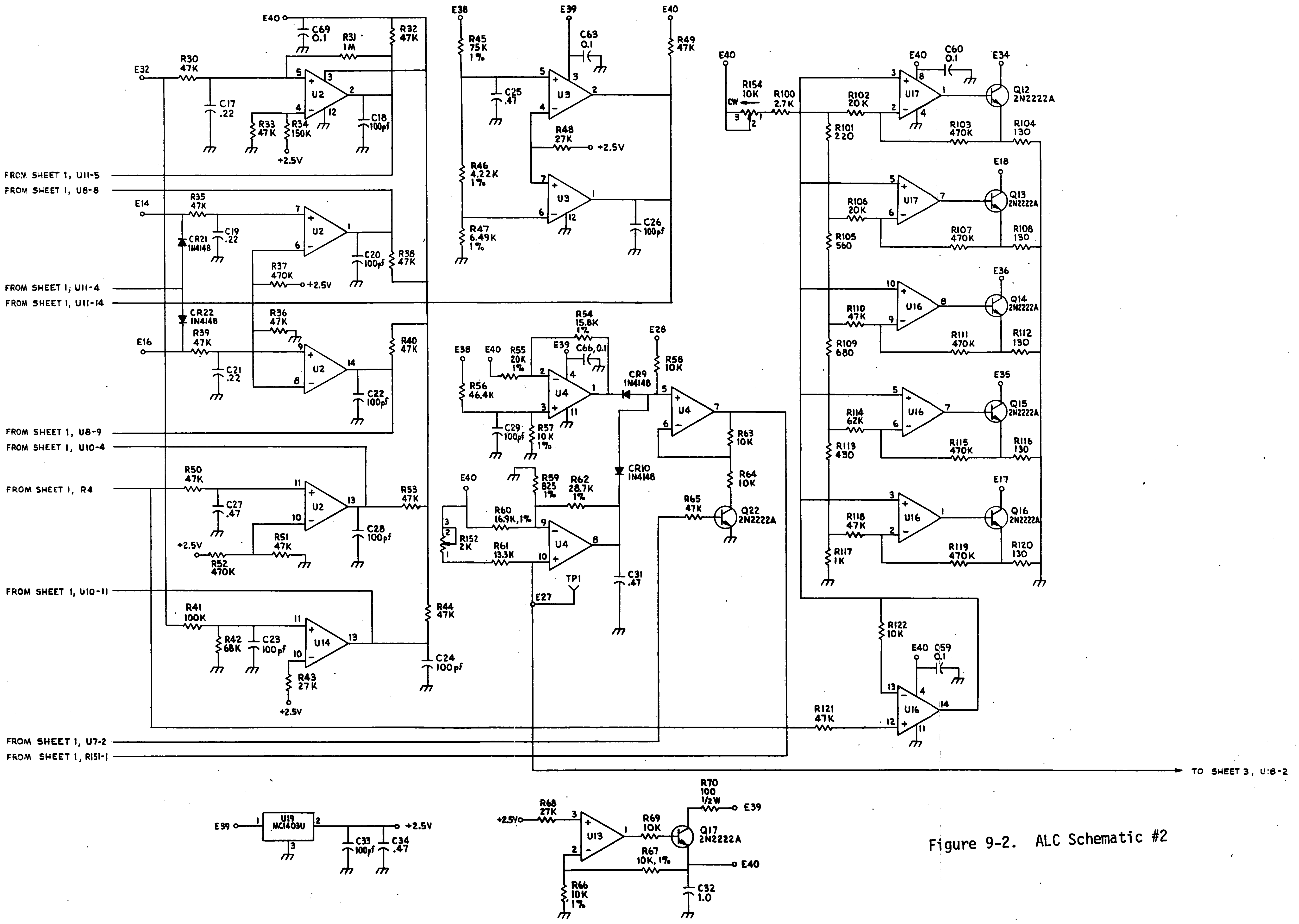


Figure 9-2. ALC Schematic #2

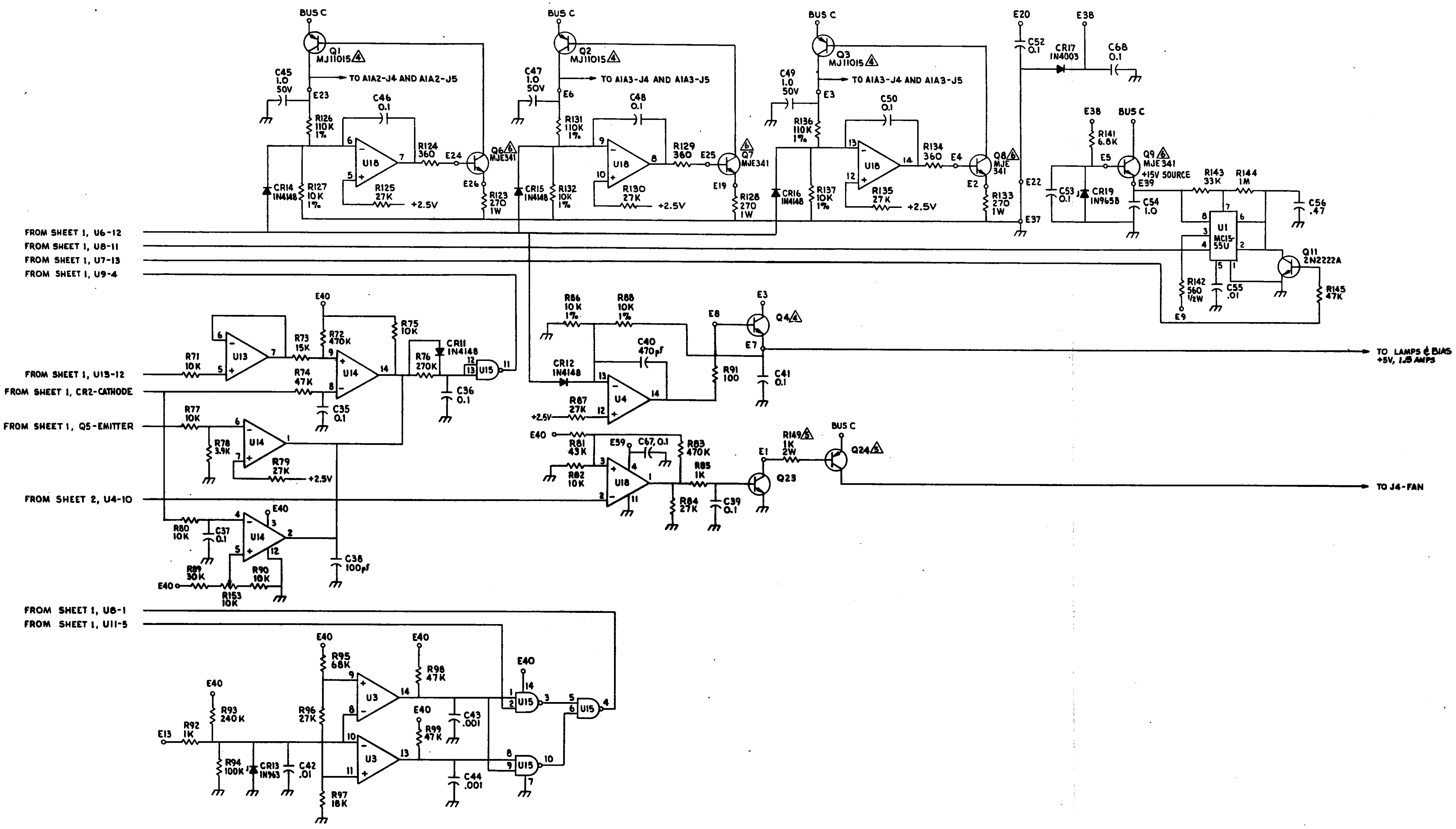


Figure 9-3. ALC Schematic #3

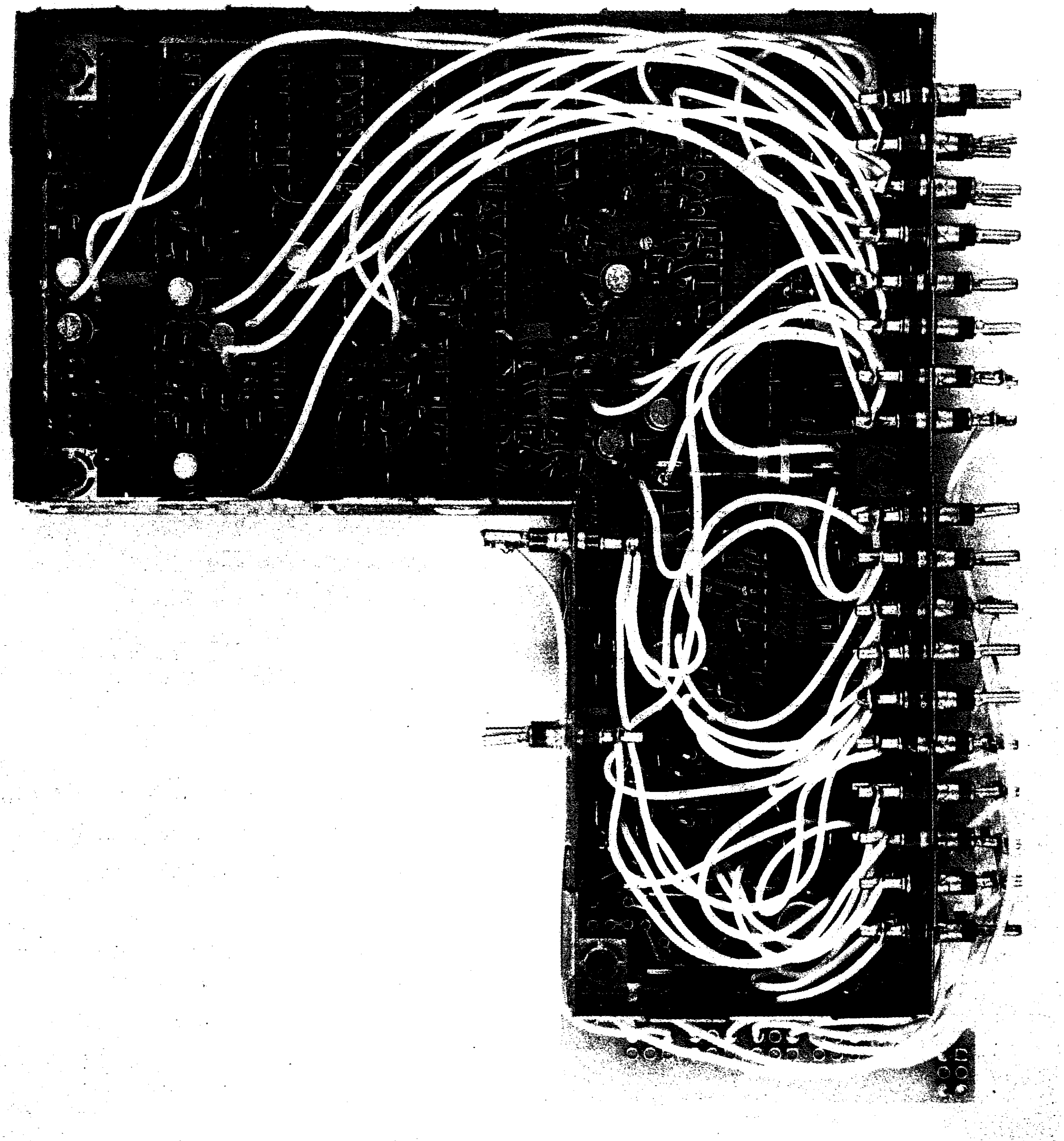


Figure 9-4. ALC Module

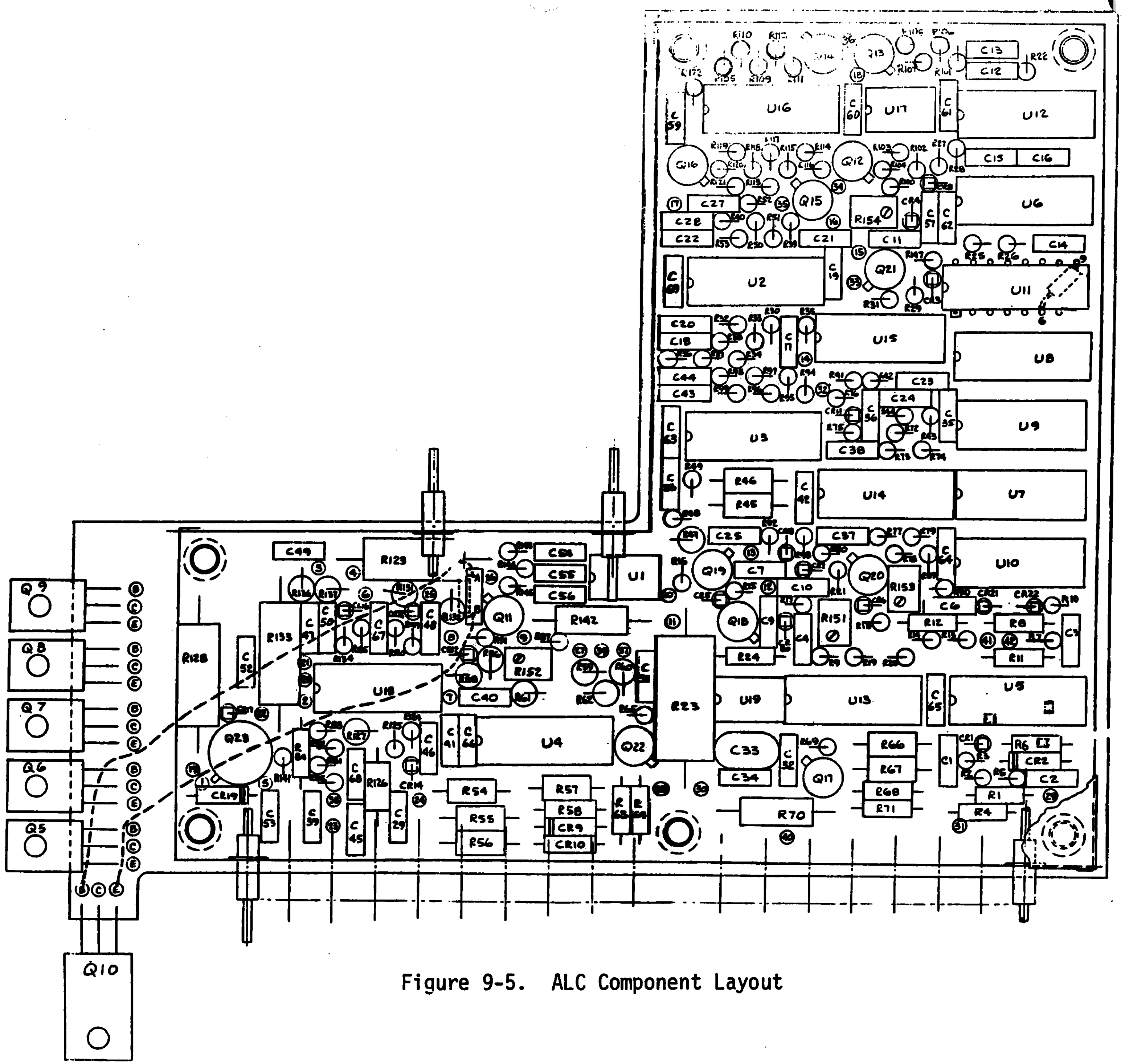


Figure 9-5. ALC Component Layout

PARTS LIST

FIND NO.	QTY REQD	CODE IDENT	PART NUMBER	NOMENCLATURE
001	1		84-P04032W001	PWB ALC Assy A2
002	6		43-P06332W002	Spacer .095
003	1		26-P06326W001	Shield, Wall
004	1		26-P06327W001	Shield, Cover
010	1		26-P06326W002	Shield, Wall
011	1		26-P06326W003	Shield, Wall
C001	1		CM04ED680J03	Capacitor 68PF-5-500
C002	1		CM04ED680J03	Capacitor 68PF-5-500
C003	1		M39014/02-1350	Capacitor .1UF-10-100
C004	1		M39014/01-1357	Capacitor 1000PF-10-200
C006	1		M39014/02-1360	Capacitor .47UF-10-50
C007	1		M39014/02-1350	Capacitor .1UF-10-100
C009	1		M39014-01-1321	Capacitor 10PF-10-200
C010	1		M39014/01-1321	Capacitor 10PF-10-200
C011	1		M39014/01-1339	Capacitor 100PF-10-200
C012	1		M39014/02-1350	Capacitor .1UF-10-100
C013	1		M39014/01-1575	Capacitor .01UF-10-100
C014	1		M39014/02-1350	Capacitor .1UF-10-100
C015	1		M39014/02-1350	Capacitor .1UF-10-100
C016	1		M39014/01-1575	Capacitor .01UF-10-100
C017	1		M39013/02-1356	Capacitor .22UF-10-50
C018	1		M39014/01-1339	Capacitor 100PF-10-200
C019	1		M39014/02-1356	Capacitor .22UF-10-50
C020	1		M39014/01-1339	Capacitor 100PF-10-200
C021	1		M39014/02-1356	Capacitor ..2UF-10-50
C022	1		M39013/01-1339	Capacitor 100PF-10-200
C023	1		M39014/01-1339	Capacitor 100PF-10-200
C024	1		M39014/01-1339	Capacitor 100PF-10-200
C025	1		M39014/02-1360	Capacitor .47UF-10-50
C026	1		M39014/01-1339	Capacitor 100PF-10-200
C027	1		M39014/02-1360	Capacitor .47UF-10-50

PARTS LIST

FIND NO.	QTY REQD	CODE IDENT	PART NUMBER	NOMENCLATURE
C028	1		M39014/01-1339	Capacitor 100PF-10-200
C029	1		M39014/01-1339	Capacitor 100PF-10-200
C031	1		M39014/02-1360	Capacitor .47UF-10-50
C032	1		M39014/02-1419	Capacitor 1UF-10-50
C033	1		CM04FD101J03	Capacitor 100PF-5-500
C034	1		M39014/02-1360	Capacitor .47UF-10-50
C035	1		M39014/02-1350	Capacitor .1UF-10-100
C036	1		M39014/02-1350	Capacitor 1UF-10-100
C037	1		M39014/02-1350	Capacitor 1UF-10-100
C038	1		M39014/01-1339	Capacitor 100PF-10-200
C039	1		M39014/02-1350	Capacitor .1UF-10-100
C040	1		M39014/01-1351	Capacitor 470PF-10-200
C041	1		M39014/02-1350	Capacitor .1UF-10-100
C042	1		M39014/01-1575	Capacitor .01UF-10-100
C043	1		M39014/01-1357	Capacitor 1000PF-10-200
C044	1		M39014/01-1357	Capacitor 100PF-10-200
C045	1		M39014/02-1419	Capacitor 1UF-10-50
C046	1		M39014/02-1350	Capacitor 1UF-10-100
C047	1		M39014/02-1419	Capacitor 1UF-10-50
C048	1		M39014/02-1350	Capacitor 1UF-10-100
C049	1		M39014/02-1419	Capacitor 1UF-10-50
C050	1		M39014/02-1350	Capacitor 1UF-10-100
C052	1		M39014/02-1350	Capacitor .1UF-10-100
C053	1		M39014/02-1350	Capacitor .1UF-10-100
C054	1		M39014/02-1419	Capacitor 1UF-10-50
C055	1		M39014/01-1575	Capacitor .01UF-10-100
C056	1		M39014/02-1360	Capacitor .47UF-10-50
C057	1		M39014/02-1419	Capacitor 1UF-10-50
C059	1		M39014/02-1350	Capacitor .1UF-10-100
C060	1		M39014/02-1350	Capacitor .1UF-10-100
C061	1		M39014/01-1350	Capacitor .1UF-10-100

PARTS LIST

FIND NO.	QTY REQD	CODE IDENT	PART NUMBER	NOMENCLATURE
C062	1		M39014/02-1350	Capacitor .1UF-10-100
C063	1		M39014/02-1350	Capacitor .1UF-10-100
C064	1		M39014/02-1350	Capacitor .1UF-10-100
C065	1		M39014/02-1350	Capacitor .1UF-10-100
C066	1		M39014/02-1350	Capacitor .1UF-10-100
C067	1		M39014/02-1350	Capacitor .1UF-10 100
C068	1		M39014/02-1350	Capacitor .1UF-10-100
C069	1		M39014/02-1350	Capacitor .1UF-10-100
C070	1		ATC100A101JP50(x)	Capacitor 100PF-5-50
C071	1		ATC100A101JP50(x)	Capacitor 100PF-5-50
C072	1		ATC100A101JP50(x)	Capacitor 100PF-5-50
C073	1		M39014/02-1360	Capacitor .47UF-10-50
CF001	1	72982	2404-000x5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF002	1	72982	2404-000x5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF003	1	72982	2402-000x5U0520P	Capacitor, Feedthru 5000PF-GMV-500
CF004	1	72982	2404-000c5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF005	1	72982	2404-000x5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF006	1	72982	2404-000x5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF007	1	72982	2404-000x5U050P	Capacitor, Feedthru 5000PF-GMV-500
CF008	1	72982	2404-000x5U050P	Capacitor, Feedthru 5000PF-GMV-500
CF009	1	72982	2404-000c5U0502P	Capicitor, Feedthru 5000PF-GMV-500
CF010	1	72982	2404-000x5U0502P	Capacitor, Feedthru, 5000PF-GMV-500
CF011	1	72982	2404-000x5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF012	1	72982	2404-000x5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF013	1	72982	2404-000x5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF014	1	72982	2404-000x5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF015	1	72982	2404-000x5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF016	1	72982	2404-000x5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF017	1	72982	2404-000x5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF018	1	72982	2404-000x5U0502P	Capacitor, Feedthru 5000PF-GMV-500

PARTS LIST

FIND NO.	QTY REQD	CODE IDENT	PART NUMBER	NOMENCLATURE
CF019	1	72982	2404-000X5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF020	1	72982	2404-000X5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF021	1	72982	2404-000X5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF022	1	72982	2404-000X5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF023	1	72982	2404-000C5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF024	1	72982	2402-000X5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF025	1	72982	2402-000X5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF026	1	72982	2404-000X5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF027	1	72982	2404-000X5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF028	1	72982	2404-000X5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF029	1	72982	2404-000X5U0102P	Capacitor, 1000-GMV-500
CF030	1	72982	2404-000X5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF031	1	72982	2404-000X5U0102P	Capacitor 1000-GMV-500
CF032	1	72982	2404-000X5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF033	1	72982	2404-000X5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF034	1	72982	2404-000X5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF035	1	72982	2404-000X5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF036	1	72982	2404-000C5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF037	1	72982	2404-000X5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF038	1	72982	2404-000X5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF039	1	72982	2404-000X5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CF040	1	72982	2404-000X5U0502P	Capacitor, Feedthru 5000PF-GMV-500
CR001	1		JAN1N4148-1	Diode
CR002	1		JAN1N4148-1	Diode
CR003	1		JAN1N4148-1	Diode
CR004	1		JAN1N4148-1	Diode
CR005	1		JAN1N963B-3	Diode, Zener 12V, 400MW
CR006	1		JAN1N963B-1	Diode, Zener 12V, 400 MW
CR007	1		JAN1N4148-1	Diode
CR008	1		JAN1N4148-1	Diode
CR009	1		JAN1N4148-1	Diode

PARTS LIST

FIND NO.	QTY REQD	CODE IDENT	PART NUMBER	NOMENCLATURE
CR010	1		JAN1N4148-1	Diode
CR011	1		JAN1N4148-1	Diode
CR012	1		JAN1N4148-1	Diode
CR013	1		JAN1N963B-1	Diode, Zener 12V, 400MW
CR014	1		JAN1N4148-1	Diode
CR015	1		JAN1N4148-1	Diode
CR016	1		JAN1N4148-1	Diode
CR017	1		.1N4003	Diode
CR019	1		JAN1N965B	Diode, Zener 15V, 400MW
CR020	1		JAN1N4148-1	Diode
CR021	1		JAN1N4148-1	Diode
CR022	1		JAN1N4148-1	Diode
Q011	1		JAN2N2222A	Transistor
Q012	1		JAN2N2222A	Transistor
Q013	1		JAN2N2222A	Transistor
Q014	1		JAN2N2222A	Transistor
Q015	1		JAN2N2222A	Transistor
Q016	1		JAN2N2222A	Transistor
Q017	1		JAN2N2222A	Transistor
Q018	1		JAN2N2222A	Transistor
Q019	1		JAN2N2222A	Transistor
Q020	1		JAN2N2222A	Transistor
Q021	1		JAN2N2222A	Transistor
Q022	1		JAN2N2222A	Transistor
Q023	1		2N5682	Transistor
R001	1		RCR07G101JS	Resistor 100-5-¼
R002	1		RCR07G512JS	Resistor 5100-5-¼
R003	1		RCR07G682JS	Resistor 6800-5-¼
R004	1		RCR07G182JS	Resistor 1800-5-¼
R005	1		RCR07G362JS	Resistor 3600-5-¼

PARTS LIST

FIND NO.	QTY REQD	CODE IDENT	PART NUMBER	NOMENCLATURE
R006	1		RCR07G272JS	Resistor 2700-5-¼
R007	1		RCR07G622JS	Resistor 6200-5-¼
R008	1		RCR07G103JS	Resistor 10K-5-¼
R009	1		RCR07G303JS	Resistor 30K-5-¼
R010	1		RCR07G103JS	Resistor 10K-5-¼
R011	1		RCR07G152JS	Resistor 1500-5-¼
R012	1		RCR07G103JS	Resistor 10K-5-¼
R013	1		RCR07G242JS	Resistor 2400-5-¼
R014	1		RCR07G472JS	Resistor 4700-5-¼
R015	1		RCR07G104JS	Resistor 100K-5-¼
R016	1		RCR07G473JS	Resistor 47K-5-¼
R017	1		RCR07G103JS	Resistor 10K-5-¼
R018	1		RCR07G472JS	Resistor 4700-5-¼
R019	1		RCR07G152JS	Resistor 1500-5-¼
R020	1		RCR07G242JS	Resistor 2400-5-¼
R021	1		RCR07G104JS	Resistor 100K-5-¼
R022	1		RCR07G754JS	Resistor 750K-5-¼
R023	1		RCR42G101JS	Resistor 100-5-2
R024	1		RCR07G102JS	Resistor 1000-5-¼
R025	1		RCR07G105JS	Resistor 1M-5-¼
R026	1		RCR07G474JS	Resistor 479K-5-¼
R027	1		RCR07G271JS	Resistor 270-5-¼
R028	1		RCR07G823JS	Resistor 82K-5-¼
R029	1		RCR07G362JS	Resistor 3600-5-¼
R030	1		RCR07G473JS	Resistor 47K-5-¼
R031	1		RCR07G105JS	Resistor 1M-5-¼
R032	1		RCR07G473JS	Resistor 47K-5-¼
R033	1		RCR07G473JS	Resistor 47K-5-¼
R034	1		RCR07G154JS	Resistor 150K-5-¼
R035	1		RCR07G473JS	Resistor 47K-5-¼
R036	1		RCR07G473JS	Resistor 47K-5-¼

PARTS LIST

FIND NO.	QTY REQD	CODE IDENT	PART NUMBER	NOMENCLATURE
R037	1		RCR07G474JS	Resistor 470K-5-¼
R038	1		RCR07G473JS	Resistor 47K-5-¼
R039	1		RCR07G473JS	Resistor 47K-5-¼
R040	1		RCR07G473JS	Resistor 47K-5-¼
R041	1		RCR07G104JS	Resistor 100K-5-¼
R042	1		RCR07G683JS	Resistor 68K-5-¼
R043	1		RCR07G273JS	Resistor 27K-5-¼
R044	1		RCR07G473JS	Resistor 47K-5-¼
R045	1		RNC55H7502FS	Resistor 75K-1-1/10
R046	1		RNC55H4221FS	Resistor 4220-1-1/10
R047	1		RNC55H6491FS	Resistor 6490-1-1/10
R048	1		RCR07GS73JS	Resistor 27K-5-¼
R049	1		RCR07G473JS	Resistor 47K-5-¼
R050	1		RCR07G473JS	Resistor 47K-5-¼
R051	1		RCR07G473JS	Resistor 47K-5-¼
R052	1		RCR07G474JS	Resistor 470K-5-¼
R053	1		RCR07G473JS	Resistor 47K-5-¼
R054	1		RNC55H1582FS	Resistor 15.8K-1-1/10
R055	1		RNC55H2002FS	Resistor 20K-1-1/10
R056	1		RNC55H4642FS	Resistor 46.4K-1-1/10
R057	1		RNC55H1002FS	Resistor 10K-1-1/10
R058	1		RCR07G103JS	Resistor 10-K-5-¼
R059	1		RNC55H8250FS	Resistor 825-1-1/10
R060	1		RNC55H1692FS	Resistor 16.9K-1-1/10
R061	1		RNC55H1332FS	Resistor 13.3K-1-1/10
R062	1		RNC55H2872FS	Resistor 27.7K-1-1/10
R063	1		RCR07G103JS	Resistor 10K-5-¼
R064	1		RCR07G103JS	Resistor 10K-5-¼
R065	1		RCR07G473JS	Resistor 47K-5-¼
R066	1		RNC55H1002FS	Resistor 10L-1-1/10

PARTS LIST

FIND NO.	QTY REQD	CODE IDENT	PART NUMBER	NOMENCLATURE
R067	1		RNC55H1002FS	Resistor 10K-1-1/10
R068	1		RCR07G273JS	Resistor 27K-5-¼
R069	1		RCR07G103JS	Resistor 10K-5-¼
R070	1		RCR20F101JS	Resistor 100-5-½
R071	1		RCR07G103JS	Resistor 10K-5-¼
R072	1		RCR07G474JS	Resistor 470K-5-¼
R073	1		RCR07G153JS	Resistor 15K-5-¼
R074	1		RCR07G473JS	Resistor 47K-5-¼
R075	1		RCR07G103JS	Resistor 20K-5-¼
R076	1		RCR07G274JS	Resistor 270K-5-¼
R077	1		RCR07G103JS	Resistor 10K-5-¼
R078	1		RCR07G392JS	Resistor 3900-5-¼
R079	1		RCR07G273JS	Resistor 27K-5-¼
R080	1		RCR07G103JS	Resistor 10K-5-¼
R081	1		RCR07G433JS	Resistor 43K-5-¼
R082	1		RCR07G103JS	Resistor 10K-5-¼
R083	1		RCR07G474JS	Resistor 470K-5-¼
R084	1		RCR07G273JS	Resistor 27K-5-¼
R085	1		RCR07G102JS	Resistor 1000-5-¼
R086	1		RNC55H1002FS	Resistor 10K-1-1/10
R087	1		RCR07G273JS	Resistor 27K-5-¼
R088	1		RNC55H1002FS	Resistor 10K-1-1/10
R089	1		RCR07G303JS	Resistor 30K-5-¼
R090	1		RCR07G103JS	Resistor 10K-5-¼
R091	1		RCR07G101JS	Resistor 100-5-¼
R092	1		RCR07G102JS	Resistor 1000-5-¼
R093	1		RCR07G244JS	Resistor 240K-5-¼
R094	1		RCR07G104JS	Resistor 100K-5-¼
R095	1		RCR07G683JS	Resistor 68K-5-¼
R096	1		RCR07G273JS	Resistor 27K-5-¼
R097	1		RCR07G183JS	Resistor 18K-5-¼

PARTS LIST

FIND NO.	QTY REQD	CODE IDENT	PART NUMBER	NOMENCLATURE
R098	1		RCR07G473JS	Resistor 47K-5-¼
R099	1		RCR07G473JS	Resistor 47K-5-¼
R100	1		RCR07G272JS	Resistor 2700-5-¼
R101	1		RCR07G221JS	Resistor 220-5-¼
R102	1		RCR07G203JS	Resistor 20K-5-¼
R103	1		RCR07G474JS	Resistor 470K-5-¼
R104	1		RCR07G131JS	Resistor 130-5-¼
R105	1		RCR07G561JS	Resistor 560-5-¼
R106	1		RCR07G203JS	Resistor 20K-5-¼
R107	1		RCR07G474JS	Resistor 470K-5-¼
R108	1		RCR07G131JS	Resistor 130-5-¼
R109	1		RCR07G681JS	Resistor 680-5-¼
R110	1		RCR07G473JS	Resistor 47K-5-¼
R111	1		RCR07G474JS	Resistor 470K-5-¼
R112	1		RCR07G131JS	Resistor 130-5-¼
R113	1		RCR07G431JS	Resistor 430-5-¼
R114	1		RCR07G623JS	Resistor 62K-5-¼
R115	1		RCR07G474JS	Resistor 470K-5-¼
R116	1		RCR07G131JS	Resistor 130-5-¼
R117	1		RCR07G102JS	Resistor 1000-5-¼
R118	1		RCR07G473JS	Resistor 47K-5-¼
R119	1		RCR07G474JS	Resistor 470K-5-¼
R120	1		RCR07G131JS	Resistor 130-5-¼
R121	1		RCR07G473JS	Resistor 47K-5-¼
R122	1		RCR07G103JS	Resistor 10K-5-¼
R123	1		RCR32G271JS	Resistor 270-5-1
R124	1		RCR07G361JS	Resistor 360-5-¼
R125	1		RCR07G273JS	Resistor 27K-5-¼
R126	1		RNC55H1103FS	Resistor 110K-1-1/10
R127	1		RNC55H1002FS	Resistor 10K-1-1/10
R128	1		RCR32G271JS	Resistor 270-5-1
R129	1		RCR07G361JS	Resistor 360-5-¼
R130	1		RCR07G273JS	Resistor 27K-5-¼
R131	1		RNC55H1103FS	Resistor 110K-1-1/10

PARTS LIST

FIND NO.	QTY REQD	CODE IDENT	PART NUMBER	NOMENCLATURE
R132	1		RNC55H1002FS	Resistor 10K-1-1/10
R133	1		RCR32G271JS	Resistor 270-5-1
R134	1		RCR07G361JS	Resistor 360-5-¼
R135	1		RCR07G273JS	Resistor 27K-5-¼
R136	1		RNC55H1103FS	Resistor 110K-1-1/10
R137	1		RNC55H1002FS	Resistor 10K-1-1/10
R141	1		RCR07G682JS	Resistor 6800-5-¼
R142	1		RCR20G561JS	Resistor 560-5-½
R143	1		RCR07G333JS	Resistor 33K-5-¼
R144	1		RCR07G105JS	Resistor 1M-5-¼
R145	1		RCR07G473JS	Resistor 47K-5-¼
R147	1		RCR07G102JS	Resistor 1000-5-¼
R151	1		RJ26FW203	Resistor Var 20K-10-¼
R152	1		RJ26FW202	Resistor, Var 2000-10-¼
R153	1		RJ26FW103	Resistor, Var 10K-10-¼
R154	1		RJ26FW103	Resistor, Var 10K-10-¼
R155	1		RCR05G102JS	Resistor 1000-5-1/8
R157	1		RCR05G104JS	Resistor 100K-5-1/8
U001	1		MC1555U	Integrated Circuit timing circuit
U002	1		LM139J	Microcircuit, Quad Volt Comp.
U003	1		LM139J	Microcircuit Quad Volt Comp
U004	1	01295	LM124J	Microcircuit Quad Op. Ampl.
U005	1	01295	LM124J	Microcircuit Quad Op. Ampl.
U006	1	04713	MC14013BAL	Integrated Circuit Dual D F/F
U007	1	04713	MC14013BAL	Integrated Circuit Dual D F/F
U008	1	04713	MC14011BAL	Integrated Circuit Quad 2-1 Nand Gate
U009	1	04713	MC14025BAL	Integrated Circuit Triple 3-1 Nor Gat
U010	1	04713	MC14002BAL	Integrated Circuit Dual 4-1 Nor Gate
U011	1		MC14049UBAL	Integrated Circuit HEX Inv/Buffer
U012	1	04713	MC3556L	Integrated Circuit Dual 555 Timer
U013	1	01295	LM124J	Microcircuit Quad Op. Ampl.

PARTS LIST

FIND NO.	QTY REQD	CODE IDENT	PART NUMBER	NOMENCLATURE
U014	1		LM139J	Microcircuit Quad Volt, Comp.
U015	1	04713	MC14011BAL	Integrated Circuit Quad 2-1 Nand Gate
U016	1	01295	LM124J	Microcircuit Quad Op. Ampl.
U017	1		LM158J	Microcircuit Dual Op. Ampl.
U018	1	02195	LM124J	Microcircuit Quad Op. Ampl.
U019	1	04713	MC1403U	Integrated Circuit 2.5V Reference

SECTION 10

RELAY ASSEMBLY

A4

10-1 PURPOSE AND GENERAL DESCRIPTION

10-2 The RELAY ASSEMBLY contains two mechanical relays and an input power sensing circuit. This power-sensing circuit senses the input RF level from a transmitter for automatic T/R control. The relays provide routing of the RF in the PA.

10-3 DETAILED DESCRIPTION

10-4 The following paragraphs provide a detailed description of the circuit operation in this module. The description refers to the Relay Assembly schematic in figure 10-1.

10-5 The RF Input sense circuit uses R2 and R3 to sample the RF voltage at the input to the board, J1. This input is connected through semi-rigid co-axial cable to the XMTR port on the front-panel of the Unit.

10-6 The sampled RF is rectified by CR1, and filtered by C1 and R1. The output to J5 is proportional to the RF level at the PA input and is used by the T/R circuitry in the ALC (A2) for automatic T/R control.

10-7 When the amplifier is off or in bypass, K1 and K2 route the signal from the XMTR input to the ANT output of the unit. When the amplifier is operating, K1 routes the input signal from the XMTR input to PA IN (J2). K2 routes PA OUT (J3) to ANT (J4).

10-8 Two relays are used in order to obtain the required isolation between the amplifier input and output to prevent oscillations. The coupling in a two section single relay would not supply enough isolation under cases of mis-match.

10-9 L1, C2, C3, C4 and C5 are filtering elements to prevent the RF from getting onto the 28 volts or relay drive lines. CR2 is a clamping element to reduce relay generated transients.

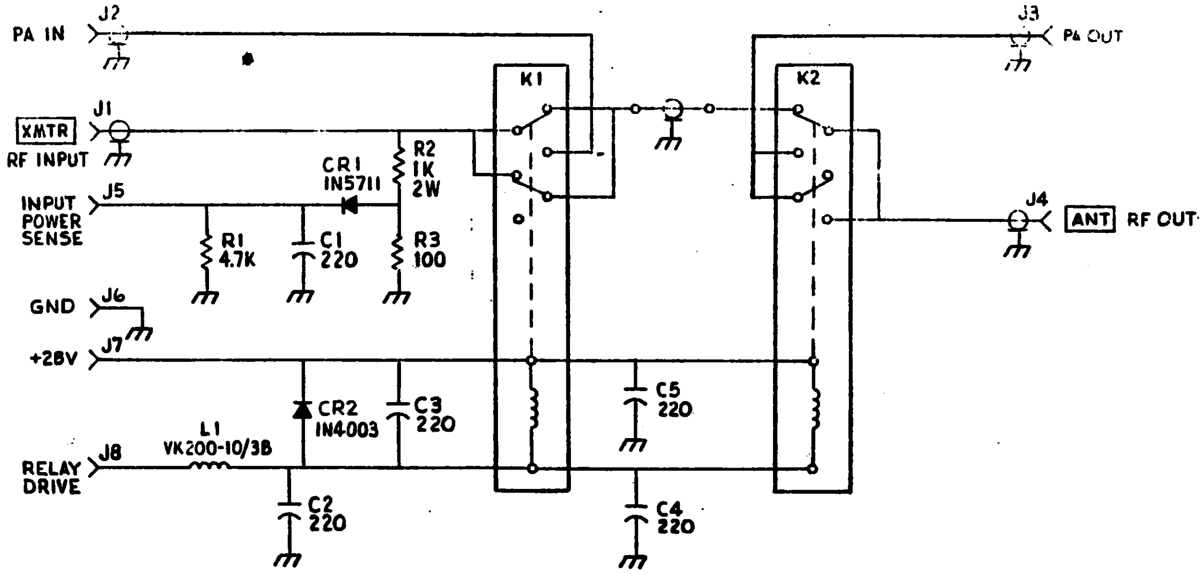


Figure 10-1. RELAY ASSEMBLY (A4) SCHEMATIC

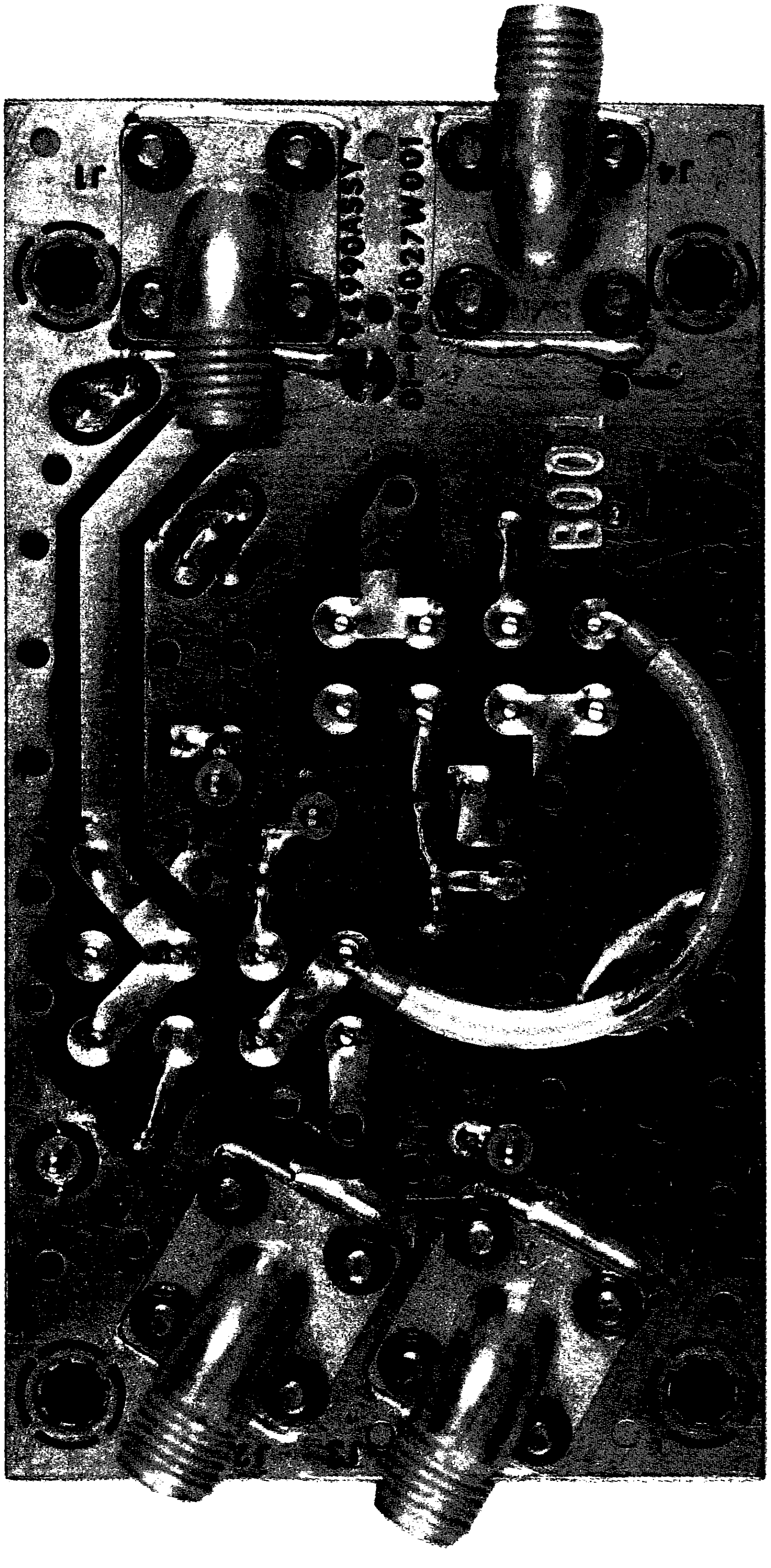


Figure 10-2. RELAY BOARD
(A4) FRONT VIEW

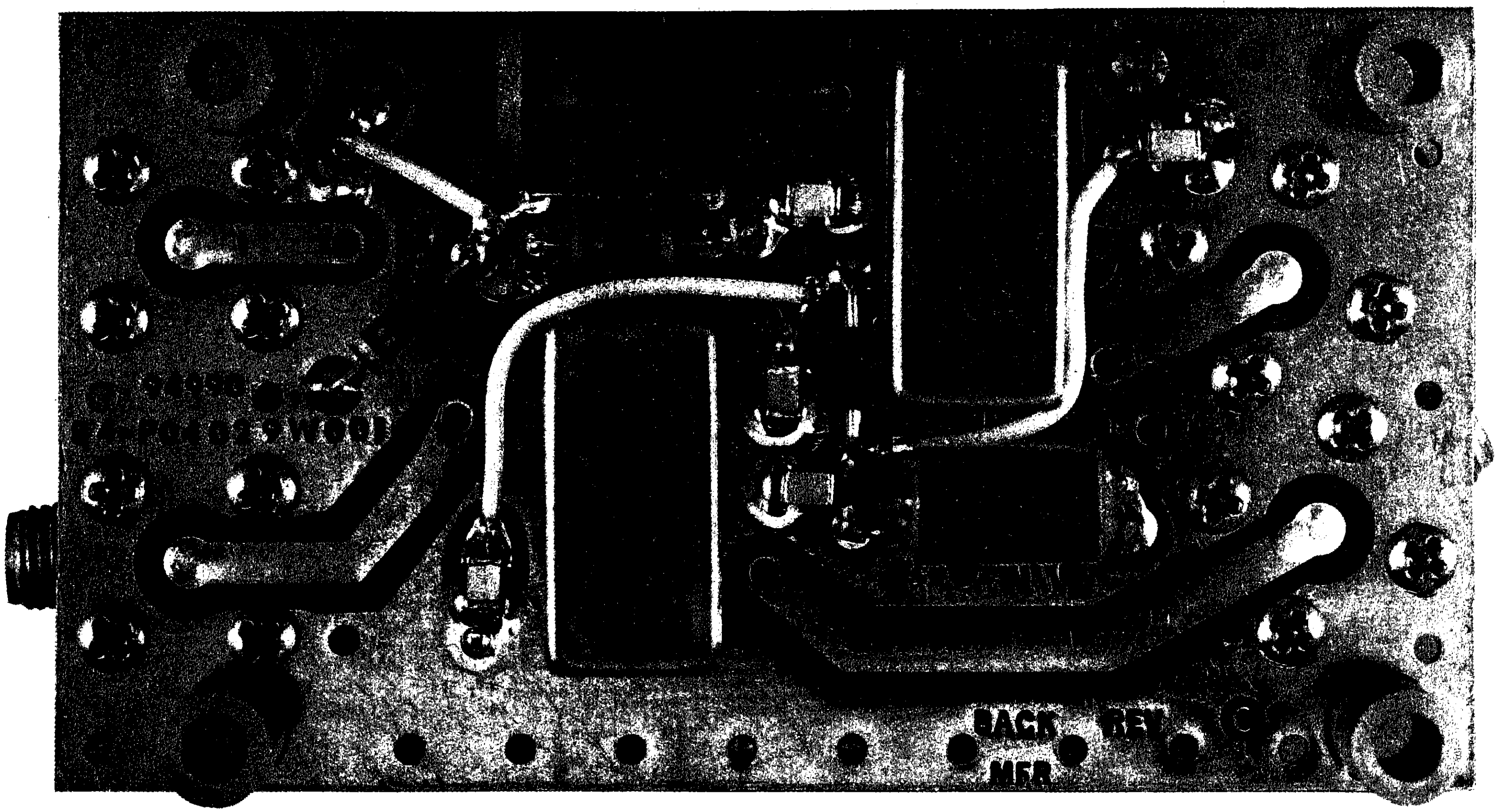


Figure 10-3. RELAY BOARD
(A4) BACK VIEW

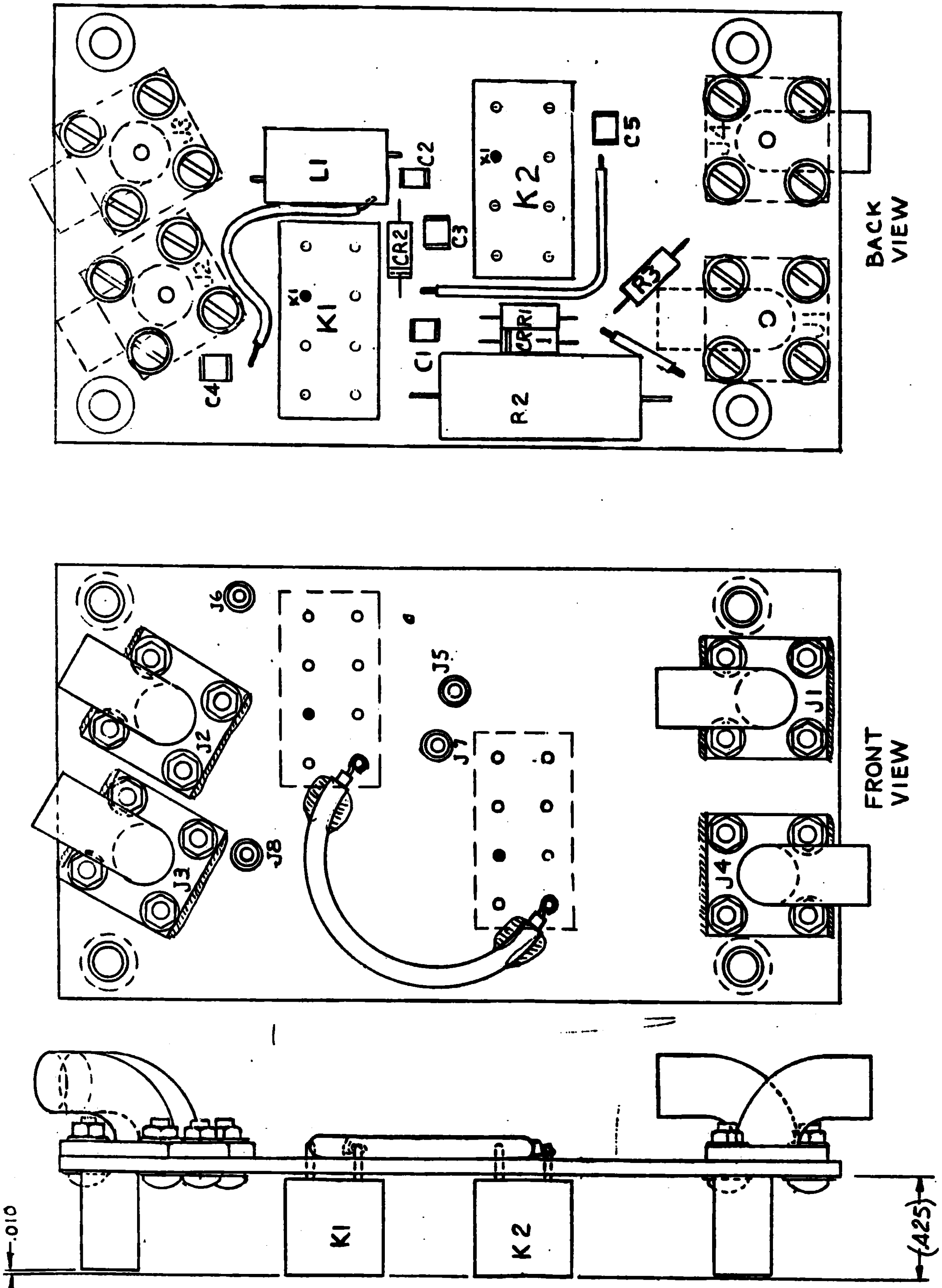

BACK VIEW
FRONT VIEW
L1
K1
K2
C1
C2
C3
C4
C5
CR1
CR2
R2
R3
J1
J2
J3
J4
J5
J6
J7
J8
X1
.010
(.425)

Figure 10-4.

PARTS LIST

ID NO.	QTY REQD	CODE IDENT	PART NUMBER	NOMENCLATURE
001	1	94990	84-P04029W001	Relay Assy A4 PWB
002	4	94990	43-P06332W004	Spacer .415
003	16		MS51957-3	Screw, PH .0860-56x.250
004	16		MS21042L02	Locknut .086-56
008	1	94990	30-P09180W001	Cable, Coax, Semirigid
C001	1	29990	ATC100B221JP200(x)	Capacitor 220PF-5-200
C002	1	29990	ATC100B221JP200(x)	Capacitor 220PF-5-200
C003	1	29990	ATC100B221JP200(x)	Capacitor 220PF-5-200
C004	1	29990	ATC100B221JP200(x)	Capacitor 220PF-5-200
C005	1	29990	ATC100B221JP200(x)	Capacitor 220PF-5-200
CR001	1		JAN1N5711	Diode
CR002	1		IN4003	Diode
J001	1	95077	2960-4019	Connector, RF
J002	1	95077	2960-4019	Connector, RF
J003	1	95077	2960-4019	Connector, RF
J004	1	95077	2960-4019	Connector, RF
J005	1	00779	60599-3	Contact
J006	1	00779	60599-3	Contact
J007	1	00779	60599-3	Contact
J008	1	00779	60599-3	Contact
K001	1		M39016/6-109M	Relay
K002	1		M39016/6-109M	Relay
L001	1		VK200-10/3B	Coil, RF
R001	1		RCR07G472JS	Resistor 4700-5-1/4
R002	1		RCR42G102JS	Resistor 1000-5-2
R003	1		RCR07G101JS	Resistor 100-5-1/4