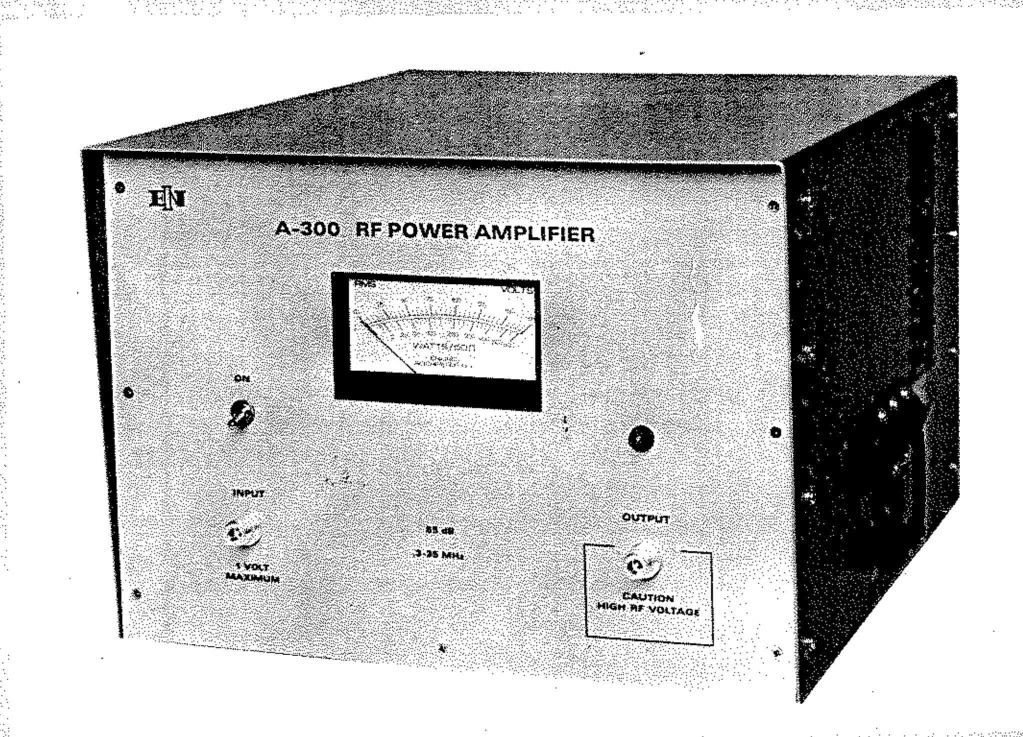
INSTRUCTION MANUAL



MODEL A300
BROADBAND POWER AMPLIFIER

ELECTRONIC NAVIGATION INDUSTRIES Inc.

ROCHESTER, NEW YORK, U. S. A.

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CHAPTER 1
GENERAL INFORMATION

1.1 INTRODUCTION

The ENI Model A300 is an all solid state amplifier which has a flat frequency response from .3 MHz to 35 MHz. It provides 300 watts of linear power with low harmonic and intermodulation distortion. Gain is 55 dB nominal, with a variation of less than ± 1.0 dB over the entire frequency range. Input and output impedance are 50 ohms and the unit may be driven to full power output by most RF synthesizers, signal generators and swept signal sources.

The ENI Model A300 will deliver its rated power output into any load impedance, regardless of match. Built-in protection circuitry will absorb the power reflected from a mismatched load without causing failure or oscillation.

Output RF voltage is displayed on the front panel meter. The Model A300 is packaged for bench mounting and is shipped with rack mounting adapters. Its integral power supply and cooling operate from a 115 or 230 V ac 50/60 Hz main supply.

The Model A300 will raise the power level of signal sources and generators without requiring tuning or band-switching. The Class A linear circuitry will amplify signals of AM, FM, SSB, TV and complex modulations limited only by their peak input and bandwidth, with minimum distortion.

1.2 SPECIFICATIONS

Physical and electrical specifications are listed in Table 1-1.

1.3 INSTRUMENT IDENTIFICATION

Each amplifier is identified by a serial number tag on the back panel of the unit. Both the model number and the serial number should be given in any correspondence with the company.

Table 1-1. Specification

FREQUENCY COVERAGE:	0.3 MHz to 35 MHz
GAIN:	55 dB
GAIN VARIATION:	± 1 dB
MAXIMUM CLASS A LINEAR POWER OUTPUT:	300 watts
HARMONIC DISTORTION:	2nd harmonic more than 35 dB below fundamental at 300 watts output. 3rd harmonic more than 25 dB below fundamental at 250 watts. Lower at reduced power.
TYPICAL 3rd ORDER INTERMODULATION INTERCEPT POINT:	+64 dBm
INPUT/OUTPUT IMPEDANCE:	50 ohms
INPUT VSWR:	Less than 1.5
OUTPUT VSWR:	Less than 2
NOISE FIGURE:	10 dB maximum
STABILITY:	Unconditionally stable; unit will not oscillate for any condition of load and source impedance.
PROTECTION:	Unit will withstand more than 16 dB of overdrive (input signal of 1V rms) for all output load conditions.
OUTPUT METERING:	Average reading voltmeter calibrated in rms volts for a sine wave with an accuracy of ± 3% of full scale (0-175 volts); also calibrated in watts into 50 ohms (0-600 watts).
POWER REQUIREMENTS:	115/230 Vac +6% -12%, 50-60 Hz, 2000 watts
OPERATING TEMPERATURE:	0^o to $+40^oC$
SIZE:	12 1/4 x 17 1/8 x 19 3/4 inches; 31 x 43.5 x 50.2 cm
WEIGHT:	89 pounds; 40.4 kg
CONNECTORS:	Type N

CHAPTER 2
PREPARATION

2.1 INITIAL INSPECTION

2.1.1 Mechanical Check

If damage to the shipping carton is evident, request the carriers agent be present when the instrument is unpacked. Check the equipment for damage and inspect the cabinet and panel surfaces for dents and scratches.

2.1.2 Claim for Damage

If the Model A300 is mechanically damaged or fails to meet specification upon receipt, notify ENI or our representative immediately. Retain the shipping carton and packing material for the carriers inspection as well as for subsequent use in returning the unit if necessary.

2.1.3 Performance Check

The electrical performance of the Model A300 should be verified as soon as possible after receipt. The following is a performance check that is suitable for incoming inspection.

a. Set the amplifier front panel power switch to the ON position and check that the pilot light illuminates and the fan motor is operating normally.

b. Perform RF Output Power Test, Section 5.1.4.

2.2 PREPARATION FOR USE

2.2.1 Power Requirements

The Model A300 requires a 50-60 Hz, single phase, power source capable of supplying 2000 watts. The unit must be adjusted to accomodate the available AC line voltage. This is accomplished by connecting the AC line cord and jumpers to the correct terminals of the terminal strip TB-3, in accordance with Table 2-1.

Terminal strip TB-3 is mounted on the baseplate at the right front side of the Model A300 and is accessable by removing the seven (7) #6-32 screws from the front panel and sliding it straight out.

Disconnect the line cord from the power main when adjusting the operating voltage. Failure to connect jumpers to their proper terminals may result in severe damage to the instrument.

2.2.2 Power Cable Ground Protection

To protect operating personnel, the ENI Model A300 is equipped with a three conductor cable consisting of a black hot line, a white common line, and a green chassis ground. For U.S. delivery, the Model A300 is supplied with a 2 pole three wire grounding, 20 ampere, 125 volt

Table 2-1 Line Voltage Connections

NOMINAL LINE VOLTAGE	LINE HOT (BLACK)	LINE COMMON (WHITE)	JUMPERS		
			YELLOW	WHITE	BLACK
103	4	1	1-2	3-4	9-10
109	6	1	1-2	5-6	9-10
115	8	1	1-2	7-8	9-10
206	4	1	2-3	Remove White & Black Jumpers	
218	6	1	2-5		
230	8	1	2-7		

plug NEMA 5-20P. This plug must be inserted into a properly wired 20 ampere, three wire grounding receptacle NEMA 5-20R.

2.2.3 Cooling

When the A300 is enclosed by an external cabinet, provisions must be made to insure an adequate flow of cooling air to the unit. Ambient temperature of the air must not exceed 40°C.

2.3 RACK MOUNTING

In order to install the Model A300 in a standard 19 inch relay rack, rack mounting brackets must be attached to the cover as follows:

a. Remove all screws, (8 #8-32 and 2 #6-32), located on both sides of the cover and the (10 #4-40) Phillips head screws located on the top of the cover. Carefully lift the cover up.

b. Remove the side handles which are held by six #8-32 screws and hardware per handle.

c. Replace the cover and its hardware with the exception of the four #8-32 screws located at each side of the cover nearest the front panel.

d. Verify left and right rack mounting brackets by holding them next to the screw holes. Mounting bracket overhang should be at the bottom of the unit.

e. Attach mounting brackets to the sides of the unit by inserting the screws removed in step a. through the brackets.

f. Tighten all screws carefully, assuring that the unit is held firmly in place.

g. The six rubber feet on the baseplate may be unscrewed and removed if the minimum vertical usage of the relay rack is necessary.

Note

Due to the weight of the A300 (89 lbs.) it is recommended that the unit be placed on a shelf attached to the inside of the rack.

2.4 PACKAGING FOR RESHIPMENT

Whenever possible, the original shipping carton and packing material should be used for reshipment. If the original packing material is not available, wrap the instrument in heavy paper or plastic. Use a strong shipping container. If a cardboard carton is used, it should be at least 200 lbs. test material. Use shock absorbing material around all sides of the instrument to provide a firm cushion and to prevent movement inside the container. A minimum of two inches should be between the instrument and the container wall on each side. Protect the front panel and meter by means of cardboard spacers inserted between the front panel and the shipping carton. Make sure that the instrument cannot move in the container during shipment. Seal the carton with a good grade of shipping tape and mark the container: FRAGILE ELECTRONIC INSTRUMENT.

CHAPTER 3
OPERATION

3.1 FUNCTIONAL DESCRIPTION

The ENI Model A300 is a linear Class A amplifier capable of increasing the output of any signal generator, frequency synthesizer, sweep generator or laboratory signal source from .3 MHz to 35 MHz.

Less than 200 millivolts of signal is required from the output of the signal source into the 50 ohm input of the amplifier to extract maximum power output. The output power of the A300 is directly proportional to the input signal and therefore, the attenuator of the signal generator will serve as attenuator for the overall output.

The Model A300 is completely protected against damage due to load mismatch provided that the input RF level does not exceed 1 volt rms or 1.4 volts peak. If the attached signal source is capable of generating substantially more than this input voltage, please use caution in adjusting it. The Model A300 will saturate well before the maximum input voltage and there will be no increase in the output power at that point.

The A300 is unconditionally stable. Any combination of input and output impedances can be connected to the amplifier without causing damage or oscillation.

The A300 will deliver its rated power to any load impedance regardless of match. Load mismatch will cause RF power to reflect back to the amplifier. The unit is designed to withstand 100 percent reflected power (a pure reactance, open or short circuit load will cause 100 percent reflected power) continuously without damage.

An output meter is provided to indicate the average output voltage (calibrated in rms) as well as the power output when the unit is connected to a 50 ohm load. Since the meter responds only to average output, the modulation characteristics of the input signal must be taken into account when interpreting the meter readings. For example, the amplifier may be in saturation during the ON portion of a pulse, yet the meter reading will be low due to the low duty cycle of the pulse input.

3.2 CONTROLS, INDICATORS AND CONNECTORS

Front and rear panel devices are described in Table 3-1.

3.3 OPERATING PROCEDURE

Refer to the following procedure as a guide to operating the Model A300.

a. The input and output are connected via the front panel type N connectors to the signal source and load respectively.

b. The input signal should be increased gradually while observing the output voltage on the output RF voltmeter.

c. When the Model A300 is connected to a 50 ohm load, the CW power output of the unit may be read directly from the meter scale.

d. When the amplifier is connected to an arbitrary or unknown load impedance, the following procedure will insure a low distortion power output.

   1. Disconnect the output load cable from the output type N connector of the Model A300.
   2. If the CW output voltage is less than 175 volts rms, the unit is operating at low distortion regardless of the load impedance.
   3. Reconnect the output of the amplifier to the load.

e. If the output of the amplifier is monitored by a high frequency oscilloscope or spectrum analyzer, the input signal may be increased until the point of maximum undistorted power output is observed.

3.4 PRECAUTIONS

a. The input and output of the Model A300 should not be connected together. This will cause oscillation and may damage the input preamplifier.

b. The Model A300 should not remain connected to an antenna when the unit is not in use. If thunderstorms are likely, it would be prudent to earth ground the unit's case.

c. When the input signal voltage of the signal source is unknown, insert an attenuator between it and the Model A300 input.

Table 3-1. Front and Rear Panel Devices

DEVICE	FUNCTION
Power Switch	Throwing toggle to "on" position connects fan and power supply to main power source.
Meter	Indicates output voltage and also power for a 50 ohm load. The meter circuit responds to the average RF voltage and is calibrated in rms volts for a sine wave. The voltage pick-off is mounted directly behind the front panel at the output connector.
Input Connector	Type N for connection of the driving generator. Input impedance is 50 ohms. No more than 0.2 volts is required to obtain saturated output. Up to 1.4 volts peak can be supplied without causing damage; however, no additional power output can be expected.
Output Connector	Type N for connection of amplifier output to load.
Fuse	Holder required 3AG size, slow-blow type fuse: 25A for 115 Vac; 15A for 230 Vac.
Line Cord	Three prong type plug with safety ground pin connected to cabinet. For U.S. delivery the Model A300 is supplied with a 2 pole, 3 wire grounding, 20 ampere, 125 volt plug NEMA 5-20P. This plug must be inserted into a properly wired 20 ampere, 3 wire grounding receptacle NEMA 5-20R.

CHAPTER 4
PRINCIPLES OF OPERATION

4.1 GENERAL

The Model A300 achieves its high level of power output by combining the power outputs of a number of individual transistor amplifiers. The hybrid combining technique permits each amplifier to operate independently of all the others and to supply its power output contribution without regard to the other amplifier stages. This isolation is afforded by ferrite loaded transformer hybrids connected at the input and output of each transistor pair.

Each amplifier module is designed to have an input and output impedance of 50 ohms. Therefore, the individual modules can be disconnected and tested independently.

Highly linear Class A transistors are used throughout the amplifier. Their linearity is augmented by negative feedback networks connected to each stage. The high power output transistors have nichrome resistors deposited at their emitter terminals to increase linearity and reliability.

The amplifier is powered by a low noise DC regulator of dissipative design. Over-temperature protection is built into the power supply and cooling fan.

4.2 BLOCK DIAGRAM DESCRIPTION

A block diagram of the entire Model A300 is shown in figure 4-1.

Input signal from the front panel type N connector is fed to the driver amplifier module (A300-4382). The driver has two equal amplitude and phase outputs. Each driver channel has an overall gain of 38 dB and a minimum power output of 13 watts. The driver outputs are fed via coaxial cables to the two four-way splitter/combiner modules (A300-4383). The splitter section of each module has four equal amplitude and phase outputs which are fed to the power amplifier modules (A300-4381).

Each power amplifier has a gain of 14 dB and is capable of producing more than 40 watts of power at its output. These outputs are summed and isolated from each other in the combiner sections of the splitter/combiner modules. The outputs of the combiner sections of these modules (A300-4383) are summed in the output combiner (A300-4384). RF output is fed to the output type N connector and to the RF voltmeter module (A300-4386). The RF voltmeter module provides a DC signal to the front panel meter, proportional to the output level. The power distribution (A300-2381) provides cooling and DC power to the entire unit. The nine regulated power supplies are each capable of supplying 27.1 volts at a current of 7 amperes.

4.2.1 Driver Amplifier Module (A48A) A300-4382

Input RF signal is fed through P1 to the base of Q1, amplified and fed to the base of Q2 through matching transformer T1. From the collector of Q2, the signal is fed through matching transformer T2 and split by transformer T3 to two identical power amplifier channels. The top channel signal is fed to the base of Q3, amplified and impedance matched in transformer T5. A phase reversing hybrid T7 then feeds the signal to the bases of Q5 and Q6 for the final stage of amplification. Reversing hybrid transformer T9 combines the power outputs of Q5 and Q6 and couples even order harmonics to resistor R57. Transformer T11 matches the output impedance to 50 ohms at P2.

4.2.2 Power Amplifier Module (A40A) A300-4381

The input signal is fed through J4, matched, split and phase reversed by transformers T1 and T2. Two equal amplitude, phase reversed signals are fed to the bases of Q1 and Q2 through matching transformers T3 and T4. The power outputs of Q1 and Q2 are matched through transformers T5 and T7 and combined in phase reversing transformer T8. Transformer T9 matches the output impedance to 50 ohms at connector J12. Transformer T6 is an RF choke which isolates the collectors of Q1 and Q2 from the power supply.

4.2.3 Bias Regulator Module (A49) A300-4387

The bias regulator module (A49) consists of an integrated circuit voltage regulator A49IC1 feeding buffer transistor A49Q1. The voltage regulated output of A49IC1 is adjusted by potentiometer A49R3. The DC output is fed to the base of transistor A49Q1 which is connected as an emitter follower. A49Q1 supplies the base current for RF output transistors A40AQ1 and A40AQ2.

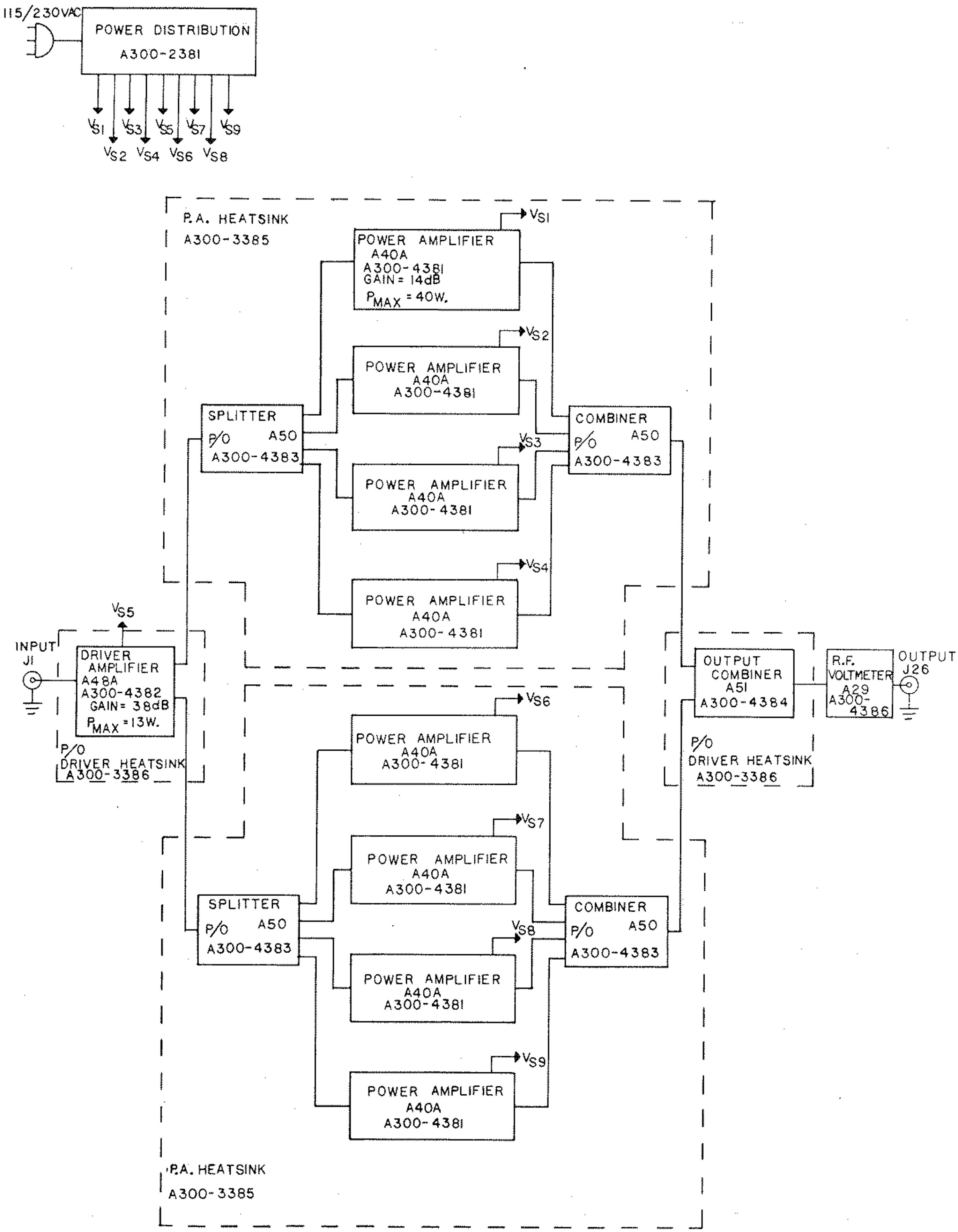


Figure 4-1. Block Diagram

4.2.4 Four Way Splitter/Combiner Module (A50) A300-4383

The splitter input signal is injected at connector J2. Transformer T1 impedance matches the signal to hybrid splitting transformers T2, T3, and T4 where it is divided into four equal phase and amplitude signals and fed to connectors P4, P5, P6 and P7.

RF power is injected into the combiner at connectors P12, P13, P14 and P15 and is summed by hybrid transformers T5, T6 and T7. Capacitor C2 compensates for the winding reactance of transformer T7. The RF power is matched to 50 ohms at the output connector J20 by transformer T8.

4.2.5 Two Way Output Combiner Module (A51) A300-4384

RF signals injected at connectors J22 and J23 are summed by transformer T1. Transformer T2 matches the output impedance to 50 ohms at connector J24.

4.2.6 RF Voltmeter Module (A29M) A300-4386

Resistors R1, R2, R3 and R4 make up a high impedance voltage divider which is connected to the RF output voltage at the A300 output connector J26 through capacitor C2. Capacitor C2 is provided so that the A300 may be connected to a load on which there is a DC potential. A fast switching hot carrier diode CR1 rectifies the RF voltage from the divider. A wire gimmick (capacitor C3) compensates for the high frequency roll off of the diode CR1. Resistors R4, R5, R6 and capacitor C1 filter the rectified RF and convert it to DC which is fed to the front panel meter.

4.2.7 Power Distribution A300-2381

The AC power is distributed from terminal block TB3 to the power transformer T1. The yellow, white and black jumpers on TB3 allow selection of line voltages for the primary of transformer T1 (see power connections section 2.2.1). The secondary of T1 supplies voltage to five full wave bridge rectifiers CR1, CR2, CR3, and CR4 on the rear panel assembly (A300-3384) and CR1 on the baseplate assembly (A300-3381). The output of each rectifier is connected to capacitor C1, C2, C3 and C4 on the rear panel assembly (A300-3384) and C1 on the baseplate assembly (A300-3381), respectively. The outputs of CR1, CR2, CR3, and CR4 from the rear panel assembly are fed to the collectors of Q1, Q2, Q3, Q4 and Q5 located on the power amplifier power supply assemblies (A300-3387). The output of CR1 from the baseplate assembly is fed to the collectors of Q1, Q2 and Q3 located on the driver power supply assembly. These power supply assemblies form a total of nine (9) series pass regulators of the dissipative type and are connected to nine (9) separate integrated circuit voltage regulators, IC1 through IC9, located on the power supply regulator board (A53A) A300-4385. The voltage output of each supply is adjusted by potentiometer A26R31 through A26R39. Each of the nine power supplies has its own short circuit protection adjusted by potentiometer A26R11 through A26R19 which are factory set.

CHAPTER 5
PERFORMANCE TEST PROCEDURES

5.1 PERFORMANCE TESTS

5.1.1 General

There are three tests required to check the operation and performance of the Model A300. These tests are as follows: the gain and gain variation test, the RF output power test and the RF output distortion test.

5.1.2 Test Equipment Required

The following test equipment is required for accomplishing the Model A300 performance tests. Equivalent substitutes for recommended models may be used.

a. Oscilloscope - Telequipment Model S54A
- or Telequipment Model D67
- or Tektronix Model D10 with 5A23N and 5A24N plug-in units.

b. RF Generator/Sweeper - HP-8601A

c. 50 ohm Detector - HP 8471A
- or Wavetek D151

d. Attenuator, 30 dB, 500 watts - Bird 8325

e. Attenuator, 30 dB, 200 watts - Bird 8322

f. Attenuator, 10 dB, 20 watts - Narda 766-10

g. Calorimetric Power Meter - HP 434A

h. Spectrum Analyzer - HP 140T Display Unit
- HP 8554L Spectrum Analyzer-RF section
- HP 8552A Spectrum Analyzer-IF section

5.1.3 Gain and Gain Variation Test

The purpose of this test is to verify the gain and gain flatness versus frequency of the Model A300.

5.1.3.1 CALIBRATION OF SET-UP

a. Set-up the test equipment as shown in figure 5-1.

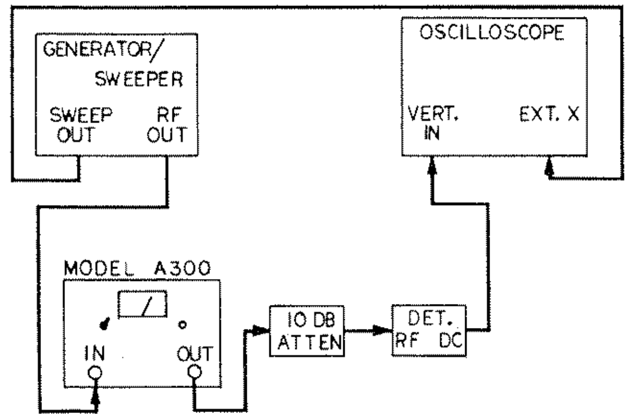


Figure 5-1. Gain and Gain Variation Test Set-Up

b. Set Oscilloscope to DC, Time/CM to Ext. X, and vertical gain to 10mV/CM.

c. Set the RF Generator/Sweeper to video sweep and frequency to 35 MHz.

d. Disconnect the Model A300 from the set-up and connect the Generator/Sweeper RF output directly to the 10 dB attenuator.

e. Adjust the output level of the Generator/Sweeper for full vertical deflection on the oscilloscope face.

f. Calibrate the scope face to show 2 dB in 1 dB steps by attenuating the Generator/Sweeper in 1 dB steps and marking the traces with a grease pencil.

g. Return Generator/Sweeper output level to full deflection. Rotate the step attenuator on the Generator/Sweeper (CCW) so that the output is reduced by 50 dB. Reduce the output an additional 5 dB with the vernier control.

h. Reconnect Model A300 into the test set-up of Figure 5-1.

5.1.3.2 MEASUREMENT PROCEDURE

a. Turn on Model A300 power switch.

b. Observe the gain versus frequency sweep on the oscilloscope.

c. The average gain should be 55 dB (within 1 dB).

d. The gain variation should be within the 2 dB markings as shown on the oscilloscope face.

5.1.4 RF Output Power Test

The purpose of the RF power output test is to verify that the Model A300 will deliver more than 300 watts of RF power over the frequency range of 0.3 MHz to 35 MHz.

5.1.4.1 MEASUREMENT PROCEDURE

a. Set-up the test equipment as shown in figure 5-2.

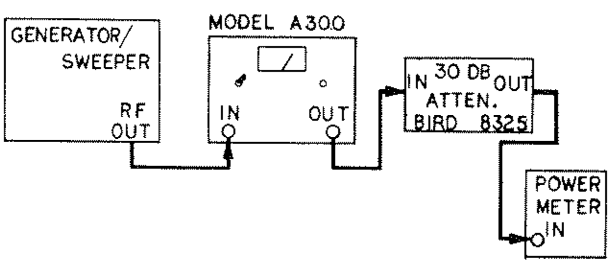


Figure 5-2. RF Output Power Test Set-Up

b. Set the calorimetric power meter to the 1.0 watt range. With the 30 dB series attenuator, this corresponds to a full scale deflection of 1000 watts.

c. Set the Generator/Sweeper to CW, output level to +10 dBm and frequency to 35 MHz.

d. Slowly decrease frequency while observing the power meter. Note that at every frequency down to 0.3 MHz, the power output is in excess of 300 watts.

5.1.5 RF Output Distortion Test

The purpose of this test is to verify that the harmonic distortion of the Model A300 and hence its linearity is within specified limits.

5.1.5.1 MEASUREMENT PROCEDURE

a. Set-up the test equipment as shown in figure 5-3.

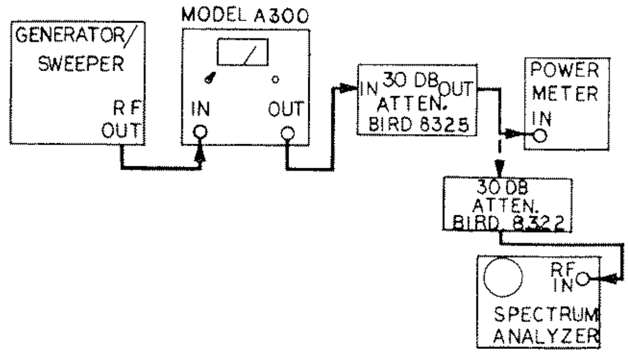


Figure 5-3. RF Output Distortion Test Set-Up

b. Set the calorimetric power meter to .30 watt range. With the 30 dB series attenuator, this corresponds to a full scale deflection of 300 watts.

c. Set the Generator/Sweeper to CW and frequency to 10 MHz.

d. Adjust the Generator/Sweeper output level so that the output power indicated on the calorimetric power meter is 250 watts.

e. Disconnect the cable from the power meter and connect it to the Spectrum Analyzer through a 30 dB attenuator.

f. Observe that the 3rd harmonic is at least 25 dB below the fundamental and the 2nd harmonic is at least 35 dB below fundamental signal.

g. Repeat steps a. through f. with the generator frequency set at 0.3 MHz, 1 MHz, 5 MHz, 20 MHz, and 35 MHz in succession.

CHAPTER 6
TROUBLE SHOOTING AND REPAIR

6.1 TROUBLESHOOTING

The first step in isolating a malfunction is to review the conditions under which the symptoms were observed and check that it was not caused by the external cabling or associated test equipment. Before proceeding to the detailed test procedure, a complete visual inspection of the A300 should be accomplished. Check for burnt or discolored components and broken wires and note any details which might localize the malfunction.

Commonly found symptoms together with their probable cause and troubleshooting recommendations are listed in the Troubleshooting Guide, Table 6-1.

Table 6-1. Troubleshooting Guide

SYMPTOM	PROBABLE CAUSE	RECOMMENDATIONS
Power lamp does not light	Burned out bulb	Check for 27.1 volts across bulb.
	Defective power supply	Perform test in section 6.3.2.
	Thermal switch open	If TS1 contacts do not close after unit has cooled, replace thermal switch.
	Defective power switch	Replace switch (S1).
	Blown fuse	Replace fuse per table 3-1.
Power Lamp dim	Power supply out of adjustment	Perform power supply adjustment section 6.3.2.
	TB3 wired incorrectly	Check section 2.2.1.
Blown fuse	Defective power supply	Perform test in section 6.3.2.
	Wrong fuse	Check per table 3-1.
	Defective line cord or AC wiring	Visually inspect for signs of insulation breakdown.
No RF output or gain	Broken input or output type N connector	Visually inspect connectors for broken pins.
	Defective input or output internal cables	Visually inspect cables at input and output connectors.

Table 6-1. Troubleshooting Guide (continued)

SYMPTOM	PROBABLE CAUSE	RECOMMENDATION
Low RF Output or Gain	Defective input cables	Visually inspect cables.
	Faulty Power Supply Adjustment	Perform power supply adjustment section 6.3.2.
	Defective RF Amplifier Module	Perform procedure for locating faulty RF module, section 6.2.
Excessive Distortion	Defective Power Amplifier Module	Perform procedure for locating faulty RF module, section 6.2.
Amplifier Overheating	Defective Fan	Check that fan is operating properly.
	Ambient air is above specifications	Measure the ambient temperature.
	Defective Power Supply	Perform test in section 6.3.2.
Incorrect Front Panel Meter Indication	Improper Calibration or defective RF voltmeter board (A29M)	Perform RF voltmeter adjustment, section 6.2.3.
	Defective Meter	Replace meter
Meter reads up scale with input and output cables removed	Sticking meter movement	Replace meter
	Unit oscillating because of loose or defective internal coax cable connections	Tighten all RF connectors
Excessive ripple on gain versus frequency sweep of amplifier	Ripple on power supply	Perform DC power supply test, section 6.3.2.

6.2 LOCATING FAULTY RF MODULE

6.2.1 General

The input and output impedance of each of the RF modules in the Model A300 is 50 ohms. Therefore, they can be disconnected from each other at any point and tested independently. The following sections provide a method of locating a faulty RF module. Figures 6-2 through 6-4 show the location of heatsink assemblies, modules and major components.

6.2.2 Isolating Amplifier Problem

a. Set-up the test equipment as shown in figure 5-2 for RF power output test.

b. Set the RF generator to CW, the frequency to 10 MHz and output level to +2 dBm. If the Model A300 output power is less than 300 watts, as indicated on the calorimetric power meter, a faulty RF module may exist.

c. With an output of 300 watts or less, disconnect the coaxial cable from J12 of the power amplifier module (A300-4381) and observe the output power of the A300 as indicated on the calorimetric power meter. The power will drop 24% (± 4%) for a properly functioning power amplifier. Reconnect the coax cable to J12 and remove the coax cable from J13. Observe the power drop. Repeat the identical procedure for J14, J15, J16, J17, J18 and J19.

If the power output drops an equal amount (within 4%) as each cable is removed, the fault is in either the two-way output combiner (A300-4384) or the driver amplifier section (A300-4382). Perform tests in section 6.2.2.1 and 6.2.2.3.

If the output power does not drop or drops less than normal, as each of the cables is removed, the fault is in the power amplifier associated with that cable. Perform tests in section 6.2.2.2.

6.2.2.1 TWO-WAY OUTPUT COMBINER TEST (A51) A300-4383

a. Set the Generator/Sweeper to CW, frequency to 10 MHz, output level to -10 dBm and connect it to the A300 input. This level should correspond to an RF output of approximately 40 watts from the A300. Connect a 50 ohm, 500 watt load (Bird 8325) to the output of the A300. Connect the calorimetric power meter in series with a 30 dB, 200 watt attenuator (Bird 8322). Set the power meter range to .1 watts which corresponds to a full scale deflection of 100 watts. Successively, connect each RF heatsink assembly output (A50P22 and A50P23) to the attenuator and record its power output.

b. Using the set-up in Figure 5-2, measure and record the output power of the A300.

c. The sum of the powers from step (a.) should be within 5 percent of the total output power recorded in step (b.). If they are not, the two-way output combiner (A300-4384) is faulty.

6.2.2.2 HEATSINK ASSEMBLY TEST (A300-3385)

Two tests are required to test a heatsink assembly. They are a bias voltage check and RF power test. In order to perform these tests the following test equipment is required. Equivalent substitutes may be used for the recommended models.

1. DVM - Fluke 8000A
   - or Fluke 8100A
   - or Weston 1241
2. Generator/Sweeper HP8601A
3. Calorimetric Power Meter - HP434A
4. Attenuator - 30 dB, 200 watts - Bird 8322
5. RF Power Amplifier - ENI 310L
6. Power Supply, Lambda LK-361-FM
7. Cooling fan - Rotron Type 113

6.2.2.2.1 Bias Voltage Check

a. Adjust the power supply to 27.1 volts.

b. Connect the power supply minus (-) lead to the heatsink. Group the red wires from the power amplifier modules together and connect them to the positive (+) lead of the supply.

c. Position the cooling fan so that the cooling air is directed at the heatsink assembly.

d. Verify that the emitter voltage of each power amplifier transistor is +3.3 VDC, ± .15 VDC.

e. If all voltages are within tolerance proceed to the RF power test.

6.2.2.2.2 RF Power Test

a. Set-up the test equipment as shown in figure 6-1 with the 310L amplifier connected to the splitter input J2 or J3 (right or left hand RF heatsink assembly).

b. Set the Generator/Sweeper to CW, frequency to 10 MHz and the output level to -20 dBm.

c. Set the calorimetric power meter to the .1 watt scale. With the 30 dB attenuator, full scale deflection on the power meter is equivalent to 100 watts.

d. With 30 dB attenuator (Bird 8322) connected to either J20 or J21 slowly increase the output level while observing the power meter.

e. Set the input level so that the power meter indicates 50 watts of output.

f. Connect the outputs (J12-J15 or J16-J19) of each power amplifier module (A300-4381) to the power meter in succession and record the individual output powers. They should be within 5 percent of 12.5 watts.

g. If the output power of a module is less than the 11.8 watts as determined in step f., then the module is faulty.

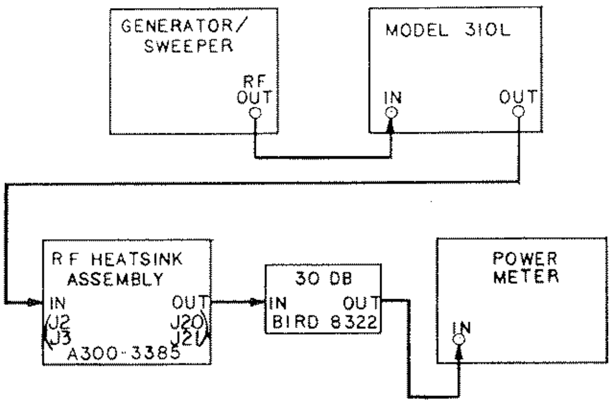


Figure 6-1. RF Heatsink Assembly Test Set Up

6.2.2.3 DRIVER AMPLIFIER MODULE (A48A) A300-4382

If the test in section 6.2.2.2 shows that the RF heatsink assemblies (A300-3385) are not faulty and the two-way output combiner test in section 6.2.2.1 shows that the output combiner is not faulty, then the driver amplifier module (A300-4382) is suspect. A check of the power supply per section 6.3.2 should be performed to conclude positively that the driver amplifier module is faulty.

6.2.3 RF Voltmeter (A29M) A300-4386

The Model A300 output meter should be accurate to within ± 20 watts of the actual output power. If the meter is out of calibration, the following alignment procedure should be used:

6.2.3.1 ALIGNMENT PROCEDURE

a. Set-up the test equipment as shown in Figure 5-2.

b. Set the Generator/Sweeper to CW, and the frequency to .3 MHz. Adjust the output level so that 300 watts is indicated on the calorimetric power meter.

c. Adjust potentiometer A29MR6, located on the RF voltmeter module so that the front panel meter indicates 300 watts.

d. Set the Generator/Sweeper to 35 MHz and adjust the output level so that 300 watts is indicated on the calorimetric power meter. Adjust the wire gimmick (capacitor C3) around resistors A29MR2 and A29MR3 until the front panel meter indicates 300 watts.

6.3 DC POWER SUPPLY

6.3.1 General

The following test and adjustment procedure should be performed after the replacement of the power supply assembly consisting of regulator board (A300-4385) and power amplifier power supply (A300-3387) or driver power supply (A300-3388), or if the power supply voltage is out of adjustment.

The power supply regulator board (A53A) is divided into nine separate voltage regulators. The individual controls, test points, voltages and destinations are shown in table 6-2.

Table 6-2 Regulator Connections

CONTROL	VOLTAGE TEST POINTS	VOLTAGE	DESTINATION
A53AR31	TB1 pin 1	↑	PA 1
A53AR32	TB1 pin 2		PA 2
A53AR33	TB1 pin 3		PA 3
A53AR34	TB1 pin 4		PA 4
A53AR35	A53A TB1 all pins	27.1	Driver, RF Voltmeter, DS1
A53AR36	TB2 pin 1		PA 1
A53AR37	TB2 pin 2		PA 2
A53AR38	TB2 pin 3		PA 3
A53AR39	TB2 pin 4	↓	PA 4

6.3.2 Test Procedure

a. To test the power supply, the following equipment is required. Equivalent substitutes may be used for the recommended models.

1. Digital Voltmeter - Fluke 8000A
   - or Fluke 8100A
   - or Weston 1241

2. Oscilloscope - Telequipment S54D
   - or Tektronix 545.

b. Disconnect all external cables from the Model A300.

c. Connect the minus (-) DVM lead to the chassis and the positive (+) lead to the terminal block (A53ATB1) on the power supply regulator. The DVM should indicate 27.1 volts DC. Adjust A53AR35 until voltage is within this range.

d. Connect the oscilloscope to the terminal block. The ripple on the supply should be less than 25 millivolts.

e. Repeat procedure for TB1 and TB2 all pins and adjust supplies per Table 6-2.

6.4 DISASSEMBLY PROCEDURES

6.4.1 General

The following disassembly procedures describe the recommended method of removing assemblies and printed circuit modules for the purpose of test, repair and/or replacement. Careful handling should be used to avoid damaging the boards.

6.4.2 Tools Required

The Model A300 is assembled with standard hardware. Screw sizes range from #2-56 to #8-32 and are of the Phillips or slotted types. Standard tools are required for their removal.

6.4.3 Removal of Cover

Remove all screws, (16 #8-32 and 4 #6-32), located on both sides of the cover and the 10 #4-40 Phillips head screws located on top of the cover. Carefully lift the cover up. To replace the cover, simply reverse the procedure. When replacing the cover, care should be taken that the cover does not come into contact with the internal cabling.

6.4.4 Driver Amplifier Heatsink Assembly A300-3386

a. Remove cover support brackets by removing five #6-32 screws per bracket.

b. Remove the six #4-40 screws holding the module to the power amplifier heatsink assemblies.

c. Remove the input cable from J1A.

d. Remove the two output cables from J2 and J3.

e. Remove the +27.1VDC input wire (red) from A53ATB1.

f. Remove the two input cables and one output cable to the output combiner from A51 J22, A51 J23 and A51 J24.

g. Carefully lift up and remove the driver amplifier heatsink assembly.

6.4.5 Power Supply Regulator Board (A53A) A300-4385

a. Remove cover support brackets by removing five #6-32 screws per bracket.

b. Remove four #4-40 screws holding the board to the power amplifier heatsink assembly.

c. Remove the three red wires from A53A TB-1-1, -2 and -3.

d. Unsolder all wires from the underside of the board.

6.4.6 Power Amplifier Heatsink Assemblies A300-3385

a. To remove either of the heatsink assemblies (A300-3385) it is necessary to remove the driver amplifier heatsink assembly (A300-3386) and the power supply regulator board (A300-4385) per sections 6.4.4 and 6.4.5.

b. Remove coaxial cables from (A300-4383), A50 J2, J3, J20 and J21.

c. Remove the red leads from the terminal blocks TB1 and TB2, located on the baseplate adjacent to the heatsinks.

d. Remove the five # 8-32 screws from the baseplate of each heatsink assembly.

6.4.7 Power Amplifier Power Supply A300-3387

a. Remove driver amplifier heatsink assembly (A300-3386) and power supply regulator board (A300-4385) per sections 6.4.4 and 6.4.5.

b. Unsolder four red wires from turret terminals of the power amplifier series regulator (A300-4389).

c. Remove two # 6-32 screws holding the assembly to the baseplate.

6.4.8 Driver Amplifier Power Supply A300-3388

a. Remove driver amplifier heatsink assembly (A300-3386) and power supply regulator board (A300-4385) per sections 6.4.4 and 6.4.5.

b. Unsolder red wire from turret terminal of driver series regulator (A300-4388).

c. Remove two # 6-32 screws holding heatsink assembly to the baseplate.

6.4.9 Four-Way Splitter/Combiner Module (A50) A300-4383

a. Disconnect all the input and output coaxial cables from the assembly and associated power amplifier modules.

b. Remove the two # 4-40 screws which hold the board to the heatsink.

6.4.10 Power Amplifier Module (A40A) A300-4381

a. Remove the heatsink assembly (A300-3385) (see section 6.4.6.).

b. Remove the four-way splitter/combiner (A300-4383) (see section 6.4.9.).

c. Remove the four # 4-40 acorn nuts which hold the module to the heatsink.

d. Remove four # 4-40 screws which hold the transistors to the heatsink.

e. Carefully lift the board from the heatsink.

f. During assembly, care must be taken to insure proper alignment of the transistors and that all wires are properly dressed.

6.4.11 Two Way Output Combiner (A51) A300-4383

a. Remove driver amplifier heatsink assembly per section 6.4.4.

b. Remove the three # 4-40 screws which hold the board to the heatsink assembly.

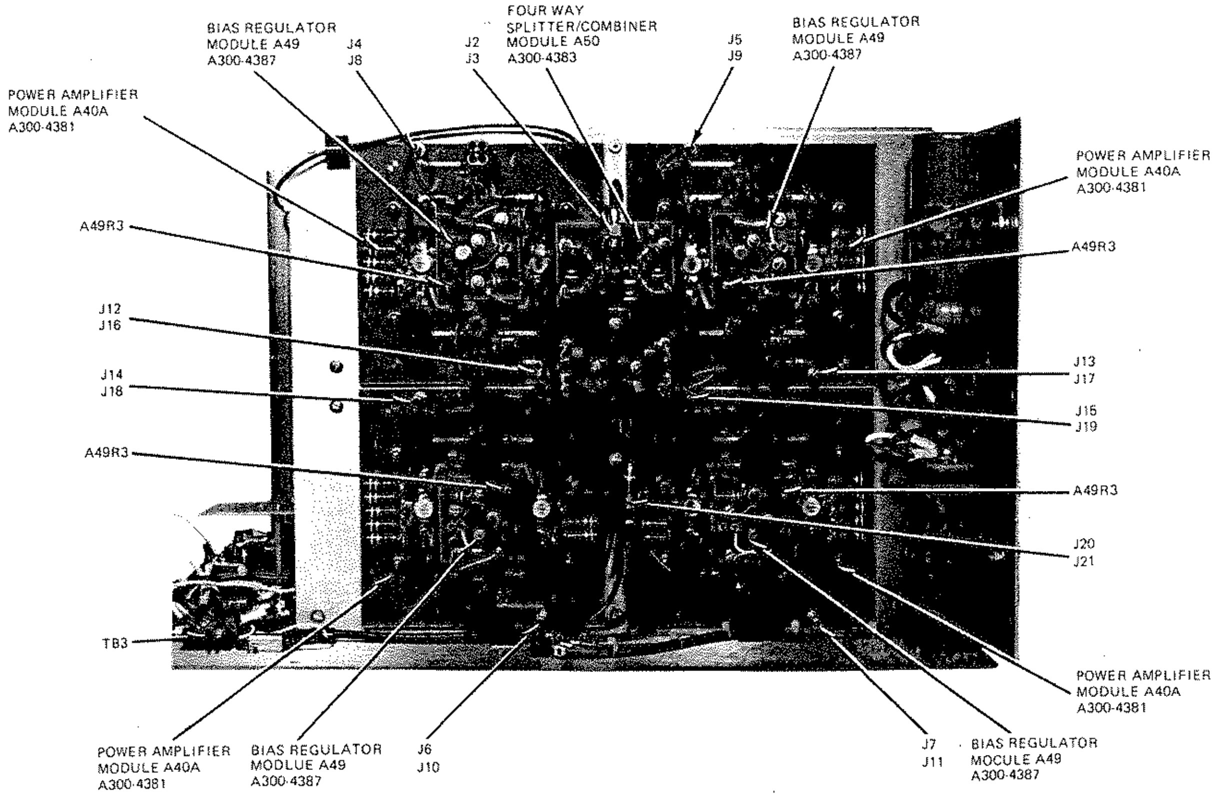


Figure 6-2. Side View, Component Location

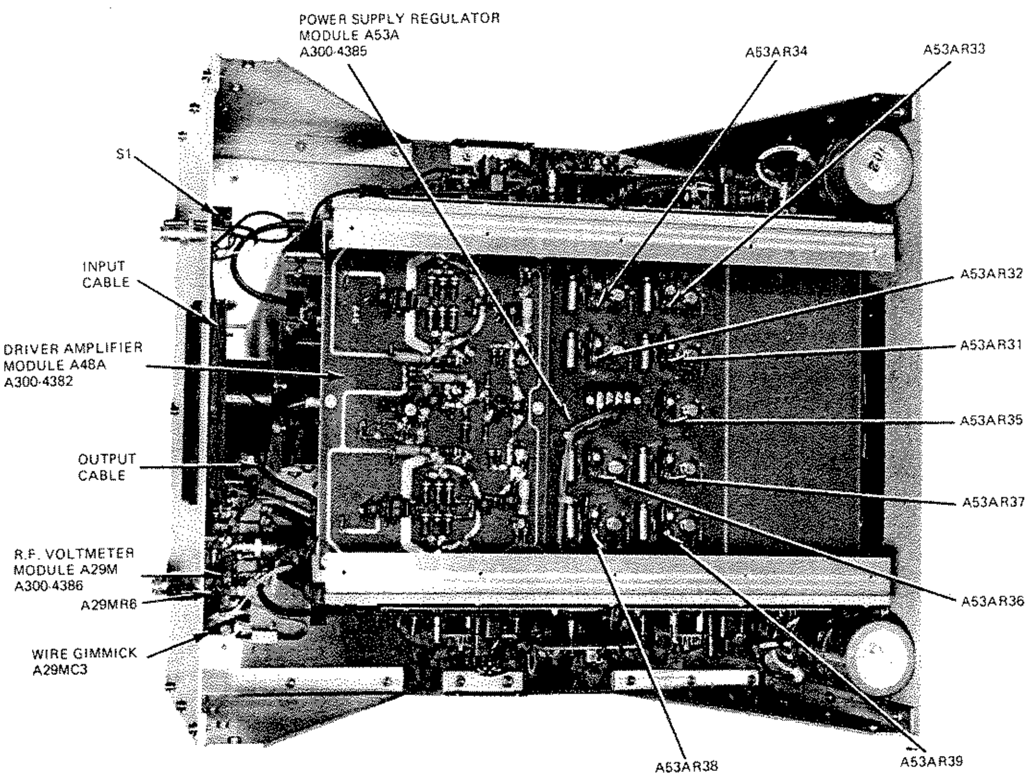


Figure 6-3. Top View, Component Location

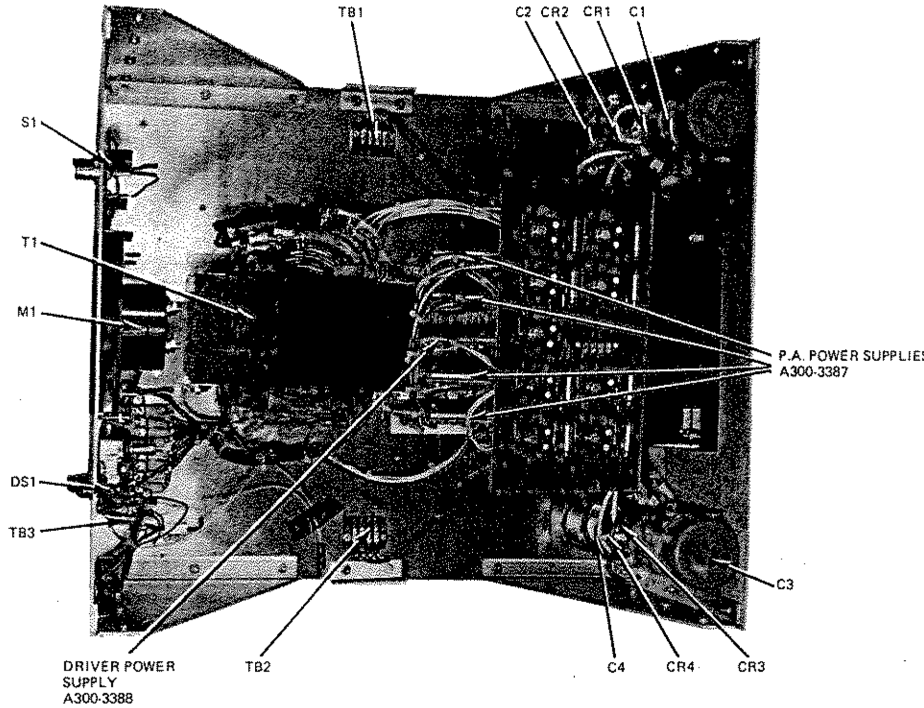


Figure 6-4. Power Distribution (A300-2381)

CHAPTER 7
SCHEMATICS AND PARTS LIST

7.1 SCHEMATIC DIAGRAMS

Complete schematic diagrams appear in figures 7-1 through 7-2.

7.2 PARTS LIST

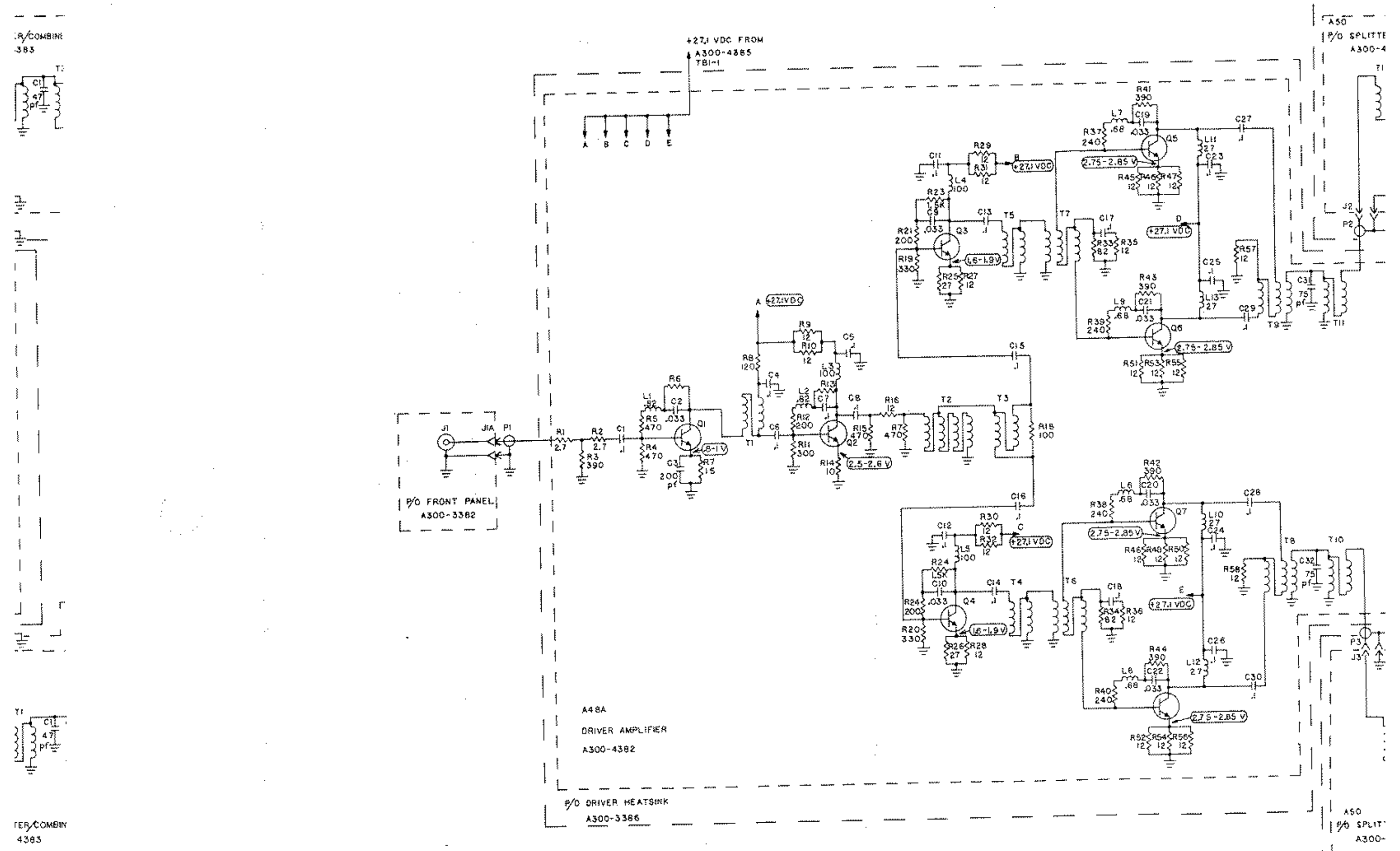
Table 7-1 provides a listing of all electrical parts and those mechanical parts which may be required for replacement. Electrical parts are listed by module number and by reference designations as indicated on the schematic diagrams. Parts list includes a description, part number and manufacturers federal supply code number. Table 7-2 provides a reference glossary of abbreviations used in the parts list.

7.3 LIST OF MANUFACTURERS

Table 7-3 provides a correlation of the manufacturers federal supply code numbers used in the parts list with the names and addresses of the manufacturers. If ENI's manufacturer code number (10226) appears, that part must be obtained directly from Electronic Navigation Industries, Inc.

7.4 ORDERING REPLACEMENT PARTS

To obtain replacement parts, address order or inquiry to Electronic Navigation Industries, Inc. or its authorized service facility. Identify parts by number as listed in the parts list (Table 7-1).



NOTES:

1. UNLESS OTHERWISE SPECIFIED;
   - A. ALL RESISTOR VALUES ARE IN OHMS.
   - B. ALL CAPACITOR VALUES ARE IN MICROFARADS.
   - C. ALL INDUCTOR VALUES ARE IN MICROHENRIES.
2. VOLTAGE MEASUREMENTS TAKEN WITH NO SIGNAL APPLIED USING A VOLTMETER WITH A HIGH INPUT IMPEDANCE (10 MEGOHMS OR GREATER).
3. ALL VOLTAGES ARE POSITIVE WITH RESPECT TO GROUND.

R.F. POWER AMPLIFIER SCHEMATIC DIAGRAM

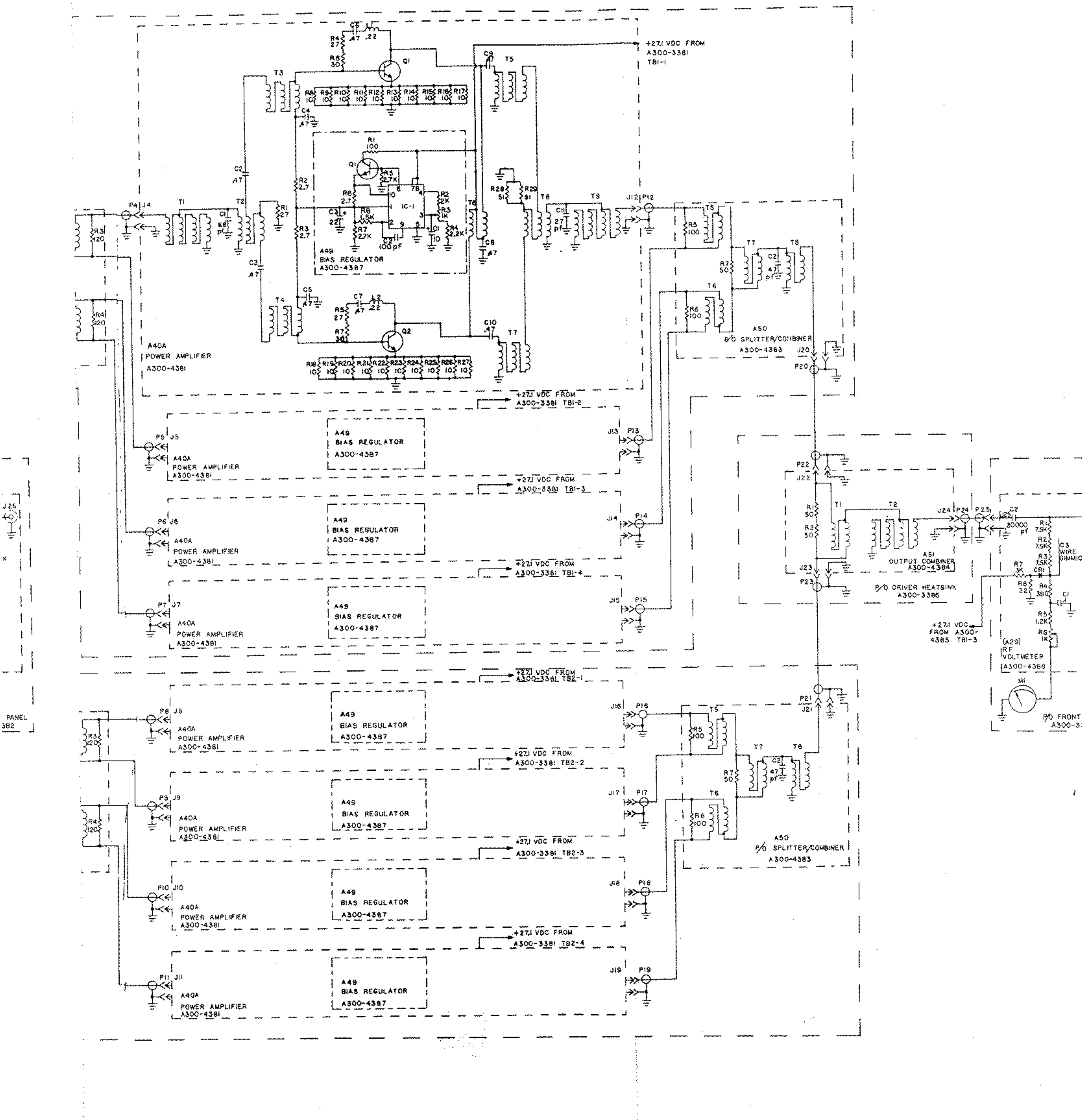
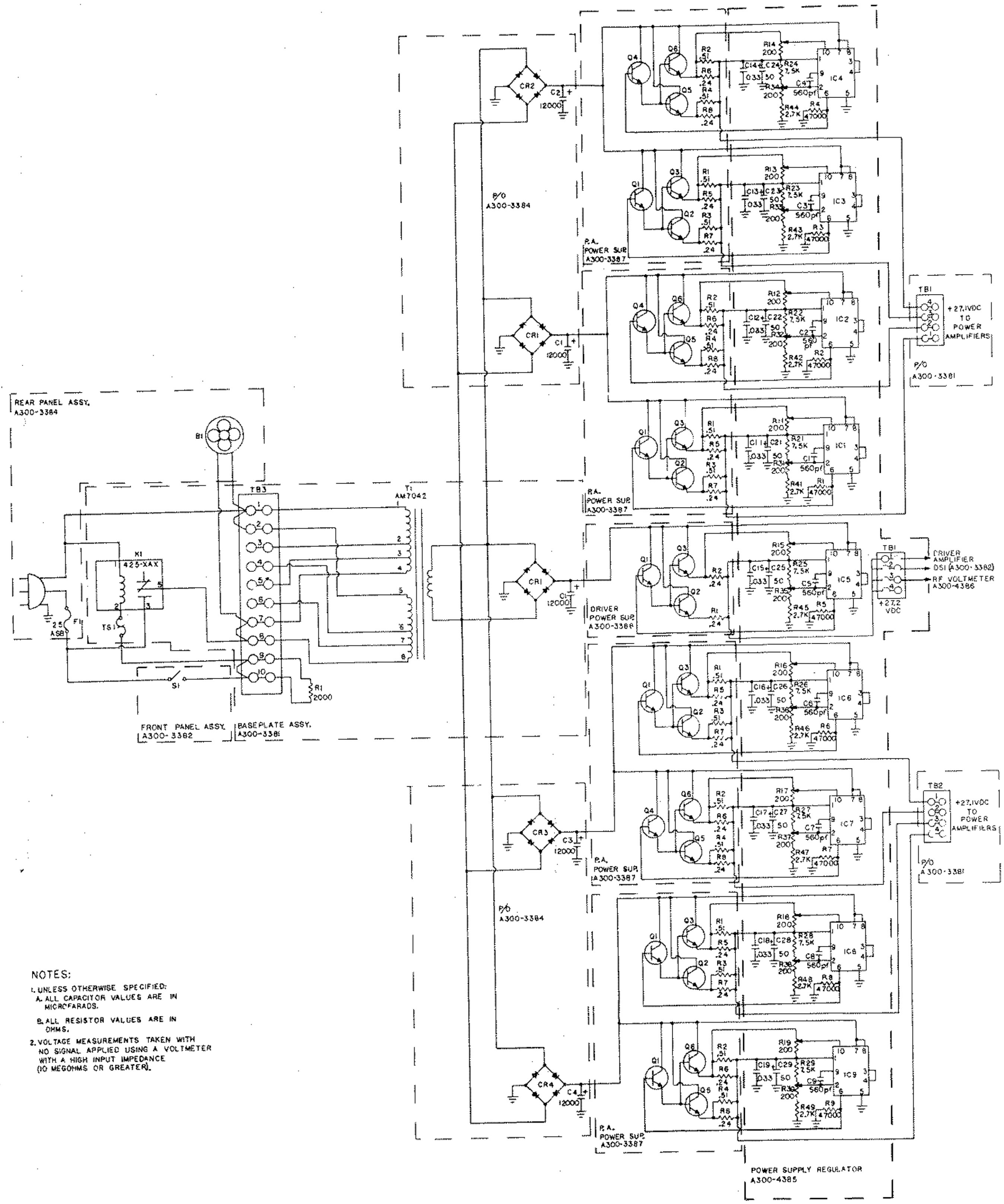


Figure 7-1. RF Power Amplifier Schematic Diagram



NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   A. ALL CAPACITOR VALUES ARE IN MICROFARADS.
   B. ALL RESISTOR VALUES ARE IN OHMS.
2. VOLTAGE MEASUREMENTS TAKEN WITH NO SIGNAL APPLIED USING A VOLTMETER WITH A HIGH INPUT IMPEDANCE (10 MEGOHMS OR GREATER).

Figure 7-2. Power Distribution (A300-2381)

Table 7-1. Replacement Parts List

REF. DESIG.	DESCRIPTION	MFR. CODE	PART NO.
	CHASSIS MOUNTED PARTS (NO PREFIX):		
	BASEPLATE ASSEMBLY	10226	A300-3381
TS1	Thermostat	14604	3450-087
T1	Transformer, Power	12715	AM 7042
K1	Contactor	78290	425-XAX
C1	Capacitor, Elect. 12000uF 40VDCW	56289	36D123G040BC2A
CR1	25 Amp 100V PIV Fullwave Br.	04713	MDA-990-2
R1	Res. 2Kohm, 1%, 10 watt	91637	RH-10-2K
	FRONT PANEL ASSEMBLY	10226	A300-3382
M1	Meter	32171	841-258
S1	Switch	04009	81015AW
DS1	Lamp Assy.	72619	101-8430-0931-201
	Bulb	71744	327
	REAR PANEL ASSEMBLY		
CR1-CR4	25A Fullwave Br.	04713	MDA-990-2
C1-C4	Capacitor, Elect. 12000uF 40V	56289	36D123G040BC2A
B1	Fan	82877	TN3A2
F1	Fuse 25A S.B.	75915	313025
	POWER AMPLIFIER POWER SUPPLY PARTS (NO PREFIX): 4 Req	10226	A300-3387
Q1 & Q4	Transistor	79089	40312
Q2,3,5,6	Transistor	04713	2N3055
A67	POWER AMPLIFIER SERIES REGULATOR (A67)		
A67R1-R4	Res. W.W. .5ohm, 5%, 2 watt	75042	BWH .5ohm
A67R5-R8	Res. W.W. .24ohm, 5%, 2 watt	75042	BWH .24ohm
	DRIVER POWER SUPPLY PARTS: (NO PREFIX)	10226	A300-3388
Q1	Transistor	79089	40312
Q2, Q3	Transistor	04713	2N3055
A66	DRIVER SERIES REGULATOR (A66)	10226	A300-4388
A66R1-R2	Res. W.W. .24ohm, 5%, 2 watt	75042	BWH .24ohm
A53A	POWER SUPPLY REGULATOR (A53A)	10226	A300-4385
A53AR1-R9	Res. Comp. 47Kohm, 5%, 1/4 watt	01121	RC07GF473J
A53AR11-R19 R31-R39	Pot. 200ohm	32997	3389T-1-201
A53A R21-R29	Res. 7.5Kohm, 5%, 1/2 watt	16299	HC5-7.5K
A53AR41-R49	Res. 2.7Kohm, 5%, 1/2 watt	16299	HC5-2.7K
A53AC1-C9	Cap. Mica 560pF, 5%	09023	CM05ED561J03
A53A C11-C19	Cap. Cer. 0.033uF, 50VDCW	72982	8121-050-651-333Z
A53A C21-C29	Cap. Elect. 50uF, 50VDCW	56289	500D506G050DD7
A53AIC1-IC9	IC Regulator	49956	RC723CT

Table 7-1. Replacement Parts List. (Cont.)

REF. DESIG.	DESCRIPTION	MFR. CODE	PART NO.
A49	BIAS REGULATOR (A49) 8 Req.	10226	A300-4387
A49 R6	Res. Comp. 2.7ohm, 5%, 1/4 watt	01121	RC07GF2R7J
A49 R8	Res. Comp. 1.5Kohm, 5%, 1/4 watt	01121	RC07GF152J
A49 R2	Res. Comp. 2.0Kohm, 5%, 1/4 watt	01121	RC07GF202J
A49 R4	Res. Comp. 2.2Kohm, 5%, 1/4 watt	01121	RC07GF222J
A49R5,R7	Res. Comp. 2.7Kohm, 5%, 1/4 watt	01121	RC07GF272J
A49 R3	Potentiometer 1Kohm	32997	33897-1-102
A49 R1	Res. Comp. 100ohm, 5%, 1 watt	01121	RC32GF101J
A49C1	Cap. Tantalum 10uF 10VDCW	80795	TAG-F-20-10/10-50
A49C2	Cap. Mica 100pF, 5%	09023	CM05ED101J03
A49C3	Cap. Tantalum .22uF, 10VDCW	80795	TAG-F-20-22/10-50
A49 Q1	Transistor	79089	40312
A49IC1	I.C. Regulator	49956	RC723CT
A48A	DRIVER AMPLIFIER (A48A)	10226	A300-4382
A48R1,R2	Res. Comp. 2.7ohm, 5%, 1/4 watt	01121	RC07GF2R7J
A48R35, R36	Res. Comp. 12ohm, 5%, 1/4 watt	01121	RC07GF120J
A48R7	Res. Comp. 15ohm, 5%, 1/4 watt	01121	RC07GF150J
A48 R33, R34	Res. Comp. 82ohm, 5%, 1/4 watt	01121	RC07GF820J
A48R12 R21, R22	Res. Comp. 200ohm, 5%, 1/4 watt	01121	RC07GF201J
A48R11	Res. Comp. 300ohm, 5%, 1/4 watt	01121	RC07GF301J
A48R19, R20	Res. Comp. 330ohm, 5%, 1/4 watt	01121	RC07GF331J
A48R3	Res. Comp. 390ohm, 5%, 1/4 watt	01121	RC07GF391J
A48R4,R5	Res. Comp. 470ohm, 5%, 1/4 watt	01121	RC07GF471J
A48R13	Res. Comp. Selected	01121	RC07
A48R6	Res. Comp. Selected	01121	RC07
A48R9,R10, R16, R27-R32	Res. Comp. 12ohm, 5%, 1/2 watt	01121	RC20GF120J
A48R25, R26	Res. Comp. 27ohm, 5%, 1/2 watt	01121	RC20GF270J
A48R18	Res. Comp. 100ohm, 5%, 1/2 watt	01121	RC20GF101J
A48R8	Res. Comp. 120ohm, 5%, 1/2 watt	01121	RC20GF121J
A48R15,R17	Res. Comp. 470ohm, 5%, 1/2 watt	01121	RC20GF471J
A48R23,R24	Res. Comp. 1.5Kohm, 5%, 1/2 watt	01121	RC20GF152J
A48R14	Res. Comp. 10ohm, 5%, 1 watt	01121	RC32GF100J
A48R45-R56	Res. Comp. 12ohm, 5%, 1 watt	01121	RC32GF120J
A48R37-R40	Res. Comp. 240ohm, 5%, 1 watt	01121	RC32GF241J
A48R41-R44	Res. Comp. 390ohm, 5%, 1 watt	01121	RC32GF391J
A48R57,R58	Res. Comp. 12ohm, 5%, 2 watt	01121	RC42GF120J
A48C2,C7, C9, C10, C19, C20, C21, C22	Cap. Cer. 0.033uF, 50VDCW	72982	8121-050-651-333Z
A48C1, 4, 5, 6, 8, 11, 12, 13, 14, 15, 16, 17, 18, 23-30	Cap. Cer. 0.1uF, 50VDCW	72982	8121-050-651-104Z
A48C31, C32	Cap. Mica 75pF, 5%	09023	CM05ED750J03
A48C3	Cap. Mica 200pF, 5%	09023	CM05ED201J03

Table 7-1. Replacement Parts List. (Cont.)

REF. DESIG.	DESCRIPTION	MFR. CODE	PART NO.
A48L6-L9	Choke, RF, .68uH, 10%	99800	MS18130-6
A48L1,L2	Choke, RF, .82uH, 10%	99800	MS18130-8
A48L10-L13	Choke, RF, 27uH, 10%	99800	MS75103-2
A48L3-L5	Choke, RF, 100uH	99800	MS75103-9
A48Q1	Transistor	10226	5744
A48Q2,Q3,Q4	Transistor	10226	3642
A48Q5,Q6,Q7,Q8	Transistor	10226	5754
A48T1	Transformer	10226	
A48T2	Transformer	10226	
A48T3	Transformer	10226	
A48T4,T5	Transformer	10226	
A48T6,T7	Transformer	10226	
A48T8,T9	Transformer	10226	
A40A	POWER AMPLIFIER (A40A) 8 Req.	10226	A300-4381
A40AR2,R3	Res. Comp. 2.7ohm, 5%, 1/4 watt	01121	RC07GF2R7J
A40AR1	Res. Comp. 27ohm, 5%, 1/4 watt	01121	RC07GF270J
A40AR8-R27	Res. Comp. 10ohm, 5%, 2 watt	01121	RC42GF100J
A40AR6-R7	Res. Comp. 27ohm, 5%, 2 watt	01121	RC42GF270J
A40AR4,R5	Res. Comp. 30ohm, 5%, 2 watt	01121	RC42GF300J
A40AR28, R29	Res. Comp. 51ohm, 5%, 2 watt	01121	RC42GF510J
A40AC2-C10	Cap. Cer. .47uF, 50VDCW	72982	8131-050-651-474Z
A40AC11	Cap. Mica 27pF, 5%	09023	CM05ED270J03
A40AC1	Cap. Mica 68pF, 5%	09023	CM05ED680J03
A40AL1,L2	Choke, RF, .22uH, 10%	99800	1025-04
A40AQ1,Q2	Transistor	10226	2241
A40AT1	Transformer	10226	
A40AT2	Transformer	10226	
A40AT3,T4	Transformer	10226	
A40AT5,T7	Transformer	10226	
A40AT6	Transformer	10226	
A40AT8	Transformer	10226	
A40AT9	Transformer	10226	
A50	FOUR WAY SPLITTER/COMBINER (A50) 2 Req.	10226	A300-4383
A50R1	Res. Comp. 24ohm, 5%, 2 watt	01121	RC42GF240J
A50R2	Res. Comp. 27ohm, 5%, 2 watt	01121	RC42GF270J
A50R3,R4	Res. Comp. 120ohm, 5%, 2 watt	01121	RC42GF121J
A50R5,R6	Res. WW, 100ohm, 1%, 30 watt	19647	MP330-100
A50R7	Res. WW, 50ohm, 1%, 15 watt	19647	MP312-50
A50C1,C2	Cap. Mica, Selected	09023	CM05
A50T1,T2	Transformer	10226	
A50T3,T4	Transformer	10226	
A50T5,T6,T7	Transformer	10226	
A50T8	Transformer	10226	
A51	TWO WAY OUTPUT COMBINER (A51)	10226	A300-4384
A51R1,R2	Res. WW, 50ohm, 1%, 15 watt	09023	MP312-50
A51T1	Transformer	10226	
A51T2	Transformer	10226	

Table 7-1. Replacement Parts List. (Cont).

REF. DESIG.	DESCRIPTION	MFR. CODE	PART NO.
A29M	R.F. VOLTMETER (A29M)	10226	A300-4386
A29MR8	Res. Comp. 22ohm, 5%, 1/4 watt	01121	RC07GF220J
A29MR4	Res. Comp. 390ohm, 5%, 1/4 watt	01121	RC07GF391J
A29MR7	Res. Comp. 3Kohm, 5%, 1/4 watt	01121	RC07GF302J
A29MR1,R2,R3	Res. Comp. 7.5Kohm, 5%, 1/2 watt	75042	RC20GF752J
A29MR5	Res. Comp. 1.2Kohm, 5%, 1/4 watt	01121	RC07GF122J
A29MR6	Potentiometer, 1Kohm	32997	3389T-1-102
A29MC1	Cap. Cer. 0.1uF, 50VDCW	72982	8131-050-651-104Z
A29MC2	Cap. Mica 20,000pF, 5%	09023	CM07FD203J03
A29MCR1	Diode	28480	HPA-5082-2800

Table 7-2. Glossary of Abbreviations

A	AMPERES	PIV	PEAK INVERSE VOLTAGE
AMP	AMPERES	POT	POTENTIOMETER
ASSY	ASSEMBLY	REF	REFERENCE
BR	BRIDGE	REQ	REQUIRED
CAP	CAPACITOR	RES	RESISTOR
CER	CERAMIC	S.B.	SLOW BLOW
COMP	COMPOSITION CARBON	uF	MICROFARAD
		V	VOLTS
DESIG	DESIGNATION	VDCW	DC WORKING VOLTS
ELECT	ELECTROLYTIC	W	WATTS
I.C.	INTEGRATED CIRCUIT	WW	WIRE WOUND
K	KILOHMS		
uH	MICROHENRY		
mV	MILLIVOLTS		
pF	PICOFARAD		

Table 7-3. List of Manufacturers

FEDERAL SUPPLY CODE NUMBER	MANUFACTURER	ADDRESS
01121	Allen-Bradley Co.	Milwaukee, WI.
04009	Arrow-Hart, Inc.	Hartford, CT.
04713	Motorola, Inc. Semiconductor Prod. Div.	Phoenix, AZ.
09023	Cornell-Dubilier Electronics	Sanford, N.C.
10226	ELECTRONIC NAVIGATION INDUSTRIES, INC.	Rochester, N.Y.
12715	American Magnetics Corp.	Carterville, IL.
14604	Elmwood Sensors, Inc.	Cranston, R.I.
16299	Corning Glass	Raleigh, N.C.
19647	Caddock Electronics, Inc.	Riverside, CA.
28480	Hewlett Packard Co.	Palo Alto, CA.
32171	Modutec, Inc.	Norwalk, CT.
32997	Bourns, Inc.	Riverside, CA.
49956	Raytheon Co.	Lexington, MA.
56289	Sprague Electric Co.	N. Adams, MA.
71744	Chicago Miniature Lamp Works	Chicago, IL.
71785	Cinch Mfg. Co.	Elk Grove Village, IL.
72619	Dialight Corp.	Brooklyn, N.Y.
72982	Erie Technological Products, Inc.	Erie, PA.
75042	I.R.C. Div. of TRW Inc.	Philadelphia, PA.
75915	Littlefuse, Inc.	Des Plaines, IL.
78290	Struthers-Dunn, Inc.	Pitman, N.J.
79089	R.C.A.	Harrison, N.Y.
80795	I.T.T.	New York, N.Y.
82877	Rotron, Inc.	Woodstock, N.Y.
91637	Dale Electronics, Inc.	Columbus, NB.
99800	Delevan Electronics Corp.	E. Aurora, N.Y.