

INSTRUCTION MANUAL



MODEL 525LA

BROADBAND POWER AMPLIFIER

ELECTRONIC NAVIGATION INDUSTRIES, INC.

Rochester, New York U.S.A.

Valuetronics International, Inc.  
1-800-552-8258  
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When warranty service is required, the instrument must be returned transportation charges prepaid to the factory or our authorized service facility. If, in our opinion, the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at cost. In this case, an estimate will be submitted before the work is started.

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## CHAPTER 1

### GENERAL INFORMATION

#### 1.1 INTRODUCTION

The Model 525LA is a general purpose broadband amplifier capable of more than 25 watts of linear power output when driven by any laboratory signal or sweep generator from 1.0 to 500 MHz.

In ultra linear Class A design, the 525LA will "boost" the output of any signal source by a flat 50 dB ( $\pm 1.5$  dB) and provide its full forward output power into any load impedance (from an open to a short circuit). Its output is a faithful reproduction of the input waveform for AM, FM, SSB, CATV, pulse and other complex modulations. Although specified only over the 1.0 to 500 MHz frequency range the amplifier is typically usable from 0.5 to 520 MHz.

The use of stud mounted UHF transistors on microstrip circuit boards makes the 525LA both reliable and easy to service.

An integral power supply and cooling system permits operation over a wide band of temperature and AC line conditions.

#### 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 serial number should be given in any correspondence with the company.

TABLE 1-1. SPECIFICATION

FREQUENCY COVERAGE:	1.0 MHz to 500 MHz
GAIN:	50 dB Nominal (-6 dBm)
GAIN VARIATION:	± 1.5 dB from 1.0 to 500 MHz
MAXIMUM CLASS A LINEAR POWER OUTPUT:	25 Watts 44 dBm
HARMONIC DISTORTION:	All harmonics greater than 23 dB down at maximum linear power output, lower at reduced power.
TYPICAL 3RD ORDER INTERMODULA- TION INTERCEPT POINT:	56 dBm
INPUT/OUTPUT IMPEDANCE:	50 ohms
INPUT VSWR:	1.8:1 Maximum
OUTPUT VSWR:	3:1 Maximum
NOISE FIGURE:	12 dB Typical
STABILITY:	Unconditionally stable; unit will not oscillate for any condition of load and source impedance.  Unit will withstand more than +30 dB of overdrive (input signal of 7V RMS) for all output load conditions.
POWER REQUIREMENTS:	115 VAC ±8% 50/60 Hz at 6 amperes 230 VAC ±8% 50/60 Hz at 3 amperes
OPERATING TEMPERATURE:	0° to 45° C
SIZE:	7.5 x 10.2 x 17.1 in. 19.05 x 25.91 x 43.43 cm.
WEIGHT:	42 lbs.; 19.05 kgs.
CONNECTORS:	Type N
RACK MOUNTING:	Adaptors Provided

## CHAPTER 2

### PREPARATION

#### 2.1 INITIAL INSPECTION

##### 2.1.1 Mechanical Check

If damage to the shipping carton is evident, request the carrier's 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 525LA 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 525LA 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 525LA requires a 50-60 Hz power source cable of 700 watts. Line voltage accommodation is accomplished by means of switch S2, recess-mounted on the rear panel. S2 may be actuated by a small flat-blade screwdriver. It is essential that S2 be set to the available line voltage.

#### CAUTION:

FAILURE to set S2 to the proper line voltage may result in SEVERE DAMAGE to the instrument.

##### 2.2.2 Power Cable Ground Protection

To protect operating personnel the ENI Model 525LA 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 525LA is supplied with a 2 pole three wire grounding, 15 ampere, 125 volt plug NEMA 5-15P. This plug must be inserted into a properly wired 20 ampere, three wire grounding receptacle NEMA 5-15R.

##### 2.2.3 Cooling

When the 525LA 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 45°C.

#### 2.3 RACK MOUNTING

Rack mounting brackets are supplied with the 525LA for installation in any standard nineteen inch relay rack cabinet. To attach the brackets to the 525LA, remove the two #8-32 screws on each side of the cover nearest the front panel and reinsert them through the corresponding holes in the brackets. Tighten securely. The bottom feet may be unscrewed and removed if the minimum vertical usage of the relay rack is necessary.

#### 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 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 525LA is a linear Class A amplifier capable of increasing the output of any signal generator, frequency synthesizer, sweep generator or laboratory signal source from 1.0 MHz to 500 MHz.

The Model 525LA is completely protected against damage due to load mismatch provided that the input RF level does not exceed 7 volt RMS. If the attached signal source is capable of generating substantially more than this input voltage, please use caution in adjusting it. The Model 525LA will saturate well before the maximum input voltage and there will be no increase in output power at that point.

The 525LA is unconditionally stable. Any impedance can be connected to the input and output of the amplifier, without causing oscillation.

The 525LA 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.

#### 3.2 CONTROLS, INDICATORS AND CONNECTORS

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

#### 3.3 OPERATING PROCEDURE

Determine and set the line voltage switch described in the previous section 2.2.1 then proceed as follows:

- a. Ensure input RF voltage from the signal source is not excessive.

The 7V RMS indicated maximum input voltage is more than 62 times the level of the input signal required to achieve maximum output. Input voltages in excess of 7 volts RMS may permanently damage the instrument.

- b. Connect the input signal via a 50 ohm coaxial lead to the input connector.
- c. Connect the output via a 50 ohm coaxial lead to the load.

#### 3.4 PRECAUTIONS

- a. The input and output of the Model 525LA should not be connected together. This will cause oscillation and may damage the input preamplifier.
- b. The Model 525LA 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 unit signal voltage of the signal source is unknown, insert an attenuator between it and the Model 525LA input.

TABLE 3-1. FRONT AND REAR PANEL DEVICES

DEVICE	FUNCTION
Power Switch	Depressing switch to "ON" position connects fans and power supply to main power source.
Input Connector	Type N for connection of the driving generator. Input impedance is 50 ohms. No more than +10 dBm is required to obtain saturated output. Up to +50 dBm 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 3 AG size, slow blow type fuse: 10A for both 115 and 230 Vac.
Line Cord	Three prong type plug with safety ground pin connected to cabinet. For U.S. delivery the Model 525LA is supplied with a 2 pole, 2 wire grounding, 15 ampere, 125 volt plug NEMA 5-15P. This plug must be inserted into a properly wired grounding receptacle NEMA 5-15R.

## PRINCIPLES OF OPERATION

## 4.1 GENERAL

The Model 525LA 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 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 high temperature film resistors deposited at their emitter terminals to increase linearity and reliability.

## 4.2 BLOCK DIAGRAM DESCRIPTION

A block diagram of the entire Model 525LA is shown in Figure 4-1. The electrical schematics are shown in Figure 7-1. Input signal from the front panel type N connector is fed to the preamplifier assembly 525LA-13165. The preamplifier has two equal amplitude and phase outputs. Each preamplifier channel has an overall gain of 33 dB and a minimum power of 0.5 watts. The preamplifier outputs are fed via coaxial cables to the two power amplifier modules (525LA-13169).

Each power amplifier has a gain of 14 dB and is capable of producing more than 15 watts of power at its output. These outputs are summed and isolated from each other in the output combiner assembly (525LA-13166). RF output is fed into the output type N connector

located on the front panel. The power distribution (525LA-12161) provides cooling and DC power to the entire unit. The regulated power supply is capable of supplying +26.4 volts to the preamplifier module and two power amplifier modules.

## 4.2.1 Preamplifier Module 525LA-13165

Input RF signal is fed through connector J1 to the base of low noise transistor Q1 through the attenuator resistors R1, R2, and R3. The gain flatness of this low noise stage is adjusted by variable capacitor C5. The output of transistor Q1 is fed via capacitor C4 to the base of transistor Q2 which is similarly adjusted for gain flatness by capacitor C34. Additional amplification is picked up in transistors Q3, Q4, and Q5. The output of transistor Q5 is split into two equal gain and phased matched signals by transformer T3.

These signals are fed to the two coaxial connectors located on the bottom of the preamplifier chassis.

4.2.2 Power Amplifier Module  
525LA-13164

The outputs of the two driver lines are fed through 50 ohm coaxial cables to the inputs of the 525LA-13164 power amplifier assemblies. The input signal at each of the two assemblies is matched and attenuated by resistors R1, R2 and R3 and fed to transformer T1 which is an input matching transformer. Capacitors C1, C3 and C5-9 match the reactive impedance of transistor Q1 to the primary of transformer T1. The output of transistor Q1 is split into four equal amplitude and phase components by transformers T2, T3 and T4. Transformers T5, T6, T7, and T8 serve to match the driving point impedance at the base of transistors Q2, Q3, Q4, and Q5 respectively. Additional impedance matching for transistor Q2 is provided by capacitors C20, C44, C28, C32, and C36.

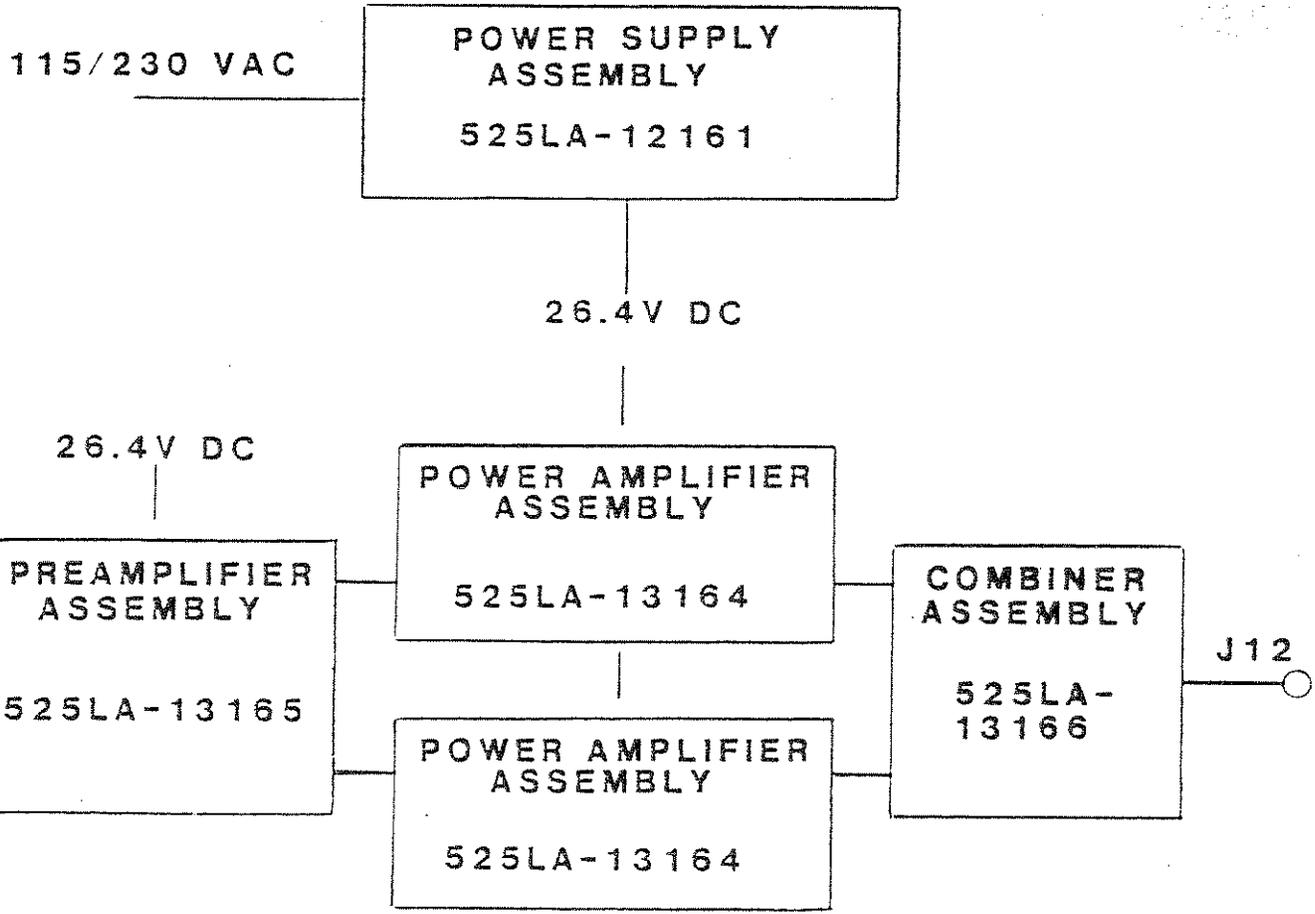


FIGURE 4.1 BLOCK DIAGRAM

Capacitors C21, C45, C29, C35 and C57 provide matching for transistor Q3. In addition, capacitors C22, C46, C30, C34 and C38 provide matching for Q4 while C23, C47, C31, C35, and C39 provide matching for transistor Q5. Resistors R28, R29, R31, R32, R34, R35, R37, and R58 provide negative feedback to level and match the gain of the output power stages. The output power stages are matched by transformers T9, T10, T11 and T12. The equal phase and amplitude output power is then coupled through hybrid transformers T13, T14, and T15 to the output transformer T16. Additional output impedance matching is provided by the coil L20.

#### 4.2.3 Combiner Assembly 525LA-13166

RF power is injected into the combiner at connectors J9 and J10. The hybrid transformer T1 produces the sum of these inputs at connector J11. Transformer T2 transforms the output impedance to 50 ohms. Capacitors C1, C2, C3, C4, and C5 provide the impedance matching which enables the combiner to tune across the band.

#### 4.2.4 Power Supply Assembly 525LA-13167

The AC power is distributed to transformer T1 through two switches, S1 and S2. S1 is the power ON switch mounted on the front panel. S2 is the line voltage setting switch which is recess-mounted on the rear panel. The secondary of T1 supplies voltage for the full wave bridge rectifier CR1. The output of the bridge is filtered by C1 and fed to the collectors of Q1 through Q5. CR1, C1, and Q1 through Q5 are all mounted on the Power supply assembly 525LA-13167. Regulation is accomplished by the circuitry which includes IC1, C1, C2, L1, R1, R7, R8, R9, and Q1. R8 is a potentiometer which permits the emitter outputs of Q2, Q3, Q4, and Q5 to be adjusted to  $26.4 \pm 0.500$  volts. Resistors R2, R3, R4, and R5 are employed to balance the current through the pass transistors Q2, Q3, Q4, and Q5. Additional filtering is provided by C3 and C4.

## 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 525LA. These tests are as follows:

## 5.1.2 Test Equipment Required

The following test equipment is required for accomplishing the Model 525LA performance tests. Equivalent substitutes for recommended models may be used.

- a. Oscilloscope - Tektronix Model T921
- b. Sweep/Signal Generator - Wavetek 2001
- c. 50 ohm Detector - Wavetek D151
- d. Calorimetric Power Meter - HP434A
- e. Spectrum Analyzer - HP140T Display Unit
  - HP8554L Spectrum Analyzer-RF Section
  - HP8552A Spectrum Analyzer-IF Section
- f. Attenuator, 30 dB, 50 Watts-Bird 8321
- g. Attenuator, 10 dB, 75 Watts-Engelman Microwave

## 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 525LA.

## 5.1.3.1 Calibration of Set-Up

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

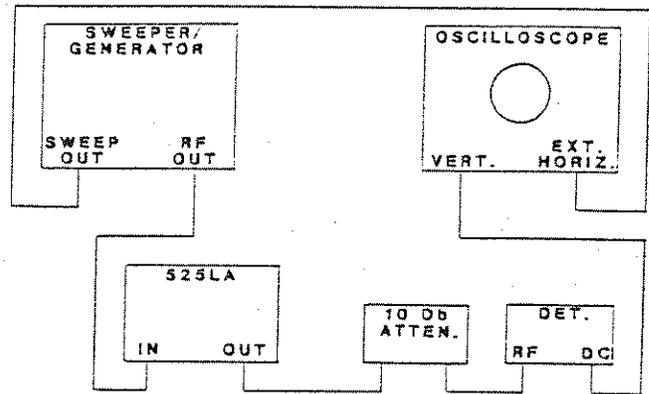


FIGURE 5-1 Gain and Gain Variation Test Set-Up

- b. Set the oscilloscope to DC, time/CM to Ext. X, and vertical gain to 10 MV/CM.
- c. Set Sweep/Generator to S/S mode with start frequency at 1.0 MHz and the stop frequency at 500 MHz.
- d. Disconnect the Model 525LA from the set-up and connect the Sweeper/Generator RF output directly to the 10 dB attenuator.
- e. Adjust the output level of the Sweeper/Generator for full vertical deflection of the oscilloscope face.
- f. Calibrate the scope face to show 3 dB in 1 dB steps and mark the traces with a grease pencil.
- g. Return Sweep Generator output level to full deflection. Rotate the step attenuator on the Sweep/Generator (CCW) so that the output is reduced by 50 dB.
- h. Reconnect Model 525LA into the test set-up of Figure 5-1.

## 5.1.3.2 Measurement Procedure

- a. Press the Model 525LA power switch.
- b. Observe the gain versus frequency sweep on the oscilloscope.

- c. The average gain should be 50 dB.
- d. The gain variation should be within the 3 dB markings as shown on the oscilloscope face.

#### 5.1.4 RF Power Output Test

The purpose of the RF power output test is to verify that the Model 525LA will deliver its rated power output over the frequency range of 1.0 MHz to 500 MHz.

##### 5.1.4.1 Measurement Procedure

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

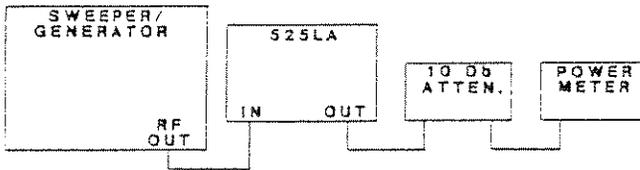


Figure 5-2 RF Output Power Test Set-Up

- b. Set the calorimetric power to the 10 watt range. With the 10 dB series attenuator, this corresponds to a full scale deflection of 100 watts.
- c. Set the Sweep/Generator Wavetek Model 2001 to the CW mode, level to +10 dBm and frequency to 500 MHz.
- d. Slowly decrease frequency while observing the power meter. Note that at every frequency down to 150 MHz the power output is greater than 30 watts and greater than 40 watts at every frequency from 200 MHz to 1.0 MHz.

#### 5.1.5 RF Output Distortion Test

The purpose of this test is to verify that the harmonic distortion of the Model 525LA 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.

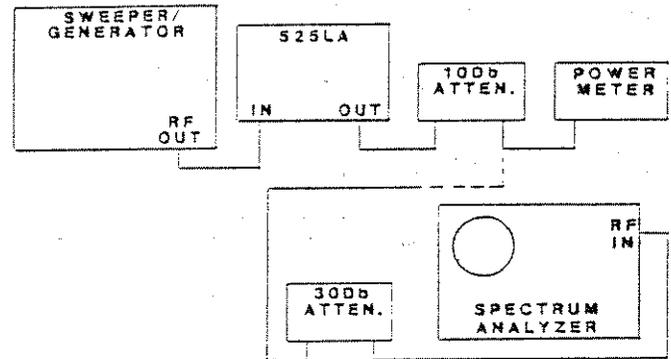


Figure 5-3. RF Output Distortion Test Set-Up

- b. Set the calorimetric power meter to the 3 watt range. With the 10 dB series attenuator, this corresponds to a full scale deflection of 30 watts.
- c. Set the Generator/Sweeper to CW and frequency to 500 MHz.
- d. Adjust the Generator/Sweeper output level so that the output power indicated on the power meter is 25 watts.
- e. Disconnect the cable from the power meter and connect it to the Spectrum Analyzer through a 30 dB attenuator.
- f. Observe that all harmonics are at least 23 dB below the fundamental.
- g. Repeat steps a through f with the generator set at 50 MHz increments from 500 MHz to 1.0 MHz.

## TROUBLESHOOTING 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 525LA 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 Defective power supply Thermal switch open Defective power switch Blown fuse	Check for 26.4 volts across bulb. Perform test in section 6.3.2 If TSI contacts do not close after unit has cooled, replace thermal switch. Replace switch (S1) Replace fuse per Table 3-1.
Power Lamp dim	Power supply out of adjustment Wrong AC line voltage	Perform power supply adjustment Section 6.3.2. Check section 2.2.1
Blown Fuse	Defective power supply Wrong Fuse Defective line cord or AC wiring	Perform test in section 6.3.2 Check per Table 3-1. Visually inspect for signs of insulation breakdown.
No RF output or gain	Broken input or output type N connector Defective input or output internal cables	Visually inspect connectors for broken pins. Visually inspect cables at input and output connectors
Low RF Output or Gain	Defective input cables Faulty power supply adjustment Defective RF amplifier module	Visually inspect cables Perform power supply adjustment section 6.3.2 Perform procedure for locating faulty RF module, section 6.2

TABLE 6-1. TROUBLESHOOTING GUIDE (continued)

SYMPTOM	PROBABLE CAUSE	RECOMMENDATIONS
Excessive Distortion	Defective power amplifier module	Perform procedure for locating faulty RF module section 6.2
Amplifier Overheating	Defective Fan Ambient air is above specifications Defective power supply	Check that the fan is operating properly. Measure the ambient temperature Perform test in section 6.3.2
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 525LA 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 0 dBm. If the Model 525LA output power is less than 25 watts, as indicated on the calorimetric power meter, a faulty RF module may exist.
- c. With an output of 25 watts or less, disconnect the coaxial cable from J1 of the power amplifier module and observe the output power as indicated on the calorimetric power meter. The power will drop 75% ( $\pm 4\%$ ) for a properly

functioning power amplifier. Reconnect the coax cable to J1 and remove the coax cable from J2. Observe the power drop.

If the power output drops an equal amount (within 4%) as each cable is removed the fault is in either the output combiner or the preamplifier section. Perform tests in section 6.2.2.1 and 6.2.3.

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

#### 6.2.2.1 Combiner Test 525LA-13166

Set the low level Sweep/Signal Generator to cover 1.0 to 500 MHz. Connect the output of the sweep generator to the output connector.

Connect the RF detector to jack J9 on the output combiner and a 50 ohm dummy load to connector J10. Measure the total loss through the combiner. If the measured response is  $3 \pm 4$  dB, then the combiner is operating properly.

### 6.2.2.2 RF Power Amplifier Module Test 525LA-13164

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

- a. DVM - Fluke 8000A or Fluke 8100A
- b. Sweeper/Generator Wavetek 2001
- c. Oscilloscope - Tektronix T921
- d. 50 ohm Detector - Wavetek D151
- e. Attenuator, 10 dB, 75 Watts  
Engelmann Microwave
- f. Power Supply, Lambda LK-361-FM
- g. Cooling Fan - Rotron Type 113

#### 6.2.2.2.1 Bias Voltage Check

- a. Adjust the power supply to +26.4 volts.
- b. Connect the power supply minus (-) lead to the heatsink. Connect the positive (+) lead of the power supply to the power amplifier to be tested.
- c. Position the cooling fan so that the cooling air is directed at the heatsink.
- d. Verify that the emitter voltage of Q1 is +2.7 VDC  $\pm$  .1 VDC and the emitter voltages of Q2-Q5 are 2.30 VDC  $\pm$  .1 VDC (See Figure 7-1).
- e. If all voltages are within tolerance proceed to the low power sweep.

#### 6.2.2.2.2 Low Power Sweep Test

- a. Set up the test equipment as shown in Figure 6-1.

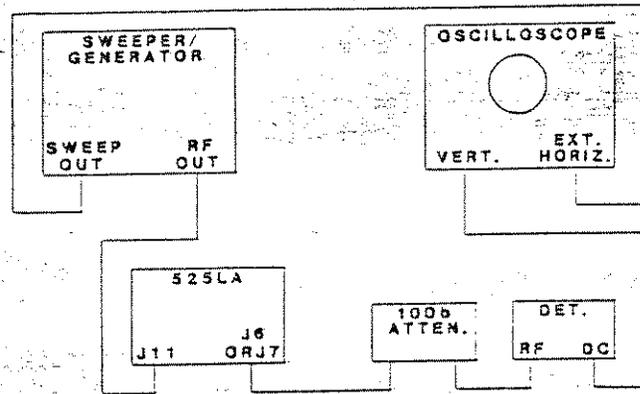


Figure 6-1. Low Power Sweep Test Set Up

- b. Set oscilloscope to DC, Time/CM to Ext. X and vertical gain to 10 MV/CM.
- c. Set the Sweeper/Generator to the S/S mode with the start frequency at 1.0 MHz and stop frequency at 500 MHz.
- d. Disconnect the power amplifier module under test from test set-up and connect the sweeper/generator RF output directly to the 10 dB attenuator.
- e. Adjust the output level of the sweeper/generator for full vertical deflection on the oscilloscope face.
- f. Calibrate the scope fact to show 3 dB in 1 dB steps and mark the traces with a grease pencil.
- g. Return sweeper/generator output level to full deflection. Rotate the step attenuator on the sweeper/generator (CCW) so that the output is reduced by 10 dB; reduce the output an additional 7 dB with the vernier control.
- h. Reconnect the power amplifier module under test per Figure 6-1.

#### 6.2.2.2.3 Measurement Procedure

- a. Turn on the power supply connected to the power amplifier module under test.
- b. Observe the gain versus frequency sweep on the oscilloscope.
- c. The average gain should be 14 dB.

- d. The gain variation should be within the 3 dB markings as shown on the oscilloscope face.

### 6.2.3 Preamplifier Module

If the test in section 6.2.2.2 shows that the power amplifier modules are not faulty and the output combiner is not faulty, then the driver is suspect. A check of the power supply per 6.3.2 should be performed to conclude positively that the driver amplifier module is faulty.

## 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.

The power supply adjustments are located on the power supply assembly. The left potentiometer adjusts the output voltage and the right potentiometer sets the current limit. (As viewed from the side of the unit).

### 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
  2. Oscilloscope - Tektronix T921
- b. Disconnect all external cables from the Model 525LA.
- c. Connect the minus (-) DVM lead to the chassis and the positive (+) lead to the power supply. The DVM should indicate 26.4 volts DC.
- d. Connect the oscilloscope to the power supply. The ripple on the supply should be less than 25 millivolts.

## 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 525LA is assembled with standard hardware. Screw sizes range from #4-40 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 (8 #8-32 and 4 #4-40) located on both sides and 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 Preamplifier Assembly

- a. Remove the cover by removing six #4-40 screws.
- b. Remove the six #6-32 screws holding the assembly to the power amplifier heatsink.
- c. Remove the input cable from J1 on the preamplifier module.
- d. Remove the +26.4 VDC input wire from the terminal block of the Regulator Board.
- e. Remove the output cables from J2 and J3.

### 6.4.5 Output Combiner Assembly

- a. Remove the cover by removing four #4-40 screws. Also disconnect the BNC output connector from the front panel.
- b. Remove the four #6-32 screws holding the assembly to the power amplifier heatsink. Remove the #4-40 screw from the front panel support bracket.

- c. Remove the input cables from J9 and J10 and one output cable from J11.

#### 6.4.6 Power Supply Assembly

- a. Remove the three red wires from the terminal block.
- b. Unsolder the blue wire.
- c. Remove the four #6-32 screws that secure the power supply to the heat-sink assembly.

#### 6.4.7 Power Amplifier Heatsink Assembly

- a. Disconnect the r-f input and output cables from the front panel.
- b. Unsolder the blue wire from the power supply assembly.
- c. Unsolder the red wire that goes to the front panel from the left side power amplifier.
- d. Remove the two #8-32 screws from the fan cover at the rear of the Model 525LA. Also remove the #6-32 screw from the front panel support bracket.
- e. Remove the eight #8-32 screws that secure the assembly to the baseplate.
- f. Lift the assembly straight up.

#### 6.4.8 Power Amplifier Module

- a. Remove the heatsink assembly (See section 6.4.7).
- b. Remove the red power supply lead of the power amplifier module being removed.
- c. Remove the eight #4-40 screws which hold the module to the heatsink.
- d. Remove input and output cables.
- e. Remove five #8-32 reduced nuts which hold the transistors to the heatsink.
- f. Carefully lift the board from the heatsink.

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

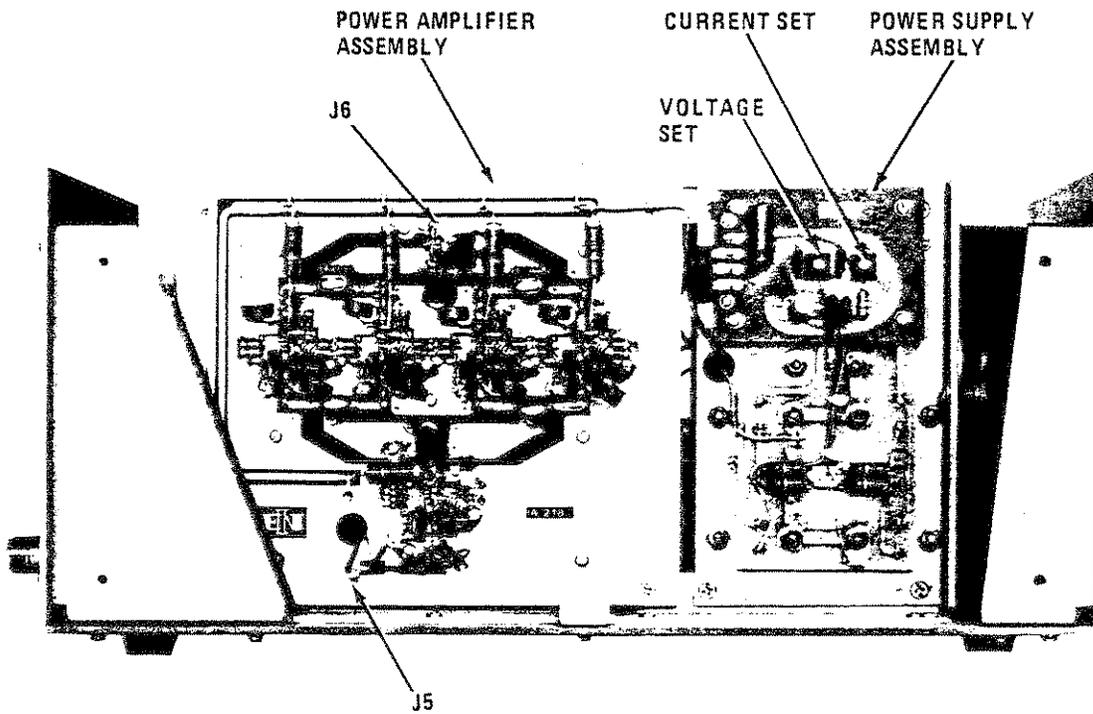


FIGURE 6-2. SIDE VIEW

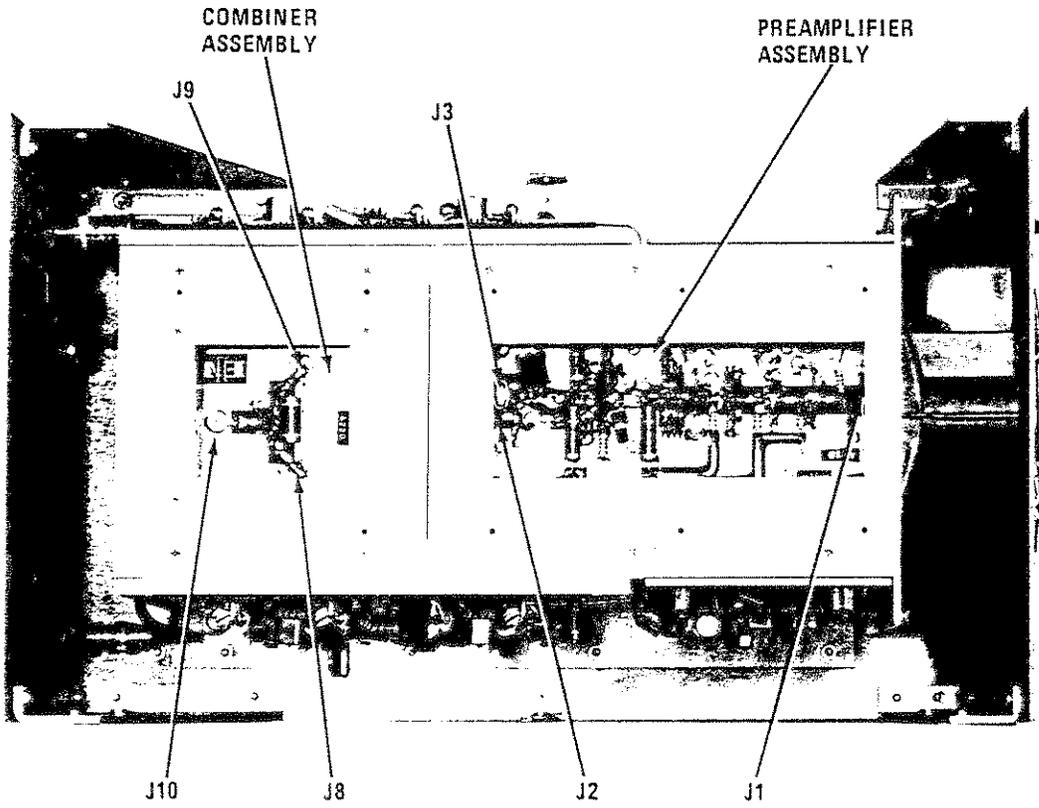


FIGURE 6-3. TOP VIEW



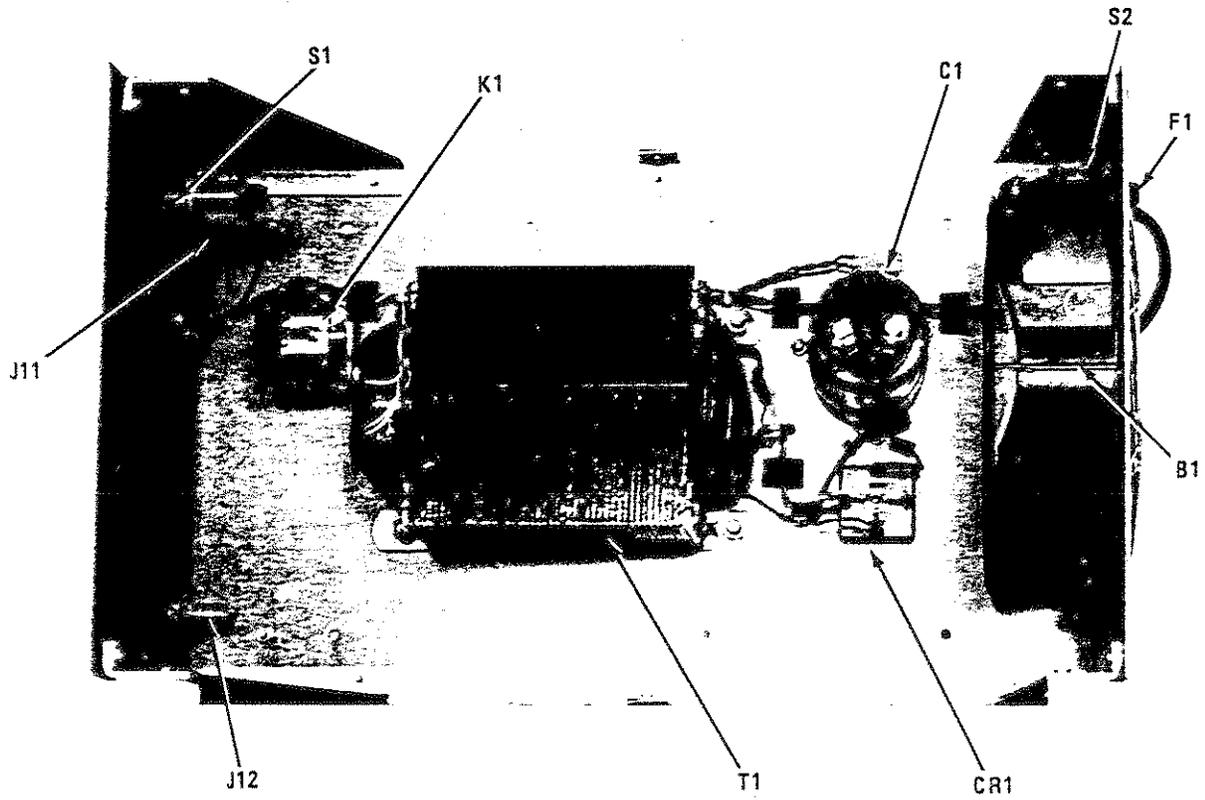


FIGURE 6-4. POWER DISTRIBUTION

## CHAPTER 7

### SCHEMATIC AND PARTS LIST

#### 7.1 SCHEMATIC DIAGRAM

A complete schematic diagram appears in Figure 7-1.

#### 7.2 PARTS LIST

Table 7-1 provides a listing of all electrical parts which may be required for replacement. Electrical parts are listed by module number and by reference designations as indicated on the schematics diagrams. The 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).

TABLE 7-1. REPLACEMENT PARTS LIST

REF. DESIGN	DESCRIPTION	MFG. CODE	PART NO.
	Baseplate Assembly	10226	525LA-13161
CB1	Bridge Rectifier	04713	MDA-3501
C1	Capacitor, 12000uf, 50V	56289	36D123G040BC2A
K1	Relay, 120 VAC	89265	KUPLAE5
TS1	Thermostat Switch	14604	3450-088-175
T1	Transformer	12715	AM5862
	Front Panel Assembly	10226	525LA-13162
S1	Switch	87034	616-6-1
DS1	Bulb	08806	327
	Rear Panel Assembly	10226	525LA-13165
B1	Fan	28875	10
F1	Fuse, 10 amp, Slo-Blo	75915	315010
S2	Switch	77946	SW622HK-1151230
	Preamplifier Assembly	10226	525LA-13165
A219A	Preamplifier Board	10226	525LA-14162
R1	47 ohm, 1/8W, 5%, Resistor	82142	CR-5
R2	180 ohm, 1/8W, 5%, Resistor	82142	CR-5
R3,R11	300 ohm, 1/8W, 5%, Resistor	82142	CR-5
R4,R9,R14	Variable Resistor, 1/4W, 5%	82142	CR-5
R5,R51	150 ohm, 1/4W, 5% Resistor	82142	CR-5
R6,R7	39 ohm, 1/8W, 5% Resistor	82142	CR-5
R8	10 ohm, 1/4W, 5% Resistor	82142	CR-5
R10	240 ohm, 1/4W, 5% Resistor	82142	CR-5
R12,R13	27 ohm, 1/8W, 5% Resistor	82142	CR-5
R15	200 ohm, 1/4W, 5% Resistor	82142	CR-5
R16	470 ohm, 1/4W, 5% Resistor	82142	CR-5
R17-R20	47 ohm, 1/4W, 5% Resistor	82142	CR-5
R21	Variable Resistor, 1/2W 5%	82142	CR-5
R22,R35,R36	150 ohm, 1/2W, 5% Resistor	82142	CR-5
R23	180 ohm, 1/4W, 5% Resistor	82142	CR-5
R24-R27,R55	22 ohm, 1/4W, 5% Resistor	82142	CR-5
R28-R31,R44-R49	33 ohm, 1/4W, 5% Resistor	82142	CR-5
R32	68 ohm, 3W, 5% Resistor	82142	CR-5
R33	5.1 ohm, 5W, 10% Resistor	11502	CR-5
R34	Variable Resistor, 2W, 5%	82142	CR-5
R37	75 ohm, 1/4W, 5% Resistor	82142	CR-5
R38-R43	27 ohm, 1/4W, 5% Resistor	82142	CR-5
R50	240 ohm, 1/2W 5% Resistor	82142	CR-5
R52	18 ohm, 1/8 W, 5% Resistor	82142	CR-5
C1,C4,C8,C12, C20,C23	Chip Capacitor, .1 mf, 50V	31433	C1210C104MSUAH
C2,C6,C10,C15, C26	Capacitor, .1 mf, 50V	31433	C330C104MSUICAC9250
C3	Capacitor, .1uf, 50V	31433	C320C103MIR5CA
C5,C19,C21,C30, C34,C35	Capacitor, 2-15 pf	80031	2810C00215QJ02F
C7,C11,C16,C24	Capacitor, .033mf, 50V	31433	C320C333MSUICAC9250
C9,C14,C17	Capacitor, 10pf DM-5	02799	DM5CC100A
C13	Chip Capacitor, 39pf	29990	100B-390-KP500

TABLE 7-1. REPLACEMENT PARTS LIST (CONT.)

REF. DESIGN	DESCRIPTION	MFG. CODE	PART NO.
C18,C32	Capacitor, 5pf, DM-5	02799	DM5CC050A
C22	Capacitor, 20uf, 50V	56289	500D206G050DD7
C25,C36	Chip Capacitor, 27 pf	29990	100B-270-KP500
C27	Chip Capacitor, 6800 pf, 50V	95275	VJ1812A682KHA
C28	Capacitor, 3pf, DM-5	02799	DM5CC030A
C29	Capacitor, 2pf, DM-5	02799	DM5CC020A
C31	Capacitor, 4pf, DM-5	02799	DM5CC040A
C33	Capacitor, .001 uf	72982	357-000-X5UO-102M
L1-L3,L5,L8,L9	Choke, 22 uhy	99800	1537-44
L4,L6	Choke, 27 uhy	99800	2890-30
L7	Choke, 150 uhy	99800	3500-12
L10	3 Turns Choke	10226	
L11	2 Turns Choke	10226	
D1	Diode	12969	UM4001B
D2	Diode	04713	LN914
Q1-Q3	Transistor	10225	CD2240
Q4	Transistor	10226	ENI-10A
Q5	Transistor	10226	ENI-28
T1	Transformer (A Core)	10226	
T2	Transformer (I Core)	10226	
T3	Transformer (I Core)	10226	
	Combiner Assembly	10226	525LA-15166
A220A	Combiner Board	10226	525LA-14163
R1	100 ohm, 50W Resistor	03888	375R750P-100
C1,C2	Capacitor, 2pf, DM-5	02799	DM5CC020A
C3	Capacitor, 3pf, DM-5	02799	DM5CC030A
C4	Capacitor, 4pf, DM-5	02799	DM5CC040A
C5	Variable Capacitor, DM-5	02799	
C6,C7	Chip Capacitor, 6800pf, 50V	95275	VJ1812A682KHA
T1	Transformer (A Core)	10226	
T2	Transformer (I Core)	10226	
	Power Supply Assembly	10226	525LA-15167
Q1	Transistor	79089	40312
Q2-Q5	Transistor	10226	ENI-1
A36	P.C. Wiring Board	10236	525LA-14165
A56R2-R5	16 ohm, 2W, 5% Resistor	11502	BWH
A221	P.S. Regulator Board	10226	525LA-14164
R1	5.1K ohm, 1/4W, 5% Resistor	82142	CR-5
R6,R8	Potentiometer, 200 ohm	32997	3386T-1-201
R7	5.1K ohm, 1/2W, 2% Resistor	16299	HC-5
R9	2.7K ohm, 1/2W, 2% Resistor	16299	HC-5
C1	Capacitor, 560 pf	09023	CM06FD561J03
C2	Capacitor, 150pf	09023	CM05FD151J03
C3	Capacitor, 50uf, 50V	56289	500D506G050DD7
C4	Capacitor, .1mf, 50V	31433	C330C104MSU1CAC9250
C5,C6	Chip Capacitor, .022uf	36346	C1005C223M5UAH
C7	Chip Capacitor, 6800 pf, 50V	95275	VJ1812A682KHA
L1	Choke, .47 uhy	99800	1537-06
D1	Diode	04713	LN753A
IC1	Integrated Circuit	04713	MCI723CP

TABLE 7-1. REPLACEMENT PARTS LIST

REF. DESIGN	DESCRIPTION	MFG. CODE	PART NO.
	P.A. Assembly	10226	525LA-15169
A218A	P.A. Board (2 Required)	10226	525LA-14161
R1,R3	200 ohm, 1/2W, 5% Resistor	82142	CR-5
R2	22 ohm, 1/2W 5% Resistor	82142	CR-5
R4,R27,R30,R33,R36	Variable Resistor, 2W 5%	82142	MO-2
R5	120 ohm, 1W, 5% Resistor	82142	MO-1
R6,R28,R29,R31,R32, R34,R35,R37,R38	150 ohm, 1W 5% Resistor	82142	MO-1
R7,R23-R26	75 ohm, 1/4W, 5% Resistor	82142	CR-5
R8-R13,R39-R44, R51-R56,R63-R68, R75-R80	33 ohm, 1/4W, 5% Resistor	82142	CR-5
R14-R19	39 ohm, 1/4W 5% Resistor	82142	CR-5
R20,R22	120 ohm, 1/4W, 5% Resistor	82142	CR-5
R21	51 ohm, 1/2W, 5% Resistor	82142	CR-5
R45-R50,R57-R62, R69-R74,R81-R86	27 ohm, 1/4W 5% Resistor	82142	CR-5
R87,R89	120 ohm, 2W 5% Resistor	82142	MO-2
R88	51 ohm, 2W, 5% Resistor	82142	MO-2
C1,C15	Capacitor, 2-15 pf	80031	2180C00215QJ02F
C2,C11,C48-C51	Chip Capacitor, .15uf	96095	18125C154KA2080
C3,C8,C9,C28-C31	Capacitor, 10pf DM-5	02799	DM5CC100A
C4,C10,C40-C43, C52,C55	Capacitor, .1mf, 50V	31433	C530C104MSUICAC9250
C5,C7-C9,C36-C39, C44-C47	Chip Capacitor, 27pf	29990	100B-270-KP500
C6	Chip Capacitor, 33pf	29990	100B-330-KP500
C12,C13,C60	Capacitor, 2pf, DM-5	02799	DM5CC020A
C14,C32-C35,C56-C59	Capacitor, 4pf, DM-5	02799	DM5CC040A
C16-C23	Capacitor, 5pf, DM-5	02799	DM5CC050A
C24-C27	Chip Capacitor, .1mf, 50V	31433	C1210C104MSUAH
L1,L16-L20	3 Turns 22 Ga. Buss Choke	10226	
L2,L8-L11	Choke, 22uhy	99800	1537-44
L3,L12-L15	Choke, 27 uhy	99800	2890-30
L4-L7	2 Turns 22 Ga. Buss Choke	10226	
Q1-Q5	Transistor	10226	ENI-28
T1,T9-T12	Torroid (A Core)	10226	
T2,T4,T13,T14	Torroid (I Core)	10226	
T3,T15	Torroid (I Core)	10226	
T5-T8	Torroid (A Core)	10226	
T16	Torroid (I Core)	10226	

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	uf	MICROFARAD
	CARBON	V	VOLTS
DESIG	DESIGNATION	VDCW	DC WORKING VOLTS
ELEC	ELECTROLYTIC	W	WATTS
I.C.	INTEGRATED	WW	WIRE WOUND
	CIRCUIT		
K	KILOHMS		
uH	MICROHENRY		
mV	MILLIVOLTS		
pF	PICOFARAD		

TABLE 7-3. LIST OF MANUFACTURERS

FEDERAL SUPPLY CODE NUMBER	MANUFACTURER	ADDRESS
02799	Arco Pacific	Torrance, CA
03888	KDI Pyrofilm Corp.	Whippany, NJ
04715	Motorola, Inc.	Phoenix, AZ
08806	General Electric Co.	Cleveland, OH
09023	Cornell-Dubiler Electronics	Sanford, NC
10226	Electronic Navigation Ind. Inc.	Rochester, NY
11502	TRW, Inc.	Boone, NC
12969	Unitrode Corp.	Watertown, MA
12715	American Magnetics Corp.	Carterville, IL
14604	Elmwood Sensors, Inc.	Cranston, RI
16299	Corning Glass	Raleigh, NC
28875	IMC Magnetics	Rochester, NH
29990	American Technical Ceramics	Huntington Station, NY
31453	Union Carbide Corp. (Kemet)	Greenville, SC
32997	Bourns, Inc.	Riverside, CA
36346	Union Carbide Corp. (Kemet)	New York, NY
56289	Sprague Electric Co.	N. Adams, MA
72982	Erie Technological Products Inc.	Erie, PA
75042	I.R.C. Division of TRW, Inc.	Philadelphia, PA
75915	Littlefuse, Inc.	Des Plaines, IL
77946	(UID) AMF Electronics Div.	Herndon, VA
79089	R.C.A.	Harrison, NY
80031	Mepco/Electra Inc.	Morristown, NJ
82142	Airco, Inc.	Hogales, AZ
87034	Marco Oak Ind.	Anaheim, CA
89265	Potter-Brumfield	Chicago, IL
95275	Vitramon Inc.	Bridgeport, CT
96095	AVX Corp.	Olean, NY
98291	Sealectro Corporation	Mamaroneck, NY
99800	Delevan Electronics Corp.	E. Aurora, NY

