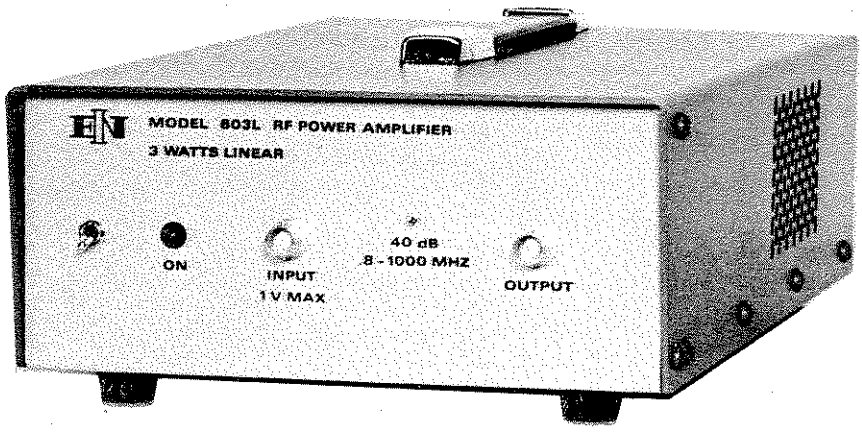
ELECTRONIC NAVIGATION INDUSTRIES, INC.

INSTRUCTION MANUAL

MODEL 603L

BROADBAND POWER AMPLIFIER



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CHAPTER 1. GENERAL INFORMATION

1.1 INTRODUCTION

The Model 603L is a general purpose broadband amplifier capable of more than 3 watts of linear power output when driven by any laboratory signal or sweep generator from .8 to 1000 MHz.

An ultra linear Class A design, the 603L will "boost" the output of any signal source by a flat 40 dB (±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 .8 to 1000 MHz frequency range, full power output is typically available from .7 to 1020 MHz.

The use of stud mounted microwave transistors on a microstrip circuit board makes the 603L both reliable and easy to service. An integral power supply permits operation over a wide range of temperature and AC line conditions.

1.2 DATA SUMMARY

Frequency Coverage:	.8 to 1000 MHz
Gain:	40 dB Nominal
Gain Variation:	±1.5 dB
Maximum Linear Power Output:	More than 3 watts
Harmonic Distortion:	All harmonics greater than 20 dB below the fundamental at 3 watts output. Lower Distortion at reduced power.
Input/Output Impedance:	50 ohms
Input VSWR:	2:1 Maximum
Output VSWR:	3:1 Maximum
Stability:	Unconditionally stable

Typical 3rd Order Intermodulation Intercept Point:	+46 dBm
Noise Figure:	10 dB Nominal
Power Requirements:	115/230V a.c. ±12% 50-60 Hz at 70 watts
Size and Weight:	3.5 x 7.7 x 15.5 inches, 10 lbs. 8.9 x 19.6 x 39.4 cm, 4.5 kg.
Operating Temperature:	0° to 45°C
Protection:	Unit will withstand a +16 dB overdrive (1 volt RMS) for all output load conditions, including short and open circuits.
Output Connectors:	BNC standard, SMA and type N optional
Rack Mounting:	Adaptors provided

CHAPTER 2. OPERATION

2.1 INTRODUCTION

The ENI 603L RF amplifier is used to increase the r.f. output level of signal sources in the .8 to 1000 MHz range. No tuning or any other form of adjustment is required other than the selection of the correct power supply input voltage.

The 603L produces rated power output at its output connectors, regardless of load impedance. Any power reflected due to output load mismatch is absorbed in the amplifier. Therefore, although the output impedance is 50 ohms (typical VSWR: 1.8:1), the amplifier will work into any load impedance.

2.2 MAINS VOLTAGE SETTING

The supply voltage selection switch is located at the rear of the instrument and is normally set for 115 V a.c. operation.

CAUTION Before connecting the unit to the main supply, check that the supply voltage selection switch is correctly set. Extensive damage will result if the Amplifier is connected to the wrong supply voltage. Under no circumstances should this switch be operated while the supply is connected.

2.2.1 MAINS FUSE RATING

The mains fuse F1 is located on the rear panel. The replacement part number details are:

2 amp Slow Blow ENI Part No. 313002

The 2 amp rating is correct for both 115 and 230 volts a.c.

2.2.2 MAINS LEAD CONNECTION

For 230 V a.c. operation, a suitable mains supply plug must be fitted to the mains lead attached to the instrument. The three conductors are color coded as follows:

BLACK - Live
WHITE - Neutral
GREEN - Earth

2.2.3 OPERATION

Determine and adjust the voltage setting and fuse rating as described in the previous sections 2.2 and 2.2.1 then proceed as follows:

(i) Ensure input voltage is not excessive.

The 1 V rms indicated maximum input voltage is 5 times the level of the input signal required to achieve maximum output. Input voltages in excess of 2 volts peak may permanently damage the instrument.

(ii) Connect the input signal via a 50 ohm coaxial lead and BNC plug to the input connector.

(iii) Connect the output via a 50 ohm coaxial lead and BNC plug to the load.

2.2.4 RACK INSTALLATION

For standard nineteen inch relay installations, rack mounting brackets are supplied with the unit. Remove the two #4-40 Phillips screws on each side of the cover nearest the front panel. Either bracket may be used on the right or left side. Attach the rack mounting brackets firmly using the hardware removed above. The rubber feet may be unscrewed and removed if the minimum vertical usage of the relay rack is necessary.

CHAPTER 3. TECHNICAL DESCRIPTION

3.1 GENERAL DESCRIPTION

The ENI Model 603L is designed to amplify signals by 40 dB in the frequency band of .8 to 1000 MHz. The signal from the front panel BNC connector is fed via a length of 50 ohm coaxial cable to the input of the amplifier module (603L-2472). The signal from the input of the amplifier module is fed via a length of microstrip transmission line to a network attenuator R1, R2, and R3 (see figure 5.1). The output of the attenuator is fed to the input of low noise transistor amplifier stage Q1. The gain variation of stage Q1 is leveled by capacitor C5 and its signal output is fed to the base of stage Q2. The gain of stage Q2 is leveled by capacitor C13 and matched by capacitor C16 to the base stage Q3. Transistor Q3 is decoupled from the DC power supply by ferrite choke L5 and inductance coil L4. Its output is leveled and matched by capacitors C26 and C21 and fed through a matching network consisting of L6, L7, C21, C23 and C24 to the base of Q4. Transistor Q4 is a medium power driver stage and its power is optimized by capacitors C25, C27 and C31. Its output is coupled to the base of the high power driver transistor Q5 via a matching network consisting of L10, C33, R33 and C34. This matching optimizes the drive level over the entire frequency band. The output of Q5 is coupled through a microstrip transmission line to the input of the final power transistor Q6, through its associated matching network consisting of C41, C42, C43 and transformer T1. Additional matching is accomplished by capacitors C44, C47, C48 and the negative feedback resistor R46. Power output from transistor Q6 is matched and coupled through transformer T2 and capacitor C51 to the output connector J4. Resistor R56 decouples the power supply turn-on spike and eliminates it from the output.

The 603L power requirements are 115 volts or 230 volts a.c. at 70 watts. The power supply provides a regulated 22 volts d.c. at 2 amperes. The 22 volt d.c. source is regulated by series pass transistor Q1 and intergrated circuit regulator IC1. Control R5 adjusts the power supply to 22 volts d.c.. Control R3 is the short circuit current limiter and it is designed to protect the power supply from damage due to a short circuit. The light located in the front panel is of the L.E.D. type and will indicate when the power supply is operating correctly.

CHAPTER 4. MAINTENANCE

4.1 INTRODUCTION

The ENI 603L amplifier requires no periodic maintenance. The instrument is unconditionally stable and is failsafe under all load conditions. Damage can only be externally caused by the incorrect selection of the supply voltage or by an input signal in excess of the specified 1 volts rms maximum.

This chapter therefore, deals only with certain fundamental procedures for fault location and with the subsequent re-alignment procedures.

Performance limits quoted are for guidance only and should not be taken for guaranteed performance specifications unless they are also quoted in the Data Summary Section 1.2.

4.2 ACCESS AND LAYOUT

The ENI 603L is housed in an aluminum chassis. Its cover is removed by releasing the four #4-40 screws on each side of the unit.

The rear panel supports the mains fuseholder, the mains input selector switch (S2), and the cooling fan.

The amplifier module (603L-2472) is mounted to the base of the one piece chassis. Before removal of this module it is necessary to first remove its coaxial cables and power connection. The module can then be removed by releasing its seven #4-40 phillips mounting screws located on the bottom of the chassis, and lifting the module straight up.

The power supply module (603L-3471) is mounted opposite the power amplifier module on the base of the one piece chassis. To gain access to the module first remove the AC transformer lead connections and release its three #4-40 phillips mounting screws.

4.3 PERFORMANCE CHECKS

To determine the amplifier's performance carry out the following procedure.

4.3.1 Initial Check

The following check can be made after repair and adjustment or whenever the condition of the unit is in question.

(i) Connect power supply. Switch on power and observe that the supply lamp (L.E.D.1) illuminates.

(ii) Connect a sweep generator (Hewlett Packard 8620C or similar) capable of sweeping the frequency range 10 to 1000 MHz to the input connector.

(iii) Adjust the output level of the sweep generator so that a 50 ohm video detector connected at the output of the unit will not be damaged by excessive power output.

(iv) Observe the gain versus frequency ripple on an oscilloscope calibrated in decibels. The gain variation must be not more than ± 1.5 dB over the frequency range.

(v) Connect a calorimetric power meter (HP434 or equivalent) through a short length of 50 ohm cable to the output connector. Adjust the input CW signal to any frequency between .8 and 1000 MHz for 3 watts output.

(vi) Observe the harmonic distortion of the output on a spectrum analyzer. The harmonic components contributed by the amplifier should be at least 20 dB down from the fundamental.

If the requirements of this check are not met, verify that:

(a) The mains supply switch and fuse are correctly selected and that L.E.D. 1 is illuminated.

(b) The power amplifier supply voltage is set at 22 volts by R5.

If the above checks are found to be correct, then fault location procedures, with reference to the circuit diagram Figure 5.1 should be followed to determine the correct operation of the amplifier module.

4.4 RE-ALIGNMENT PROCEDURE

Before any adjustment is made to the unit, first

(i) Ensure that the mains switch and fuse are correctly selected and that L.E.D. 1 is illuminated.

(ii) Measure the power supply voltage and adjust per section 4.3.1 (b).

4.4.1 Measurement of Gain

Equipment required:

(a) HP8620C - Sweep Oscillator
(b) HP86222A - RF Plug-in
(c) Oscilloscope - Telequipment Model S54A
(d) 50 ohm Detector - Wavetek D151
(e) Attenuator, 10 dB, 20 watts - Narda 766-10
(f) HP8601A Sweep Signal Generator

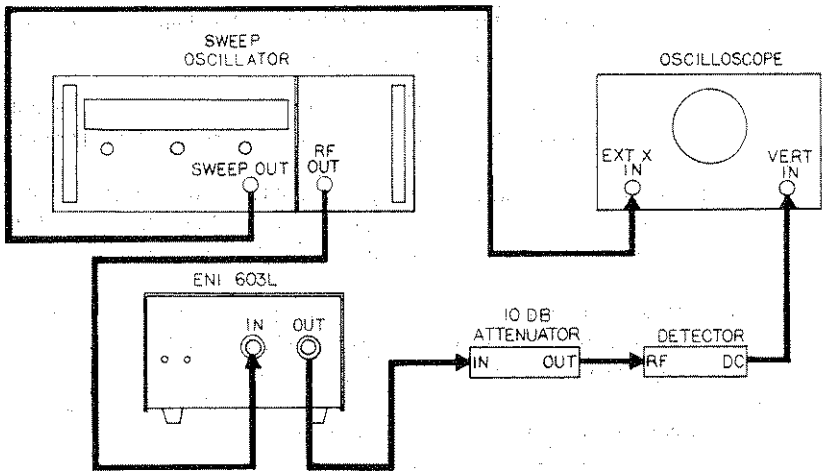


Figure 4.1 Gain Measurement

Connect the equipment as shown in Figure 4.1, then proceed as follows:

(a) Set the oscilloscope to DC, time/CM to Ext. X, and vertical gain to 10MV/CM.

(b) Set the sweep/generator to the sweep mode with the start frequency at 10 MHz and the sweep width to 1000 MHz.

(c) Disconnect the ENI 603L from the set-up and connect the sweep/generator RF output directly to the 10 dB attenuator.

(d) Adjust the output level of the sweep/generator for full vertical deflection on the oscilloscope face.

(e) Calibrate the scope face to show 3 dB in 1 dB steps by attenuating the sweep/generator in 1 dB steps and marking the traces with a grease pencil.

(f) Return sweep/generator output level to full deflection. Route the step attenuator on the sweep/generator (CCW) so that the output is reduced by 40 dB.

(g) Reconnect the 603L into the test set-up of Figure 4.1.

(h) Flip the 603L power switch to the "on" position.

(i) Observe the gain versus frequency sweep on the oscilloscope.

1. The average gain should be 40 dB (within 1 dB).

2. The gain variation should be within the 3 dB markings as shown on the oscilloscope.

(j) Repeat steps (a) through (i) using the HP8601A Sweep Generator with start frequency at 800 KHz and the stop at 10 MHz.

4.4.2 Measurement of Harmonics

Equipment required:

(a) HP8620C - Sweep Oscillator
(b) HP86222A - RF Plug-in
(c) Calorimetric Power Meter - HP434A
(d) Spectrum Analyzer - HP140T Display Unit
HP8555A Spectrum Analyzer
RF Section
HP8552A Spectrum Analyzer
IF Section

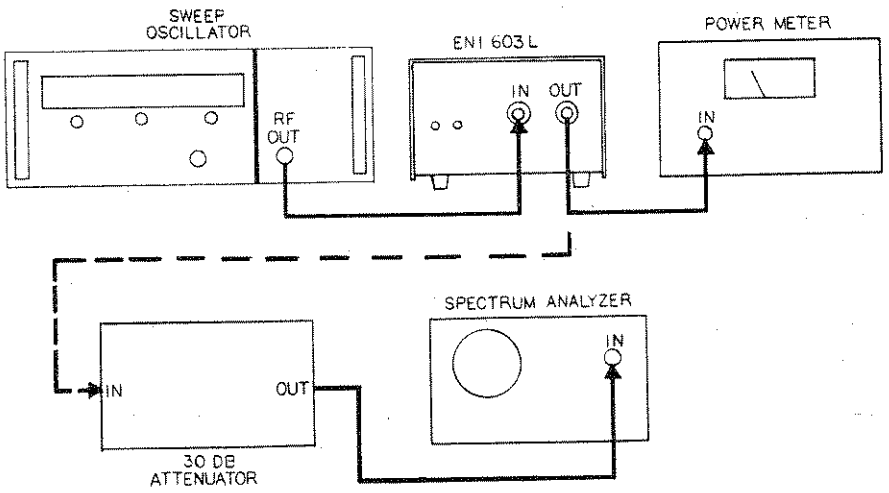


Figure 4.2 Harmonic Measurement

Connect the equipment as shown in Figure 4.2 then proceed as follows:

(a) Adjust the sweep/signal generator at a CW center frequency of 500 MHz for an indicated output of 3 watts on the power meter.

(b) Using the spectrum analyzer, check that the level of the carrier harmonics are less than 20 dB with respect to the carrier.

(c) If the above specification is not met, the 22 volt d.c. supply may be varied up to ±.5V to reduce the harmonic level.

4.5 PACKAGING FOR RESHIPMENT

In the event of the equipment being returned for servicing it should be packed in the original shipping carton and packing material. If this is not available, wrap the instrument in heavy paper or plastic and place in a rigid outer box of wood, fiberboard or very strong corrugated cardboard. Use ample soft packing to prevent movement. Provide additional support for projecting parts to relieve these of unnecessary shock. Close the carton securely and seal with durable tape. Mark the shipping container FRAGILE to ensure careful handling.

CHAPTER 5. SCHEMATIC AND PARTS LIST

5.1 SCHEMATIC DIAGRAM

A complete schematic diagram appears in figure 5.1.

5.2 PARTS LISTS

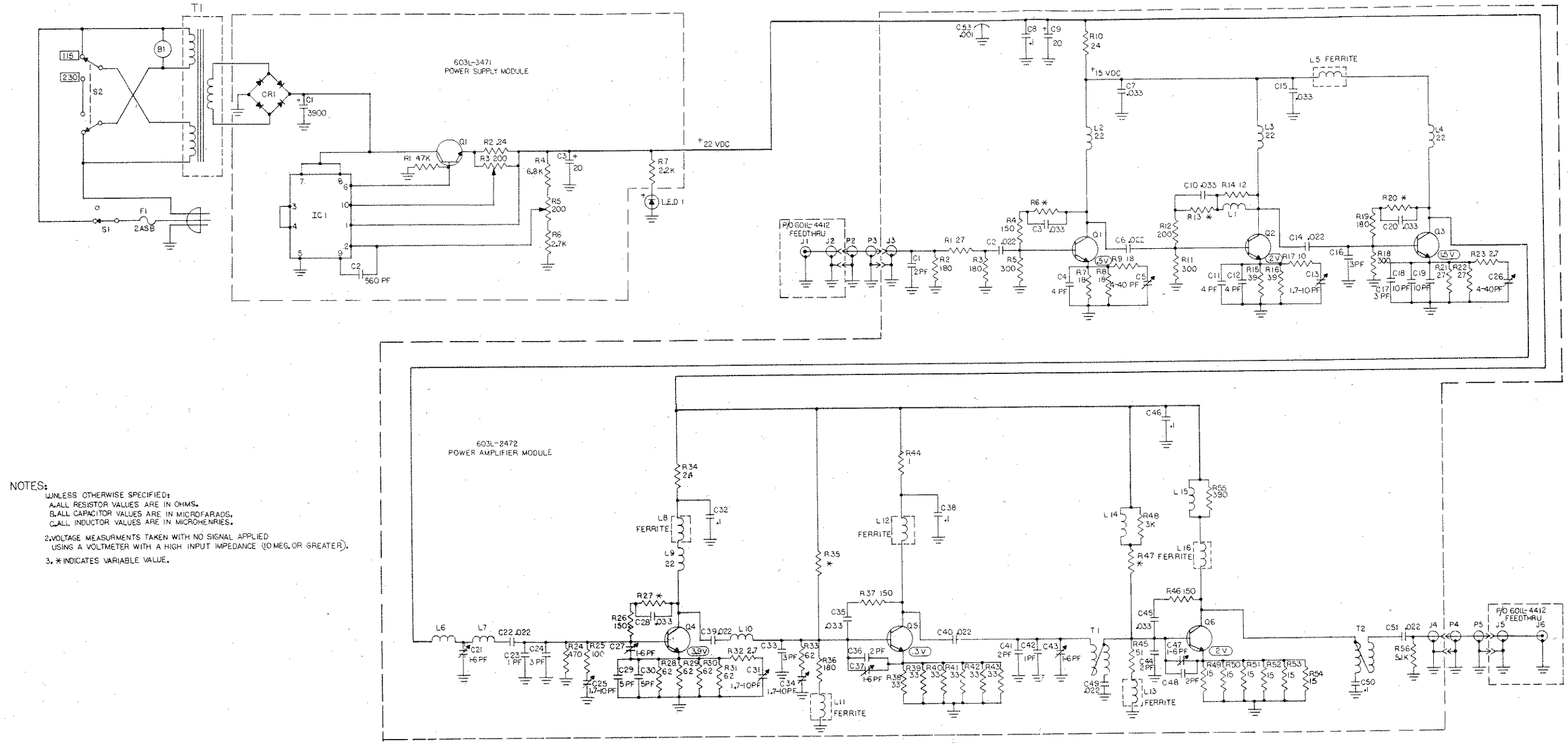
Table 5.1 provides a listing of all electrical parts and those mechanical parts which may be required for replacement. Electrical parts are listed by module number and by reference designations as indicated on the schematic diagram. Parts list includes a description, part number and manufacturers federal supply code number. Table 5.2 provides a reference glossary of abbreviations used in the parts list.

5.3 LIST OF MANUFACTURERS

Table 5.3 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.

5.4 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.



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 MEASURMENTS TAKEN WITH NO SIGNAL APPLIED USING A VOLTMETER WITH A HIGH INPUT IMPEDANCE (10 MEG. OR GREATER).
3. * INDICATES VARIABLE VALUE.

Figure 5.1 Schematic Diagram

TABLE 5-1. REPLACEMENT PARTS LIST
MODEL 603L

REF. DESIGN	DESCRIPTION	MFG. CODE	PART NO.
	POWER DISTRIBUTION ASSEMBLY		603L-2471
L.E.D.1	Light Emitting Diode	28480	5082-4430
T1	Transformer	12715	AM5177B
Q1	Transistor	10226	ENI-1
S1	Switch, Toggle	10226	ST1-1
S2	Switch, Slide DPDT	22753	622-HK-115/230
F1	Fuse 3AG, 2 ASB	75915	313002
FX	Fuseholder	75915	342001
B1	Fan	82877	SU2A1
CR1	Bridge Rectifier	83003	VH148
A1471C1	Regulator	49956	RC723CT
A147R1	Resistor, Comp. 47K ohm, 1/4W, 5%	01121	RC07GF473J
A147R2	Resistor, W.W. .24 ohm, 2W, 5%	75052	BWH.24
A147R3,R5	200 ohm Pot 5%	32997	3386T-1-501
A147R4	Resistor, Film, 6.8K ohm, 1/2W, 5%	16299	HC-5-6.8K
A147R6	Resistor, Film, 2.7K ohm, 1/2W, 5%	16299	HC-5-2.7K
A147R7	Resistor, Comp. 2.2K ohm, 1/2W, 5%	01121	RC02GF222J
A147C1	Cap. Elect., 3900 ufd, 50VDCW	56289	36D392G050AC2A
A147C2	Cap. MICA, 560 pf 5%	09023	CM06FD561J03
A147C3	Cap. Elect., 20 ufd, 50VDCW	56289	TE1305
J1,J6	Connector, BNC	13511	UG625/U
	RF ASSEMBLY		603L-2472
Q1,Q2,Q3	Transistor	10226	ENI-6
Q4	Transistor	10226	CD2240
Q5	Transistor	10226	ENI-10A
Q6	Transistor	10226	ENI-12A or ENI-14A
R10	Resistor, 24 ohm, 5W, 5%	10226	TM-5N.I.
C53	Cap. Feedthru .001 ufd	72982	357-000X-540-102M
J3,J4	Connector, SMA	10226	142-0293-001
A144R1,21,22	Resistor, Comp. 27 ohm, 1/8W, 5%	01121	RC05GF270J
A144R2,3	Resistor, Comp. 180 ohm, 1/8W, 5%	01121	RC05GF181J
A144R4,26	Resistor, Comp. 150 ohm, 1/8W, 5%	01121	RC07GF151J
A144R5,11,18	Resistor, Comp. 300 ohm, 1/4W, 5%	01121	RC07GF301J
A144R6,13,20,27	Resistor Variable	01121	
A144R7,8	Resistor, Comp. 18 ohm, 1/8W, 5%	01121	RC05GF180J
A144R9	Resistor, Comp. 18 ohm, 1/4W, 5%	01121	RC07GF180J
A144R12	Resistor, Comp. 200 ohm, 1/4W, 5%	01121	RC07GF201J
A114R15,16	Resistor, Comp. 39 ohm, 1/8W, 5%	01121	RC05GF390J
A144R17	Resistor, Comp. 10 ohm, 1/4W, 5%	01121	RC07GF100J
A144R19,36	Resistor, Comp. 180 ohm, 1/4W, 5%	01121	RC07GF181J

TABLE 5-1. REPLACEMENT PARTS LIST
MODEL 603L (Continued)

REF. DESIGN	DESCRIPTION	MFG. CODE	PART NO.
A144R23,32	Resistor, Comp. 2.7 ohm, 1/4W, 5%	01121	RC07GF2R7J
A144R24	Resistor, Comp. 470 ohm, 1/4W, 5%	01121	RC07GF471J
A144R25	Resistor, Comp. 100 ohm, 1/4W, 5%	01121	RC07GF101J
A144R28-31,R33	Resistor, Comp. 62 ohm, 1/4W, 5%	01121	RC07GF620J
A144R34	Resistor, W.W. 2.4 ohm, 5W	44655	4539
A144R35	Resistor, Variable	01121	
A144R37,46	Resistor, Comp. 150 ohm, 1/2W, 5%	01121	RC20GF151J
A144R38-R43	Resistor, Carbon Film 33 ohm, 1/4W, 5%	10226	CR25
A144R44	Resistor, W.W. 1 ohm, 5W	44655	4530
A144R45	Resistor, Comp. 51 ohm, 1/4W, 5%	01121	RC07GF510J
A144R47	Resistor, Variable	01121	
A144R48	Resistor, Comp. 3K ohm, 1/2W, 5%	01121	RC20GF302J
A144R49-R54	Resistor, Carbon Film 15 ohm, 1/4W, 5%	10226	CR25
A144R55	Resistor, Comp. 390 ohm, 1/2W, 5%	01121	RC20GF391J
A144R56	Resistor, Comp. 5.1K ohm, 1/4W, 5%	01121	RC07GF512J
A144C1,44	Cap. Cer., 2pf Chip	36346	C080C209D5GAH
A144C2,6,14,22, 39,40,49,51	Cap Cer., .022ufd Chip	36346	C1005C223M5UAH
A144C3,7,10,15, 20,28,35,45	Cap. Cer., .033 ufd	36346	C320C333M5U5EA
A144C4,11,12	Cap. Mica, 4 pf, 5%	09023	DM5CC040A
A144C5,26	Cap. Variable 4-40 pf	91293	9304
A144C8,32,38,46	Cap. Cer., .1 ufd 50 VDCW	36346	C330C104M5U5EA
A144C9	Cap. Elect., 20 ufd, 50VDCW	56289	TE1305
A144C13,25,31, 34	Cap. Variable 1.7-10 pf	91293	9301
A144C16,17,24, 33	Cap, Mica, 3 pf, 5%	09023	DM5CC030A
A144C18,19	Cap, Mica, 10 pf, 5%	09023	DM5CC100A
A144C21,27,37, 43,47	Cap, Variable 1-6 pf	10226	2222-801-96135
A144C23,42	Cap, Mica, 1 pf, 5%	09023	DM5CC010A
A144C29,30	Cap, Mica, 5 pf, 5%	09023	DM5CC050A
A144C50	Cap, Cer., .1 ufd Chip	36346	C1210C124M5UAH
A144C36,41,48	Cap, Mica, 2 pf, 5%	09023	DM5CC020A
A144L2,L3,L4, L9	Choke, RF, 22 uhy, 10%	99800	1537-44
A144L5,L8	Choke, RF	10226	
A144L11,L13	Choke, RF	10226	
A144L12	Choke, RF	10226	
A144L16	Choke, RF	10226	
A144T1	Transformer, Matching	10226	
A144T2	Transformer, Matching	10226	

TABLE 5-2. GLOSSARY OF ABBREVIATIONS

AMP	AMPERES	PF	PICOFARAD
AMPL	AMPLIFIER	POT	POTENTIOMETER
BKT	BRACKET	REF	REFERENCE
CAP	CAPACITOR	RES	RESISTOR
CER	CERAMIC	SIL	SILICON
COMP	COMPOSITION CARBON	UF	MICROFARADS
DPDT	DOUBLE-POLE THROW	UH	MICROHENRY
ELECT	ELECTROLYTIC	V	VOLTS
IN	INCHES	VAR	VARIABLE
K	KILOHMS	VDCW	DC WORKING VOLTS
MTG	MOUNTING	W	WATTS
MW	MILLIWATTS	WW	WIRE WOUND

TABLE 5-3. LIST OF MANUFACTURERS

FEDERAL SUPPLY CODE	MANUFACTURER	ADDRESS
01121	Allen-Bradley Company	Milwaukee, WI
09023	Cornell-Dubilier Electronics	Sanford, NC
10226	Electronic Navigation Ind. Inc.	Rochester, NY
12715	American Magnectics Corporation	Carterville, IL
13511	Amphenol Corporation, Inc.	Los Gatos, CA
16299	Corning Glass	Raleigh, NC
22753	UID Electronics Corporation	Hollywood, FL
28480	Hewlett Packard	Palo Alto, CA
32997	Bourns, Inc.	Riverside, CA
36346	Union Carbide	New York, NY
44655	Ohmite MFG. Company	Skokie, IL
49956	Raytheon, Company	Lexington, MA
56289	Sprague Electric Company	N. Adams, MA
72982	Erie Technological Products, Inc.	Erie, PA
75052	IRC Div. of TRW, Inc.	Philadelphia, PA
75915	Littlefuse, Inc.	Des Plaines, IL
82877	Rotron	Woodstock, NY
83003	Varo, Inc.	Garland, TX
99800	Delevan Electronics Corporation	E. Aurora, NY

ADDENDUM

All model 630L Broadband power amplifiers with serial number 181 or higher have been modified for use with a new and more rugged transistor in the output stage. The component changes which result from this modification are as follows: (Refer to figure 5.1)

1. Resistor R33 and adjustable capacitor C34 have been removed.

2. L11 has been changed from a ferrite choke to a 22 µhy choke number 1537-44 (Mfg. Code 9980).

3. L13 has been changed from a ferrite choke to two 22 µhy chokes in series. Part number same as above.

4. L16 has been changed from a ferrite choke to a 27 µhy choke number 2890-30 (Mfg. Code 9980).

5. Transistor Q6 is now an ENI-14B.