

ELECTRONIC NAVIGATION INDUSTRIES, INC.

OPERATING AND SERVICE INSTRUCTIONS

MODEL 406L

BROADBAND RF POWER AMPLIFIER

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1.0 INTRODUCTION

The Model 406L is a broadband solid state power amplifier covering the frequency range of 150 KHz to 250 MHz.

Over 5 watts of RF power can be produced at the output, with low harmonic and intermodulation distortion. A highly linear Class A design, the Model 406L will amplify inputs of AM, FM, SSB, pulse and other complex modulations, with minimum distortion. The 40 dB gain of the unit permits it to be driven to its full power output by any signal or sweep generator capable of supplying a minimum -3 dBm (.15 volts RMS) signal level into its 50 ohm input. Virtually all commercial signal and sweep generators are capable of supplying this signal.

The Model 406L operates over its entire bandwidth without tuning or other adjustments. It is capable of supplying useful power output up to 270 MHz, at reduced gain.

The unit is unconditionally stable and will not oscillate for any possible combination of source and load impedances. It is protected against failure due to output load mismatch and/or overdrive. The Model 406L will withstand a +16 dB overdrive (input signal of 1 volt RMS) for all output load conditions including both short and open circuit loads.

Output RF voltage level, as well as power output into 50 ohms, is monitored by a front panel meter. An integral power supply permits operation directly from the AC line.

2.0 SPECIFICATIONS

Frequency Coverage:	150 KHz to 250 MHz without tuning.
Maximum Power Output:	5 watts CW and PEP (Peak Envelope Power) at rated distortion; higher power output at increased distortion.
Input Signals:	Unit will accept CW, AM, FM SSB, Wideband Sweep and other complex modulations, limited only by their bandwidth and peak input level.
Gain:	40 dB nominal.
Gain Variation:	Less than ± 1.5 dB from 150 KHz to 250 MHz.
Harmonic Distortion Products:	Typically better than 25 dB at 5 watts; 30 dB at 4 watts.
Typical 3rd Order Inter-modulation Intercept Point:	+ 47 dBm
Input-Output Impedance:	50 ohms.
Input VSWR:	Less than 1.5
Output VSWR:	Less than 2.0 (typical).
Noise Figure:	Less than 10 dB
Stability:	Unconditionally stable; unit will not oscillate for any condition of load and source impedances.
Protection:	Unit will withstand a +16 dB overdrive (input signal of 1 volt RMS) for all output load conditions, including short and open circuit loads.

Output Metering:	Average reading voltmeter, calibrated in RMS volts for a sine wave, with an accuracy of + 5% of full scale (0 - 22 volts); also calibrated in watts into 50 ohms (0 - 9 watts).
Power Requirements:	105 - 125 VAC, 50 to 60 cps or 210 - 250 VAC
Operating Temperature:	0° to + 50° C.
Size:	6 x 8 1/2 x 15 inches.
Weight:	17 lbs.
Input and Output Connectors:	BNC

3.0 OPERATING INSTRUCTIONS

The Model 406L is easy to connect and use. The input and output are connected via the front panel BNC connectors to the signal source and load respectively.

The input signal should be increased gradually while observing the output voltage on the output RF voltmeter. Input signal voltage should never be allowed to exceed 1 volt (RMS) or 1.4 volts (peak).

When the Model 406L is connected to a 50 ohm load, the CW power output of the unit may be read directly from the meter scale. The red portion of the meter indicates that the amplifier is no longer operating in its most linear region and increased distortion may result. This occurs at 5 watts (PEP or CW) of RF output power into 50 ohms (22.4 volts peak).

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

- (1) Disconnect the output load cable from the output BNC connector of the Model 406L.
- (2) If the CW output voltage is less than the red line value (16 volts RMS), the unit is operating at low distortion regardless of the load impedance.
- (3) Reconnect the output of the amplifier to the load.

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.

4.0 TEST PROCEDURE

To determine proper operation of the Model 406L, the following test procedure should be used:

- (1) Connect a sweep generator capable of sweeping the frequency range of 1 to 250 MHz to the input BNC connector.
- (2) Adjust the output level of the sweep generator so that a 50 ohm video detector connected at the output will not be damaged by excessive power.
- (3) Connect the 50 ohm video detector to the output of the Model 406L.
- (4) Observe the gain versus frequency ripple on an oscilloscope calibrated in decibels.
- (5) The gain variation over the frequency range should be less than ± 1.5 dB.
- (6) Connect a calorimetric power meter (i.e., HP 434A) through a short length of 50 ohm cable to the output BNC connector.

- (7) Adjust the input CW signal level (at any frequency between 0.15 and 250 MHz) until the front panel meter reads 5 watts. Compare this with the reading of the calorimetric wattmeter. They should be within ± 1 watt.
- (8) Observe the output signal on a spectrum analyzer connected to the output through at least 40 dB of external attenuation. The individual harmonic components contributed by the amplifier should be more than 20 dB down from the fundamental.

5.0 CIRCUIT DESCRIPTION

A block diagram of the entire 406L is shown in Figure 1.

Input signal from the front panel BNC is fed to the preamplifier module (Item 1, Figure 2). The preamplifier has four equal amplitude and phase outputs. These are fed via RG 174 coaxial cable to the inputs of the four power amplifier modules. Each preamplifier channel has an overall gain of 15 dB and a maximum power output of 100 milliwatts into 50 ohms. A factory-adjusted peaking control (Item 2) compensates for the high frequency gain roll-off of the power amplifier modules.

The Model 406L achieves its high power output by combining the outputs of sixteen separate power amplifier stages. Hybrid combiners couple the individual stage outputs to the main amplifier output. The stages are highly isolated by these combiners and between stage interaction is negligible. Four power amplifier modules, consisting of four output stages each, are mounted symmetrically on the 406 heat sink shown in Figure 2, Items 3, 4, 5, and 6.

Each of the four power amplifier modules has a 50 ohm input and output impedance. The inputs (UG 1619) are mounted at the bottom of the modules and the outputs are located at their tops. The modules are individually adjusted for a maximum power of 1.5 watts output and have a gain of approximately 20 dB at the low end of the frequency range, decreasing to 18 dB at 250 MHz.

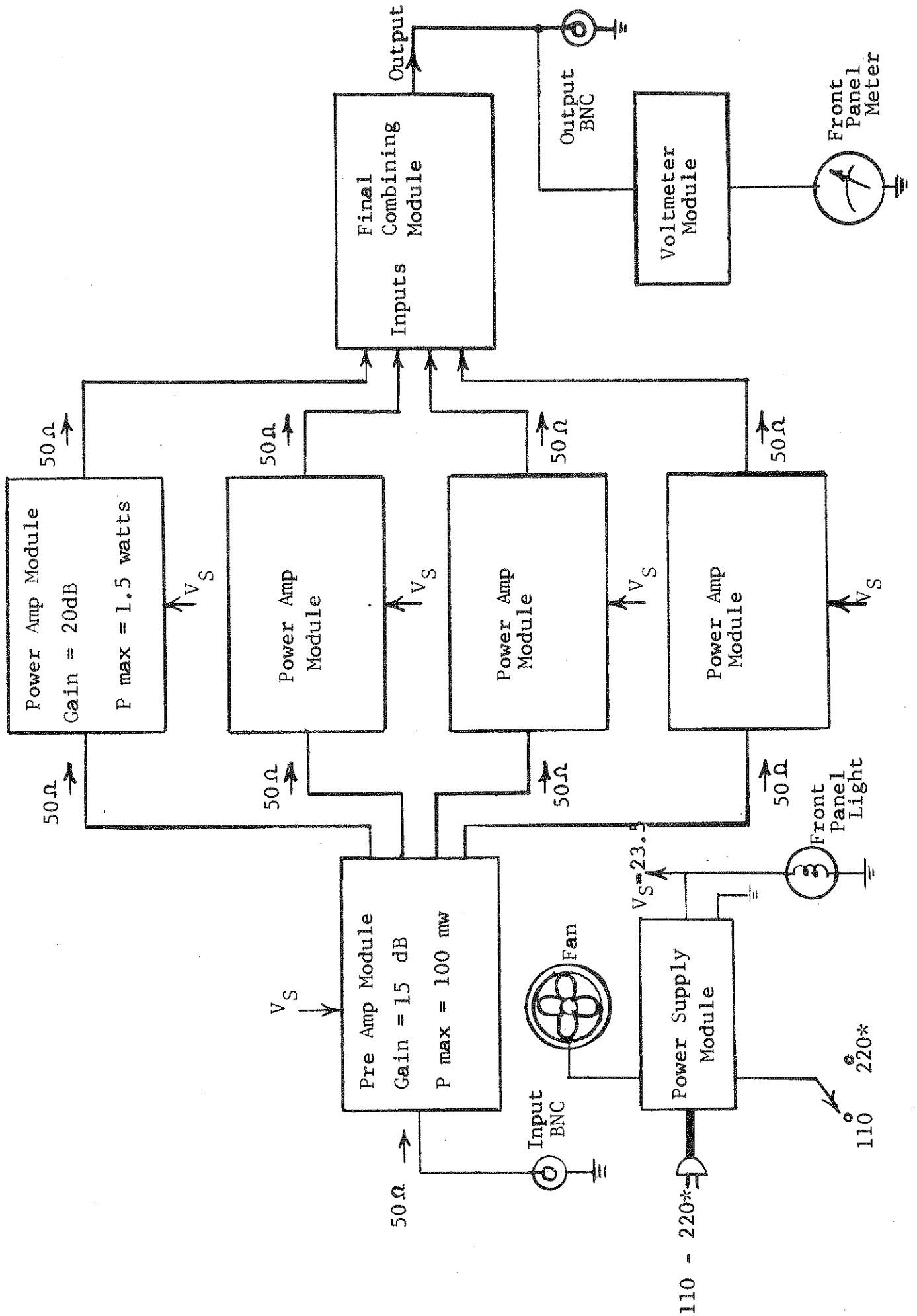


Figure 1 BLOCK DIAGRAM - MODEL 406L

*Optional

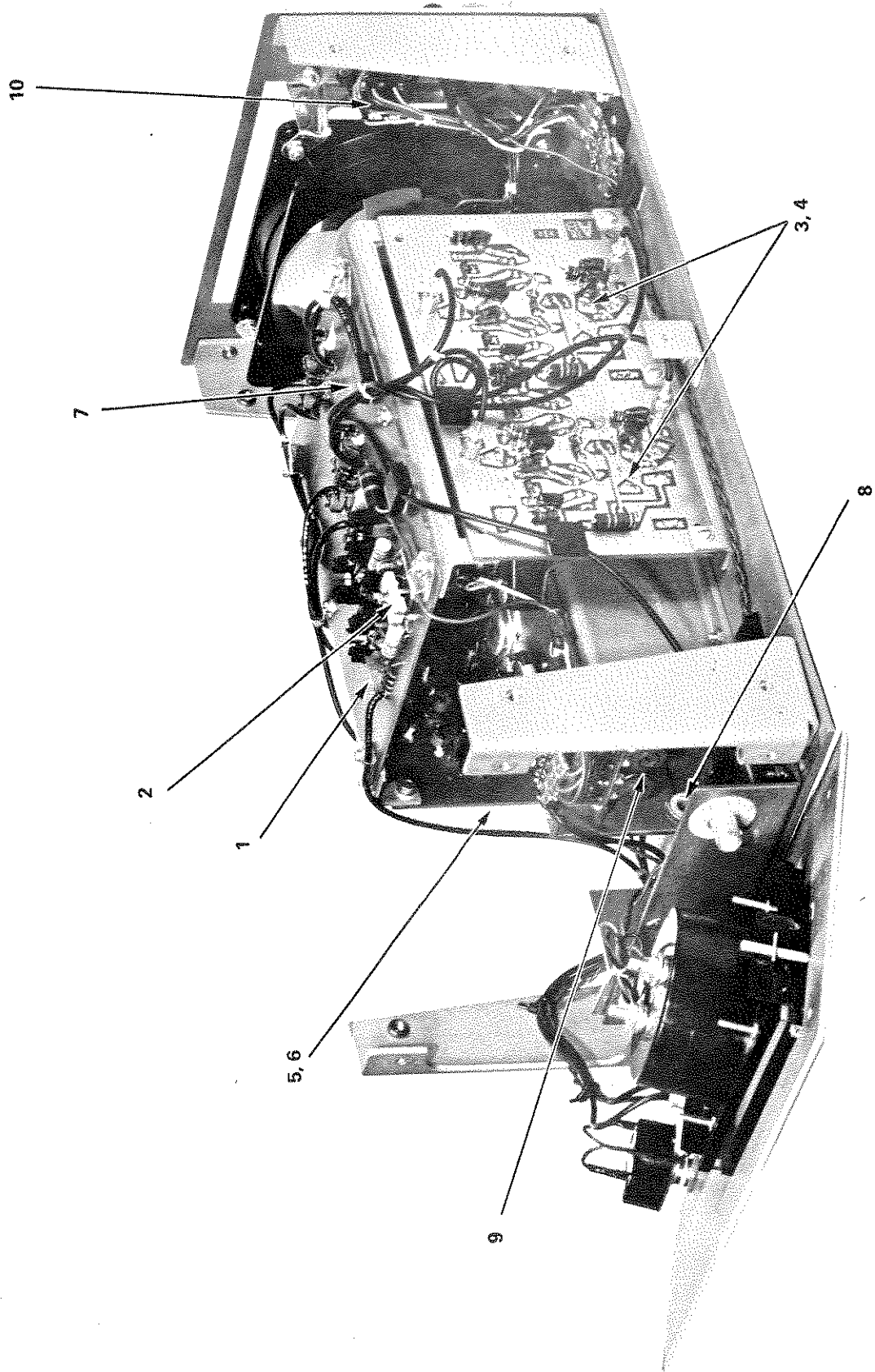


FIGURE 2 INSIDE VIEW -- MODEL 406 L

The outputs of the power amplifiers are combined in the final combining module (Item 7). This hybrid combiner covers the entire frequency range with a maximum of 0.5 dB insertion loss. The main output of the combining module is fed via coaxial cable to the front panel output BNC connector.

The voltmeter module is connected to the output BNC connector. It samples the RF voltage present at that point and produces a DC voltage proportional to its average value. This DC output is fed to the front panel meter, which is calibrated in RMS volts for a sine wave. The bottom scale of the meter is calibrated in watts into 50 ohms for a sine wave. Absolute calibration of the voltmeter is accomplished by a variable control mounted on the module (Item 8).

The entire unit is powered by a regulated power supply capable of supplying 23.5 volts (approximately) at a current of 2.5 amperes. The power supply circuit module is mounted directly below the inverted "U" in the path of the forced air cooling. DC voltage adjustment is accomplished by a variable control mounted on the module (Item 9). A short circuit protection control located next to the output control is set at the factory to protect against damage due to inadvertent (short time) output short circuits. The DC output current is fed in series with a thermostat mounted on the rear of the power supply. Should the fan fail or dirt in the filter screen prevent adequate cooling, the thermostat will open and prevent damage to the unit.

An optional 110 - 220 v switch mounted on the rear panel enables the 406L to be operated from either line voltage (Item 10).

6.0 REGULAR ADJUSTMENT AND MAINTENANCE

There are no periodic electrical adjustments required to maintain the amplifier gain and power output characteristics.

Periodic cleaning and lubrication of the fan filter should be done every six months under ordinary service conditions. To remove the fan filter, insert a screw driver in the two top slots and gently pry it off. To clean the filter, it

soaked in an industrial cleaner solution such as "Toluene" for two minutes. After drying thoroughly, lubricate it with a few drops of number 10 oil. To re-insert the filter, push in both sides, until the unit "clicks" into its holder.

7.0 110 - 220 VOLT OPERATION

The optional power supply switch is located at the rear of the back panel through a snap plug. The 110 volt connector is the top position of the switch and is clearly labeled on the back panel. For 220 volt (foreign voltage) operation, the switch should be in the down position. Under no circumstances should this switch be thrown while power is connected. Before the Model 406L is connected to a 220 volt line, check the position of this switch. Extensive damage will result to the unit if it is placed in the wrong position.

If there is no voltage label (110-220) on the back panel, the Model 406L is permanently wired for 110 volt AC operation.

8.0 CASE REMOVAL

The front panel may be disassembled by removing its four retaining screws. Access is provided through the front panel opening to the power supply and the RF voltmeter calibration controls (see Figure 2).

The screws located on both sides of the cover and at the top of the bezel must be removed as the first step in removing the cover. Slide the cover backwards approximately one inch until it clears the front bezel and lift off. To reassemble, simply reverse the process. When replacing the cover, care should be taken that the case does not come in contact with the internal amplifier cabling.

9.0 PRECAUTIONS

(1) The Model 406L output is at DC ground potential through the final combining transformer. Therefore, the output should not be directly connected to a load on which there is a DC potential. If the output load has a DC potential, insert a series capacitor with the appropriate voltage breakdown rating (.1 mfd is the recommended value) between the load and the output cable.

(2) The input and output of the Model 406L should not be connected together. This will cause oscillation and may damage the input preamplifier.

(3) The 406L 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.

(4) When the input signal voltage of a drive source is unknown, insert an attenuator between it and the Model 406L input.

10.0 TROUBLESHOOTING

If the Model 406L should fail to operate, and the panel light does not glow, check the condition of the fuse at the rear of the unit (2 amp SB, 3 AG).

If the unit cycles on and off over a period of time, check the condition of the fan filter (see maintenance instructions).

Should the Model 406L fail to operate properly, each individual amplifier module may be tested for power output and frequency response in accordance with Figure 1 and following the test procedures of Section 4.

The Model 406L circuit modules should be serviced only by the factory or its authorized facility. However, ENI will supply pre-aligned and calibrated module boards as replacement items.

DO NOT ATTEMPT to probe the circuit modules while they are mounted in the amplifier case, as extensive damage may result.

11.0 FACTORY SERVICE

When factory service is required, the following steps should be taken:

(1) Notify us, giving full details of the difficulty. Include the instrument's serial number.

(2) Upon receipt of shipping instructions, forward the instrument transportation prepaid, to the factory or to the authorized repair station indicated on the instructions.

If requested, an estimate of the charge will be made before the work begins, provided the instrument is not covered by warranty.



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W A R R A N T Y

Electronic Navigation Industries, Inc. warrants each instrument to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing and replacing any defective parts for a period of one (1) year after delivery to the original purchaser.

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.

There are no other warranties expressed or implied, including any warranty of merchantability or fitness. Seller shall not be responsible for any incidental or consequential damages arising from any breach of warranty.