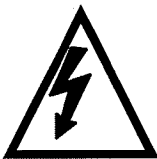




SERVICE MANUAL

OEM-6M RF Plasma Generator



HIGH RF VOLTAGES MAY BE PRESENT AT THE OUTPUT OF THIS UNIT. All operating personnel should use extreme caution in handling these voltages and be thoroughly familiar with this manual.



DO NOT USE ANY CFC (CHLOROFLUOROCARBON) SOLVENT IN THE MAINTENANCE OF THIS PRODUCT. In recognition of our responsibility to protect the environment, this product has been manufactured without the use of CFC's. The no-clean flux now used in all soldering operations may leave a small inert residue which will not affect the performance of the product. The use of CFC's for cleaning or maintenance may result in partial liquification of the no-clean flux residue, which will damage the unit and void the warranty.



This product is manufactured at ENI's Rochester NY plant, an ISO 9001 Quality System Certified Facility.

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ENI warrants to the original purchaser for a period of one year from the date of delivery, each instrument to be free from defects in materials and workmanship. For a period of one year, ENI will, at its option, adjust, repair, or replace defective parts, without charge to the original purchaser, so that the instrument performs according to its specifications.

When warranty service is required, the instrument must be returned, transportation prepaid, to the factory or to one of ENI's designated service centers. If, in our opinion, the instrument has been damaged by accident, unreasonable use, buyer-supplied software or interfacing, improper site preparation or maintenance, or abnormal conditions of operation, repairs will be billed at standard rates. In this case, an estimate will be submitted before the work is started.

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Service And Technical Assistance

For Service or Repair contact the closest Customer Service Department with the following information:

- Model and serial number
- Purchase order number
- Detailed description of malfunction
- Your company's "Bill To" and "Ship To" address

You will receive a RMA (Return Materials Authorization) number, the warranty status of the unit to be returned and estimated repair charge, if any. The RMA number is your authorization number. Please type this number on your purchase order and shipping label. After ENI receives the unit, a firm quote and estimated date of completion will be given.

For Technical Assistance for your particular application, contact the nearest ENI Sales and Service Center. The following information will help us provide you with prompt and efficient service:

- All of the information contained on the unit's name plate.
- Names and telephone numbers of important contacts.
- Detailed description (i.e. physical damage and/or performance anomalies, quantitative and/or qualitative deviation from specifications), including miscellaneous symptoms, dates and times.
- The environment and circumstances under which the issue developed
- Supporting test data and/or records that can be provided.
- Any previous, related conversations and/or correspondence with ENI.

Sales & Service Locations

ROCHESTER, NY

A Division of
Astec America, Inc.
100 Highpower Road
Rochester, NY 14623

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Fax: (716) 427-7839
Svc: (716) 292-7478

Toll Free USA Sales Hotline:
Toll Free USA Service
Hotline:

1-800-267-5362
1-800-724-EN11 (3641)

FREMONT, CA

48834 Kato Road,
Suite 110A
Fremont, CA 94538

Tel: (510) 353-4EN1 (4364)
Fax: (510) 353-4360

AUSTIN, TX

4150 Freidrich Lane
Suite J
Austin, TX 78744

Tel: (512) 462-2191
Fax: (512) 462-9411

UNITED KINGDOM

Mundells Court,
Welwyn Garden City
Hertfordshire AL7 1EN
England

Tel: (01707) 371 558
Fax: (01707) 339 286

GERMANY

Sielminger Str. 63
D-70771 Leinfelden-
Echterdingen (Stetten)
Stuttgart, Germany

Tel: (0711) 947 70 0
Fax: (0711) 947 70 25

JAPAN

541 Aoyogi Kunitachi
Tokyo 186
Japan

Tel: (0425) 229 011
Fax: (0425) 222 636

TAIWAN

No. 15, Lane 24,
Ming Hsiang 1 Street
Hsinchu 300, Taiwan

Tel: (35) 787 762
Fax: (35) 787 760

Product and Applications information also available on the Internet at:

<http://www.enipower.com>

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OEM-6 Appendix

Schematics and Materials

This section contains the following board layouts, related schematics and parts list.

	<i>Drawing P/N</i>	<i>Assy P/N</i>
<i>Silkscreens</i>		
Soft On Board	511229	OEM-6-14397-51
<i>Schematics</i>		
Schematic Index	OEM-6-SCH-01	
<i>Parts List</i>	OEM-6M-11781	
<i>Glossary</i>		

OEM-6 Appendix

Schematics and Materials

This section contains the following board layouts, related schematics and parts list.

	<i>Drawing P/N</i>	<i>Assy P/N</i>
<i>Silkscreens</i>		
Soft On Board	511230	OEM-6-14397-51

Schematics

Schematic Index	OEM-6-SCH-01
Block Diagram	OEM-6-SCH-02
Baseplate Diagram	OEM-6-SCH-03
RF Chassis Diagram	OEM-6-SCH-04
Front Panel Diagram	OEM-6-SCH-05
Control Board Diagram	OEM-6-SCH-06

<i>Parts List</i>	OEM-6M-11781
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Glossary

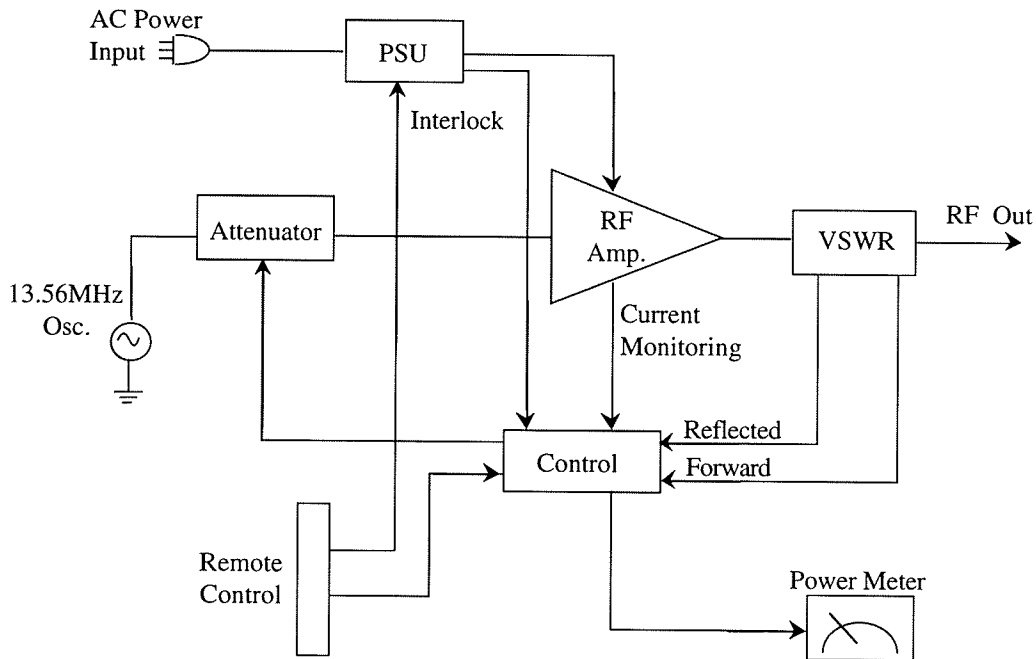
Chapter S1

Technical Description

1.0 System Overview

This section briefly describes the way in which each of the following blocks work:

- Power Supply
- RF Chassis
- Control Board Assembly
- Local and Remote Control Interface Circuits



OEM-6M Overall Block Diagram

Figure 1.0

1.1 Power Supply

The Power Supply provides approximately +44-48V unregulated DC to the RF amplifier module. The circuit consists of a single phase full-wave bridge rectifier assembly with a capability of 35A DC. The transformer is provided with taps to accept line voltages of 190, 208, 220, 230 and 240V. The AC line is fused and an RFI line filter is included. Set-up is aided by a line voltage test circuit which allows the unregulated DC voltage to be read on the front panel power output meter.

The power supply also provides bias voltages to the control board using a transformer with two center-tapped secondary windings. Both windings are rectified by separate full-wave bridge circuits and provide outputs of (+) and (-) 15V. One is referenced to DC ground while the other is referenced the 44-48VDC. The rectifiers and regulators are located on the control board and the transformer is mounted to the RF Amplifier module.

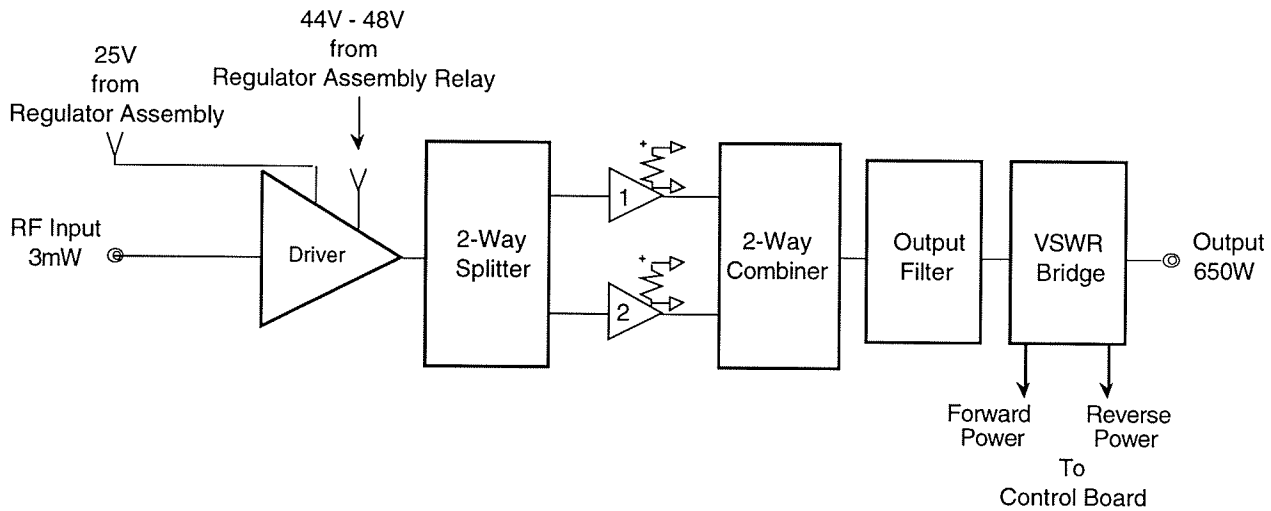
A +25V regulator is located in the RF module for biasing of the driver amplifier. It operates from the unregulated DC. The TIP-35C, high power transistor is used here as a regulator. Bias is present only when the RF ON function is enabled, either locally or through the accessories connector.

1.2 RF Section

This section describes the following assemblies of the RF module:

- RF Driver Amplifier Assembly
- RF Power Amplifiers (2)
- 2-Way Output Combiner
- Harmonic Filter Assembly
- VSWR Bridge Assembly

Figure 1.2 depicts the basic structure of the generator's RF circuitry.



OEM-6M RF Section Module
Figure 1.2

1.2.1 RF Driver Amplifier Assembly

This is a Class A, linear driver with the first two stages operating from regulated +25V. The output stage uses the unregulated DC for the collector supply while the base bias is taken from the regulated +25V.

1.2.2 Power Amplifiers

The two power amplifiers each operate in push-pull Class B mode and are feedback stabilized for operation into high VSWR loads without spurious oscillations. Output from each module is about 350W. Collector bias is unregulated DC at 15A maximum (limited by circuitry on the control board). Resistors used for current sensing are located on each power amplifier.

1.2.3 Output Combiner

The output combiner combines the two power amplifier outputs. It consists of two transformers such that all three ports are 50Ω.

1.2.4 VSWR Bridge Assembly

The VSWR bridge assembly senses the forward and reverse power simultaneously and provides DC outputs to the control board for monitoring and protection functions. These DC levels are applied to a voltage squaring circuit on the control board so that all control and interface functions are linear and directly proportional to power outputs. The VSWR bridge was designed specifically for the OEM-6M and has a residual null reading of less than 1W at full output into a 50Ω load.

1.2.5 Harmonic Filter

The harmonic filter is a seven section Chebyshev design using high voltage capacitors for reliable operation into high VSWR loads. This filter ensures that all harmonics from the power generator are more than 55dB below the fundamental.

1.3 Control Board Assembly

The control board consists of the following circuit assemblies:

- Rectifiers and voltage regulators for the ground referenced and DC referenced $\pm 15\text{V}$ bias supplies
- Current Sensing Protection Circuits
- Reverse Power Protection and Metering Circuits
- Forward Power Control and Metering Circuits
- Maximum Power Indicating Circuit
- RF ON Control Logic and Indicating Circuit
- Line Voltage Test Circuit
- Thermostat Control Interface
- 13.56MHz Oscillator and Buffer Circuits

1.3.1 $\pm 15\text{V}$ Power Supplies

The dual ± 15 volt supplies operate from center-tapped windings on the control transformer mounted on the RF amplifier module. The Supply used with the current sensing is referenced to the unregulated DC (44 to 48V). The voltage regulator is IC1, MC1468. These voltages are used only with IC2, and Q1.

The other supply is referenced to DC ground and uses 3-terminal IC8 (LM337) and IC9 (LM317). These voltages are used for all other circuitry on the control board except where $+25\text{V}$ is used on Q2 and Relay K1.

1.3.2 Current Sensing/Protection Circuit

The current sensing and protection circuit operates from the voltage drop across the current sense resistors located on each power amplifier module. The power supply side (high side) of the resistor is connected to the inverting input of an op-amp through a voltage divider. The power amplifier (low side) of the resistor is connected to the non-inverting input. When the current through the sense resistor is less than 15A, the output of the op-amp will be high and allow Q1 to remain off.

When 15A is exceeded, the voltage to the non-inverting input will be less than that to the inverting input and the op-amp output will be driven low, thus turning on Q1. This, in turn, turns on Q2 which pulls the attenuator bias line down toward ground, reducing the RF output of the attenuator. Thus, drive to the RF module is reduced, further reducing the output power sufficiently to limit current to the power amplifier modules to 15A.

1.3.3 Reverse Power Sensing

The reverse power sensing and protection circuit operates from the reverse output of the VSWR bridge. The control signal is first linearized with respect to power by a squaring circuit IC4. It is then applied to the control amplifier for comparison to the internal reference voltage. If the reverse power signal exceeds this reference the control amplifier output goes high, which turns on Q3 and pulls the attenuator control line toward ground. The net effect is the same as for current limiting: Drive to the RF module is reduced sufficiently to limit the reverse power to a safe level. This level is normally set to 150W. The output of the squaring circuit is also applied to the linear power meter on the front panel and to the I/O connector located on the rear panel. This accessories output is 1V/KW (1V for 1000W).

1.3.4 Forward Power Sensing and Leveling Circuit

The forward power sensing and leveling circuit operates from the forward output of the VSWR Bridge. As in the case of reverse power, the control signal is first linearized by a squaring circuit, IC5. It is then applied to the control amplifier for comparison to a reference voltage. This reference can be either the front panel power control (ten-turn potentiometer) or an external voltage applied through the accessories connector on the rear panel. This external voltage is applied to an amplifier/limiter circuit such that calibration for 1V per kW can be done. It can be adjusted by R110 for 650W maximum limited output. Additionally, this voltage may be pulsed to any peak power level up to 650W with a pulse width as narrow as 1.0 mSec.

The remainder of the circuitry is identical to the reverse power sensing circuit. The output of the control amplifier turns on Q3, thus reducing drive to the RF module and thereby limits the RF output to that set by the variable reference voltage. The control range available extends to typically 60dB below 650W. At 0V control voltage the RF output will be less than 1mW.

1.3.5 Maximum Power Indicating Circuit

The maximum power indicating circuit operates in the absence of forward power leveling control. The maximum power indicator may light even though slightly more RF power may be available from the generator. This is perfectly normal and is due to hysteresis in the threshold detector. It indicates that the generator is not able to produce the output called for by the controlling signal. This situation will occur under high VSWR conditions where either the current sense limiting or the reverse power limiting circuits are operating to protect the unit.

The circuit operates from the output of the forward control amplifier. When this amplifier is not controlling forward power, its output is a negative voltage. This is fed to a threshold detector. The output of the detector then goes high thus enabling the LED indicator on the front panel. A TTL compatible output is also provided to the rear panel accessories connector (+5V = Maximum Power, 0V = Normal Operation). Diode control logic prevents a false indication by sensing the conditions of the RF ON line.

1.3.6 RF ON Control

The RF ON control logic and indicating circuits act upon the 13.56MHz oscillator transistor base bias. When the RF ON/OFF function is disabled the driver regulator voltage is low (approximately 1V) and the oscillator bias voltage is off through Diode D28.

When the RF ON/OFF function is enabled the driver regulator voltage is high (25.4VDC) and the cathode of D28 is biased with 3.3VDC which allows the proper biasing of an 13.56MHz oscillator.

For local control operation the front panel RF ON/OFF switch acts upon the driver regulator. For remote operation the front panel switch must be in the down position (RF OFF). When a +5V signal is supplied through the accessories connector Pin 7 enables the RF ON function.

1.3.7 Line Voltage Test

The line voltage test circuit consists of a voltage divider across the unregulated DC voltage. The output of this divider is fed via a push-to-test switch on the rear panel to the meter on the front panel.

1.3.8 Thermostat Control

The thermostat is located on the RF Module Heatsink and has an operating temperature of +50 degrees Celsius. This is sufficient to allow a cooling water temperature of +35 degrees Celsius maximum. When the thermostat closes it grounds the RF ON line, removes bias to the pre-amplifier and driver and lights the red overheat LED on the front panel. Diode logic is used to isolate the above functions.

1.3.9 Oscillator Circuit

The 13.56MHz oscillator circuit, with the attenuator and buffer amplifier, is similar to that used in other highly reliable ENI equipment. The oscillator generates a sine wave at precisely 13.56MHz at a maximum power level of 3mW. The output of the attenuator is fed to a buffer amplifier which makes up for the 10dB insertion loss of the attenuator and provides for an overall system gain adjustment. The low-pass filter attenuates all harmonics of 13.56MHz by a minimum of 50dB and its output is fed to the input of the driver on the RF Assembly.

Chapter S2

Maintenance and Calibration

2.1 Recommended Test Equipment

The following test equipment is recommended to aid in maintenance and calibration of the OEM-6M.

Description	Recommended Type	Use
Power Meter	HP435B or HP437B	Power measurement and meter calibration.
50 Ω load, 2000W	Bird #8329	50 Ω load and attenuator for HP-435B.
Digital DVM	Fluke 77 or equivalent	Voltage measurements
Oscilloscope Probe	Textronix 10:1, P6120 or equivalent	
Oscilloscope	60MHz oscilloscope or better	AC Signal Measurement

2.2 Periodic Maintenance

For optimum performance the OEM-6M calibration should be checked once per year.

Before making any adjustments to the unit, first check that it performs to the specification. If this is the case adjustment is unnecessary.

Cooling and reliability of the OEM-6M is dependent on the cleanliness of the water supply. Problems with the water supply normally show up as frequent overheat indications on the front panel. If this is the case check water flow rate and look for obstructions in the water inlet and outlet connectors on the rear of the OEM-6M.

2.3 OEM-6M Calibration

This section outlines how to calibrate the OEM-6M. It will help to refer to *Technical Descriptions*, Section 1, and the schematics at the end of this manual.

2.3.1 RF Section Calibration

The RF Section of the OEM-6M consists of:

- Driver Amplifier Assembly
- RF Power Amplifiers (2)
- 2-Way Output Combiner
- Harmonic Filter Assembly
- VSWR Bridge Assembly

Problems in these circuits can be isolated with a systematic test procedure. The test equipment shown in Service Section 2.1 will be needed for thorough check-out of the OEM-6M.

2.3.1.1 Driver Amplifier Assembly

The driver amplifier consists of three amplifier stages, a voltage regulator and a 2-way splitter at the output. Bias voltages are as follows

	Emitter	Base	Collector
Q1	0.4V	1.1V	12V
Q2	1.5V	2.2V	25V
Q3	1.2V	1.9V	42V

Note: These voltages will appear only when the RF control function is “On”. Correct measurement of these voltages requires the RF control function to be “On” and the RF power adjust to be at zero.

Refer to the schematic diagrams at the back of this manual. The output of the voltage regulator is 25V +5%. The regulator assembly is mounted to a heatsink bracket beside the driver PC board. To verify proper driver operation, disconnect both driver outputs from the P.A. inputs and apply an input of 3mW at 13.56MHz (the output of the oscillator/buffer is suitable for this). Both driver outputs should be terminated in 50Ω and should be at least 15W when read on the power meter. Most driver components can be replaced from inside the RF module. This includes the driver voltage regulator and all resistors, capacitors and transformers. Q1 and Q2 are stud-mounted and cannot be replaced without access to the bottom of the module. See Service Section 2.6.1.2 for instructions on how to remove the RF module. See Service Section 2.6.1.5 for instructions on how to replace the RF power transistors.

2.3.1.2 Power Amplifiers

The two power amplifiers operate in Class B with the base bias at the DC ground. RF gain of each P.A. is approximately 12dB. A faulty module can be isolated by operating the OEM-6M into a 50Ω load and monitoring the current into each P.A. A defective P.A. module will consume less than normal current due to the fact that the failure mode of the power transistors is almost always open circuit. Normal current in each power amplifier is 13-14A at 650W into a 50Ω load. A defective power amplifier will give a current measurement of 0-8A.

2.3.1.3 2-Way Combiner

The output power of both P.A. modules is combined to produce the 650W output of the OEM-6M. A combiner is best tested by measuring the total output power and then the individual power of each P.A. Module. The sum of the individual P.A. Module outputs should be within 5% of the total output power.

Perform the following calibration procedure to ensure proper calibration:

1. Turn the Power Adjust fully CW. Note the setting of R126 RF level control which is located in the upper right corner of the control board assembly. Reduce the output power to 200W by rotating R126 counter-clockwise (CCW).
2. Turn off the OEM-6M. Remove the cover from the RF module and connect the output of the one P.A. module to the attenuator power meter set-up. Be sure the output of the OEM-6M is terminated in a 50Ω load.
3. Turn on the OEM-6M and note the P.A. module output power. Measure the output power of the other P.A. Modules in the same way. Individual P.A. outputs should be within 10% of each other with the total power equal to 200W. If the total is significantly greater than the 200W setting of Step 1, above, the combiner is defective. Return R126 to the original setting as noted above in Step 1.

2.3.1.4 Low-Pass Filter Assembly Calibration

The filter alignment is set at the factory and should be adequate for the life of the equipment.

CAUTION !

DO NOT DISTURB THE MECHANICAL ORIENTATION OF THE COILS.

Check for normal operation by observing normal output power and P.A. module current. Alignment of the filter is beyond the scope of this manual and requires the use of vector impedance measuring equipment. Consult the factory should this become necessary.

2.3.1.5 VSWR Bridge Calibration


The VSWR bridge consists of a toroidal transformer and various voltage divider, detector, and filter networks. Its function is to provide outputs proportional to the forward and reverse power on the transmission line to the leveling and protection circuits on the control board.

The center conductor of the output transmission line passes through the center of a toroidal transformer and constitutes a single turn primary.

Current through the transmission line induces equal voltages in two parts of the center-tapped secondary winding. One voltage is in-phase with the line current: The other is 180 degrees out-of-phase with the line current. C3 is part of voltage divider that provides a reference voltage to the center tap of the transformer. This voltage is in-phase with the line voltage. When the load on the OEM-6M is 50Ω resistive there is no reverse power and the output from the VSWR bridge is a forward power signal only. At all other load impedances there are outputs from the forward power as well as the reverse power port. The only alignment necessary is to null C3 for reverse power when operating into a 50Ω resistive load.

This is done as follows:

1. Connect the RF output of the OEM-6M to a 1000W 50Ω dummy load.
2. Remove the rear cover from the unit . The VSWR bridge is located immediately behind the output connector. Pull upward on the interlock switch to defeat it.
3. Turn on the OEM-6M and set the power adjust for 200W forward power.

WARNING  When working on the OEM-6M, peak RF voltages in excess of 300V may be present while operating.

4. Using a long, insulated tuning tool, adjust C3 for minimum reverse power as observed on the front panel meter. Note that the forward power will also change as C3 is adjusted. After the coarse null obtained above, increase the forward power to 650W and carefully null C3 again for minimum reverse power.

CAUTION ! High RF voltages are present on the low-pass filter.

- If C3 will not null on the front panel meter:
Check for a null on Pin 13 of the control board connector using a voltmeter of at least 100KΩ input impedance. If a null is present at this point the problem is in the control board.
- If C3 will not null at Pin 13:
Remove and inspect the VSWR Bridge. Check diodes D1 and D2 and inspect all components for damage.

Note: Following installation of a new or repaired VSWR bridge all forward and reverse metering and leveling circuits must be realigned. Follow the procedure in Service Section 2.4, *Control Board Assembly*.

2.4 Control Board Calibration

The Control Board Assembly contains the calibration controls for the protection and logic functions in the OEM-6M.

These functions can be grouped as follows:

- Power Supplies for Control Functions
- Current Sensing Protection
- Reverse Power Protection and Metering
- Forward Power Control and Metering
- Maximum Power Indicating Circuit
- RF ON Control Logic and Indicating Circuits
- 13.56MHz Oscillator and Buffer Amplifier
- Overheat Protection and Indicating Circuit

Test points are provided on the control board for checking power supply voltages and are shown below with expected, normal voltages.

TP	Voltage	Refer To
IC9-0	+15V	Chassis Ground
IC8-0	-15V	Chassis Ground
P7-22	+25V	Chassis Ground
P7-32	0V	Chassis Ground

WARNING

The OEM-6M is factory calibrated with instruments traceable to the US National Institute of Standards and Technology. Recalibration should not be necessary unless the Directional Coupler/Detector or Control Board Assemblies are replaced or repaired. Accuracy of calibration depends upon the accuracy of the external power and voltage measurement equipment. The following procedure is provided should recalibration be deemed necessary.

2.4.1 Power Supplies for Control Functions

There are two $\pm 15\text{V}$ power supplies on the control board. The first is referenced to DC ground and provides $\pm 15\text{V}$ for all circuits except current sensing. The output of this supply is nominal and a tolerance of $\pm 10\%$ is acceptable. No adjustments are provided.

- If the voltages are outside of the 10% tolerance check for 40V rms AC across the control transformer secondary (Pins 20 and 21).
- Then check for approximately +23V DC across C1 and C2. If these voltages are nominal replace IC8 or IC9 for the -15V and +15V supplies respectively.

The second power supply is also $\pm 15\text{V}$ but is referenced to the unregulated +40V to the power amplifiers. As a result, this supply floats with changes in the actual +44-48V, depending upon the line voltage and RF power output. This power supply is used only to bias the current sensing circuit comprised of IC2 and associated components.

- Measurements made in this circuit and this power supply are best referenced to the 44V supply on Pin 3 of the control board connector or Pin 1 of IC1.
- Voltage readings of $\pm 15\text{V} \pm 5\%$ are nominal for the output of IC1, Pins 4 and 11 respectively.
- Check for 40V rms AC across the other control transformer secondary (Pins 1 and 2). If these voltages are nominal and the outputs of IC1 are faulty, replace IC1.

2.4.2 Current Sensing Protection

Current sensing is accomplished by measuring the voltage drop across a $0.01\Omega \pm 1\%$ resistor located on each P.A. module in the RF module assembly. This voltage is supplied to IC2 via the control board connector wiring. At IC2 it is compared with a reference voltage of 0.150V set by R49 and R50. If the current sense voltage drop exceeds 0.150V the output of IC2 immediately pulls the base of Q1 low, turning on Q1 and Q2 which pulls the attenuator bias line low and reduces the RF output of the unit. This effectively limits the current draw of each P.A. Module. The current limit adjustments are set to limit the current draw of each P.A. Module to $15.4 \pm 0.2A$.

Use the following procedure to set this limit:

1. Remove the OEM-6M cover and the RF module cover. Disconnect the input cable to P.A. Module #2. Tape the loose end of the cable to the side of the RF Module.
2. Replace the RF module cover to prevent RFI from the low-pass filter from affecting the operation of the control board circuits.
3. Connect a suitable voltmeter having an input impedance of at least $500k\Omega$ across the P.A. #1 current monitor test points on the side of the RF module.
4. Connect the RF output of the OEM-6M to a 50Ω load. Turn R49 and R50 fully CW.
5. Be certain that an adequate supply of coolant is circulating through the OEM-6M. Turn Power Adjust fully CCW and turn on the OEM-6M AC ON and RF ON switches.
6. Slowly increase forward power while monitoring the current (150mV corresponds to 15A). Increase the power until $154mV \pm 2mV$ is indicated.
7. Turn R49 CCW until limiting is reached. Turn the Power Adjust 1 or 2 revolutions CW to verify that limiting is effective. It may be necessary to make slight adjustment of R49. Note that the current limiting is active.
8. Turn the OEM-6M off, remove the RF module cover and replace the input cable to P.A. Module #2.
9. Repeat the above procedure for P.A. Module #2 by removing the input cable to P.A. Module #1. Adjustment will be made with R50.

2.4.3 Reverse Power Protection and Metering

Note: Before making any adjustments to the reverse power protection circuit, the technician should understand thoroughly the operation of the power control loop. Making a guess of critical adjustments may degrade the linear integrity of the unit as well as the ability to sense and protect itself from excessive levels of reflected power.

This circuit obtains its input from the VSWR Bridge. Verify that this is operating properly before troubleshooting the reverse power circuits on the control board. Refer to Service Section 1.2.4, Service Section 1.3.3 and the appropriate schematics at the back of this manual.

If alignment is necessary, use the following procedure:

1. Connect the OEM-6M to the 50 Ω load and RF Power Meter. Verify that an adequate flow of coolant is present through the unit.
2. Connect a digital voltmeter to the reverse power output Pin 2 of the rear panel accessories connector. Zero the front panel meter using the zero adjustment screw just below center of the meter. Turn on the AC ON switch and adjust REV Null control R87 until the front panel meter reads 0 in the reverse power position.
3. Turn on the OEM-6M RF ON switch and set the output power to 100W on the RF Power Meter.
4. Turn off the RF ON switch and open circuit the RF output of the OEM-6M. Turn on the RF ON switch and set R83 REV. IN. for 0.1V on the digital voltmeter. Adjust R89 REV. meter for a reading of 100W on the front panel meter.
5. With the output still open circuit, increase the power to 150W reverse and set R108 REV. SET. for limiting at this level. Rotate the power adjust an additional one or two turns to verify limiting action. If necessary re-adjust R108 for limiting to 150W.
6. This completes the adjustment. Turn off the RF On switch and replace the 50 Ω load if additional test or alignment is being done to other circuits.

2.4.4 Forward Power Control and Metering

This circuit obtains its input from the VSWR bridge. Verify that this is working properly before troubleshooting or adjusting the forward power circuits on the control board. Refer to Service Section 1.2.4 for information on the VSWR bridge, Service Section 1.3.4 and the appropriate schematic at the back of this manual.

If alignment is necessary use the following procedure.

1. Connect the OEM-6M to the load and RF power meter. Verify that an adequate flow of coolant is present through the unit.
2. Connect a digital voltmeter to the forward power output Pin 3 of the rear panel accessories connector. Zero the front panel meter using the zero adjustment screw just below center of the meter. Turn on the AC ON switch and adjust FWD Null control, R88, until the front panel meter reads 0 in the forward power position. Set power adjust to 0.
3. Turn on the OEM-6M RF ON switch and set the output power to 650W on the RF power meter, using the front panel power adjust.
4. Set R84 FWD IN for 0.65V on the digital voltmeter while maintaining 650W output with front panel power adjust. Adjust R90 FWD meter for a reading of 650W on the front panel meter.
5. Rotate R111 MAX FWD fully CW and turn the power adjust to 10.0 (fully CW). Slowly, turn R111 CW to limit forward power to 670W.
6.
 - a. Adjust power down to a reading of 100W (0.1V on Pin 3 of the accessories connector).
 - b. Adjust "FWDX = OFST" potentiometers (R147 and R148) for a proper load power reading.
 - c. Adjust power to 670W and adjust "FWD IN" potentiometer for proper load power reading.
 - d. Recheck accuracy at 100W. Accuracy is to be $\pm 5\%$ of the command power.

Note: Steps a-d may have to be repeated to obtain proper accuracy.

7. Reduce forward power to minimum by turning the power adjust control to 0. Adjust R79 for the lowest possible forward power null using a lower range of the RF power meter if necessary.
8. Turn the RF ON switch off. Turn R110 fully CW. Move the rear panel LOCAL/REMOTE switch to REMOTE. Provide a DC control voltage to Pin 5 of the rear panel accessories connector at the level desired for a given peak RF output. (This procedure describes a set-up for 1V per kW; other calibrations can be used up to 10V.) For a calibration of 1V/kW this voltage should be .65 for 650W.
9. Turn the RF ON switch on. Slowly increase the output power by turning R110 until 670W is reached.
10. Turn R141 to reduce power to 650W. Verify control voltage vs. power tracking by reducing the control voltage to 0.3V. The output power should be 300W. Calibration is now complete.

2.4.5 Maximum Power Indicating Circuit

Refer to Service Section 1.3.5 for a description of this circuit as well as the appropriate schematic, located at the back of this manual. No calibration or adjustment is required for this circuit. This circuit is activated when IC6 "C" functions as an inverting switch which drives the buffer amplifier IC6 "D". Troubleshooting should be done with a voltmeter having an input impedance of at least $1M\Omega$.

2.4.6 RF On Control Logic and Indicating Circuit

Refer to Service Section 1.3.6 for a description of this circuit as well as the appropriate schematic, located at the back of this manual. Diode logic is used to interface with the oscillator, driver amplifier, maximum power circuit and the thermostat. Calibration is not necessary and adjustments are not provided.

IC7, "A" drives the RF ON LED when there is emitter current in oscillator transistor Q4. Troubleshooting should be done with a voltmeter having an input impedance of at least $1M\Omega$.

2.4.7 Oscillator and Buffer

The 13.56MHz oscillator and buffer provides a low-level RF signal to the driver amplifier (Locate the appropriate schematic at the back of this manual). The RF output, when the attenuator bias on Q3 collector is 10V or greater, should be at least 3mW when operating into a 50Ω load. Bias voltages on Q4 and Q5 should be checked with a suitable voltmeter having an input impedance of $100K\Omega$ or greater. Note that Q4 will be off when the RF ON function is disabled and ON when that function is enabled.

2.4.8 Overheat Protection and Indicating Circuit

The thermostat, attached to the RF amplifier heatsink, closes at 50 degrees Celsius. At closure the thermostat will effectively disable the 13.56MHz oscillator, the driver regulator and the maximum power detector, through diode logic. The overheat LED lights through the ground provided by the thermostat closure.

2.5 DC Power Supply

The DC power supply consists of the power transformer, rectifiers and filter capacitors (see Service Section 2.1, *Power Supply*, and the appropriate schematic at the back of this manual). The output voltage of the power supply is adjusted by changing the tap on the power transformer (Operation Section 2.3.1). No other adjustments are provided. The rectifiers are located on the baseplate of the OEM-6M under the RF module assembly.

2.6 Disassembly Procedure

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. Generally these procedures can be reversed for reassembly.

The Model OEM-6M is assembled with standard hardware. Screw sizes range from #4-40 to #8-32 and are of the Phillips or slotted types. Transformer mounting bolts are 1/4-28. Standard tools required are screwdrivers, nut drivers (1/4" through 7/16"), and open end wrenches (1/4" through 5/8"). A 3/32" Hex Key (allen wrench) is needed to remove the power transistors. A torque wrench with a 3/32mm allen bit is recommended for proper assembly of RF power devices to the heatsink.

2.6.1 Component Removal

2.6.1.1 Removal of Covers and Front and Rear Panels

Remove the top cover by removing the eight (8) #8-32 screws from each side of the cover and lift the cover straight up.

To remove the front panel for servicing:

Remove the seven (7) #6-32 screws holding the front panel to the baseplate assembly. Unplug the three (3) MOLEX connectors from the harness to completely remove the front panel for servicing.

To remove the rear panel for servicing:

CAUTION !

Do NOT apply torque to the pipes. Instead, place a wrench on the pipe fittings of the OEM-6M while the mating pipe fittings are being loosened.

Disconnect the RF output cable and the water inlet and outlet pipes.

Remove the two (2) 4-40 screws on either side of the RF output connector. Unplug the MOLEX connector from the rear panel. Remove the nine (9) #6-32 screws and two (2) #8-32 screws holding the rear panel to the baseplate assembly. Remove the rear panel.

WARNING ⚡

To avoid serious shock hazard: Ensure that the AC line power is disconnected or defeated at the rear panel before attempting to remove the front panel.

2.6.1.2 Removal of RF Module

1. Remove the front and rear panels as described in Section 2.6.1.
2. Remove the +40V and GND connections from the side of the module.
3. Unplug the one (1) MOLEX connector from the baseplate.
4. Remove the six (6) #4-40 screws from under the baseplate which hold the RF Module in place.
5. Carefully lift the RF module out.

To replace the RF module, simply reverse the above procedure.

2.6.1.3 Removal of Driver Assembly

Note: To replace the power transistors and most other components, it is not necessary to remove the assembly. There is adequate access from the top of the unit.

1. Remove the RF Module as previously described.
2. Remove the two (2) allen head #4-40 screws holding Q3 in place. Remove the hardware from the mounting studs of Q1 and Q2.
3. Remove the fan from the side of the RF module.
4. Remove the RF input cable and both RF output cables from the driver. Unsolder all wires to the driver PC board after carefully noting the location of each.
5. Remove the four (4) #4-40 screws holding the PC board in place and lift the driver assembly out.

Note: To replace Q1 and Q2 it is not necessary to remove the driver assembly. Q3 can be replaced entirely from the top of the OEM-6M without removing the RF module (See Section 2.6.1.5).

2.6.1.4 Removal of Power Amplifier Assembly

Note: To replace the power transistors and most other components, it is not necessary to remove the printed circuit board. There is adequate access from the top of the unit.

1. Remove the RF input and RF output connectors. Unsolder all wires to the P.A. PC board after carefully noting the location of each.
2. Remove the four (4) #4-40 screws holding the power transistors and remove the three (3) #4-40 screws that hold the power amplifier assembly in place.
3. Lift the power assembly out.

2.6.1.5 Replacement of RF Power Transistor

Note: Power transistor removal is accomplished without removing the printed wiring board (PWB).

1. Remove the mounting hardware: 2 screws in the case of flange mount, #8-32 nut and washers in the case of stud mount..
2. Carefully heat and remove as much solder as possible from each of the four (4) transistor leads. Use care not to damage the printed circuit board.
3. Apply heat to melt the remaining solder and lift the transistor leads one at a time with pliers or a pick. Use de-soldering braid to wick the remaining solder out from under the leads. Repeat this step until all leads are free of the circuit board.
4. Lift out the transistor. Thoroughly clean the old thermal grease from the copper heatsink. Except for Q1 and Q2, located on the driver assembly, a properly cleaned surface will be a bright copper color.

Note: There must be **NO SIGN** of old thermal grease, metal chips or residue of any kind on the mounting surface. A solvent and cotton swab is useful for this process. This cleaning is mandatory to provide the degree of thermal contact necessary.

5. Clip the transistor leads to the same length as those on the defective transistor.
6. Place a small amount of clean thermal grease uniformly on the transistor mounting flange.
7. Place the transistor on the heatsink and secure with the hardware removed in step one. Flange mount transistors should be tightened to 6.0 lb/in. Stud mount transistors should be tightened to not more than 6.5 lb/in to avoid fracturing the copper stud.

Note: **DO NOT** solder the transistor before tightening the mounting hardware.

8. Solder all four leads to the circuit board, soldering as close to the transistor case as possible. Use the least amount of necessary heat; do not overheat the transistor.

2.7 Troubleshooting

Refer to this simplified table should you believe that the OEM-6M is not functioning properly. This table is an itemized listing of the most frequent type difficulty anyone might encounter while operating the OEM-6M.

The first step in isolating a malfunction is to review the conditions under which the symptoms were observed. Unplug any rear panel interface connectors. Determine that the problem was not due to external cabling or abnormal line voltages. If the equipment is being operated by remote control, verify that proper commands are being received by the OEM-6M. After the problem has been definitely attributed to the OEM-6M, refer to the Troubleshooting Guide. Note that many of the circuits can be checked without the application of RF Power. A systematic fault-localizing procedure is mandatory for rapid trouble shooting. When the problem has been isolated to a particular circuit, refer to **Theory of Operation** as well as to the appropriate schematic for an explanation of the circuit.

Troubleshooting Guide

Symptoms	Probable Cause	Recommendations
Power lamp does not light	Burned out LED	Check for voltage to LED.
	AC line phase is absent	Check 3-Ø AC line.
	Faulty 40V or 25V power supply	Check per Service Section Sections 2.4, 2.4.1 and 2.5.
	Defective power relays	Replace relay.
	Defective power switch	Replace switch.
	Circuit breaker open	Close circuit breaker.
RF ON lamp is dim	Defective RF oscillator or RF ON control circuit	See Service Section 1.3.9, 2.4.7.
Low RF Output	Defective RF amplifier	Perform procedure for locating faulty RF amplifier, Service Section 2.3.1.2.
	Faulty power supply	Check power supply, Service Section 2.5.
No RF Output	Broken output ,Type "N" connector	Visually inspect connector for broken pin.
	Defective output cable	Visually inspect cable at output connector.
	OEM-6M is in the remote control mode	Check for ground on the accessories connector, Pin 10.
Circuit breaker open	Defective power supply	See Service Section 2.5.
	Defective linecord or AC wiring	Visually inspect for signs of insulation breakdown.
Power generator overheating	Defective cooling	Check that the coolant is circulating properly.
	Defective internal fan	Check for proper operation.
	Coolant temperature excessive	Reduce coolant temperature.
Incorrect front panel meter reading	Improper calibration of the meter or the VSWR bridge	Perform adjustment per Service Section 2.3.1.5, 2.4.3 and 2.4.4.
	Test switch in wrong position	Move test switch to "RF Power".
	Defective meter	Replace meter.

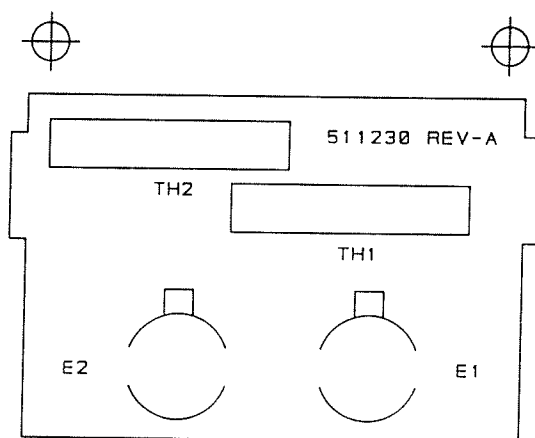
OEM-6 Appendix

Schematics and Materials

This section contains the following board layouts, related schematics and parts list.

	<i>Drawing P/N</i>	<i>Assy P/N</i>
<i>Silkscreens</i>		
Soft On Board	511229	OEM-6-14397-51
<i>Schematics</i>		
Schematic Index	OEM-6-SCH-01	
<i>Parts List</i>	OEM-6M-11781	
<i>Glossary</i>		

OEM-6M Soft On Board
(Drawing 511229)
(Assembly OEM-6-14397-51)
(Rev. A)



ENI
OEM6A/650A SOFT START
SILKSCREEN
511229 REV-A
MAR 21 91