GMW-25

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 that 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 an MKS Instruments' ISO-9001:2000-Quality-System-compliant facility.

Notice

Manual Order Number: 1050-001
Revision Level: B 10/07/04

Warranty

MKS, ENI Products 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, MKS, ENI Products 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 MKS, ENI Products' 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.

THIS LIMITED WARRANTY IS EXCLUSIVE AND MKS, ENI PRODUCTS MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, AND ALL OTHER EXPRESS ORAL OR WRITTEN WARRANTIES AND ALL WARRANTIES IMPLIED BY LAW, INCLUDING ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR OTHER WARRANTY OF QUALITY ARE EXCLUDED AND DISCLAIMED. IN NO EVENT SHALL MKS, ENI PRODUCTS BE LIABLE FOR SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING FROM BREACH OF ANY WARRANTY, WHETHER EXPRESS OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, OR FROM ANY CAUSE WHATSOEVER, INCLUDING NEGLIGENCE. Buyer's sole and exclusive remedy under this warranty shall be repair or replacement as set forth above, or if MKS, ENI Products is unable to repair or replace the defective part within a reasonable time, a refund of the price of the part or goods that give rise to the warranty claim.

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 MKS, ENI Products receives the unit, a firm quote and estimated date of completion will be given.

For Technical Assistance for your particular application, contact the nearest MKS, ENI Products 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 nameplate.
- 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 MKS, ENI Products.

Sales & Service Locations

ROCHESTER, NY	MKS Instruments, Inc. 100 Highpower Road Rochester, NY 14623 **Toll Free USA Sales Hotline:** **Toll Free USA Service Hotline:**	Tel: (585) 427-8300 Fax: (585) 427-7839 **1-800-267-5362** **1-800-724-ENI1 (3641)**
SAN JOSE, CA	MKS Instruments, Inc. 70 Rio Robles San Jose, CA 95134	Tel: (408) 750-0300 Fax: (408) 428-0390
AUSTIN, TX	MKS Instruments, Inc. 1321 Rutherford Lane Suite 200 Austin, TX 78753	Tel: (512) 719-8000 Fax: (512) 719-8095
ENGLAND	1 Anchorage Court Caspian Road Altrincham, Cheshire WA14 5HH, England	Tel: 44-161-929-5500 Fax: 44-161-929-5511
GERMANY	Sielminger Str. 63 D-70771 Leinfelden-Echterdingen (Stetten) Stuttgart, Germany	Tel: 49-711-947700 Fax: 49-711-9477025
JAPAN	1-21-15 Aoyagi Kunitachi Tokyo 186-0013 Japan	Tel: 81-425-229-011 Fax: 81-425-222-636
KOREA	1ST Floor, DK Plaza-I 375-1, Geumgok-dong City Bundangogu, Seongnam Kyonggi-do, Korea 463-805	Tel: 82-31-717-9244 Fax: 82-31-717-9244
SINGAPORE	Blk 4010 Techplace 1 #01-07/08/09 Ang Mo Ko Ave 10 Singapore 569626	Tel: 65-6451-1062 Fax: 65-6451-0172
TAIWAN	2F, No. 47, Ln. 2, Sect. 2 Kuang Fu Rd. Hsinchu 300 Taiwan, ROC	Tel: 886-3-575-3040 Fax: 886-3-575-3048
P.R. of CHINA	West end of 2nd floor, No. 3 building (T20-3) No. 258 Jinzang Rd., Shanghai Jin Qiao Export Processing Zone Pudong, Shanghai 201206 P.R. of China	Tel: 86-21-5834-7934 or 86-21-5834-7914 Fax: 86-21-5834-7794

Product and Applications information also available on the Internet at:

http://www.mksinst.com

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TABLE OF CONTENTS

Chapter 1

Introduction

The GMW-25 Plasma Generator is a rugged, highly reliable RF power source for plasma etching, CVD, and sputtering applications. Featuring precise power control and digital interfacing and increased load-power capability, the GMW-25 generator provides the exceptional reliability and repeatability required for today's demanding plasma processes.

Operating at a customer-specified frequency in the range of 1.8 MHz to 2.17 MHz, the GMW-25 generator produces 2500 W of power into a 50Ω load. The DSP-based control module automatically measures forward RF power and reflected RF power, maintaining constant power output within ±1% of set point over a Dynamic Power Range of 25 to 2500 watts.

Precise power calibration is traceable to NIST (National Institute of Standards and Technology) through the ENI Power Standard. Low harmonic distortion and spurious-free performance complement the unit's RF power output control and unconditional RF stability.

An extremely rugged and highly efficient RF power section ensures greater power delivery into fixed match systems. The DSP-based control constantly monitors internal subsystem status to maximize system availability. Extensive built-in diagnostics and internal fail-safe memory simplify maintenance requirements and increase system uptime.

A new 9-pin digital interface provides remote control, monitoring and diagnostic capability via the RS-232 serial link to a computer or host terminal. Optional custom interface cards are also available.

1.1 About This Manual

The manual provides all of the information required to safely install, setup, and operate your generator. While every attempt has been made to provide a concise set of installation and operating procedures in the Getting Started Quickly section, detailed instructions are also available.

It is essential that you become thoroughly familiar with the contents of this manual prior to using your generator. If used properly, the information contained in this manual will not only promote reliable generator performance but will also encourage a safe operating or service environment for all individuals.

1.1.1 Finding Your Way Around

This manual is divided into five chapters and three appendices. The main Table of Contents will help you to quickly locate the chapter that contains the information you may be seeking. The following is a brief description of each chapter.

Chapter 1	The chapter you are reading. This chapter provides information on the content of the manual, the documentation conventions used, safety considerations that need to be observed, and a concise Getting Started Quickly section.
Chapter 2	This chapter acquaints the user with the GMW-25 Plasma Generator. It covers major features and front and rear panel descriptions.
Chapter 3	This chapter covers everything needed to install and set up your generator from Unpacking and Inspection to Initial Power up.
Chapter 4	This chapter covers in more detail how to operate your generator and take advantage of all of its features.
Chapter 5	This chapter details common troubleshooting situations and solutions you may encounter when using your generator.
Appendix A	This appendix provides complete physical and electrical characteristics of your generator.
Appendix B	This appendix provides a glossary of all the symbols used in this manual and on the generator per UL, CSA, TUV, and CE certifications.
Appendix C	This appendix provides a glossary of new terms that have been used throughout this manual.

1.1.2 Documentation Conventions

To better emphasize important information in this manual, the below methods of formatting have been used to call attention to this information.

Commands

Many parts of this manual refer to computer commands and data. It is important to recognize the conventions used in this manual in order to understand the meaning of these commands.

Angle Brackets	**< >**	These brackets are shown for command parameters. They are not part of the command and should not be entered.
Rounded Brackets	**( )**	These brackets contain hex-equivalent numbers for printable or non-printable characters. The lower-case "h (h) stands for hexadecimal.
Square Brackets	**[ ]**	These brackets indicate a symbol name for special control codes or non-printable characters. Examples of commonly used control codes are listed below.

[LF]	Line Feed	(0Ah)
[CR]	Carriage Return	(0Dh)
[ESC]	Escape	(1Bh)

Definitions

This icon is used to set off a definition of a new term used in this manual. Appendix C provides a complete list of all the new terms used here.

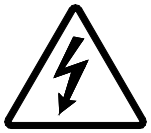
1.2 Safety Considerations

Certain safety considerations must be observed before operation of this generator can be attempted. Safety labels are used in both the manual and on the generator to alert operating and service personnel to conditions that may cause personal injury or damage to the equipment from misuse or abuse. Please read the labels and understand their meaning.

1.2.1 Operating and Maintenance Cautions

The caution label is used in this manual to caution the reader that failure to follow important operating or maintenance instructions could adversely affect equipment reliability.

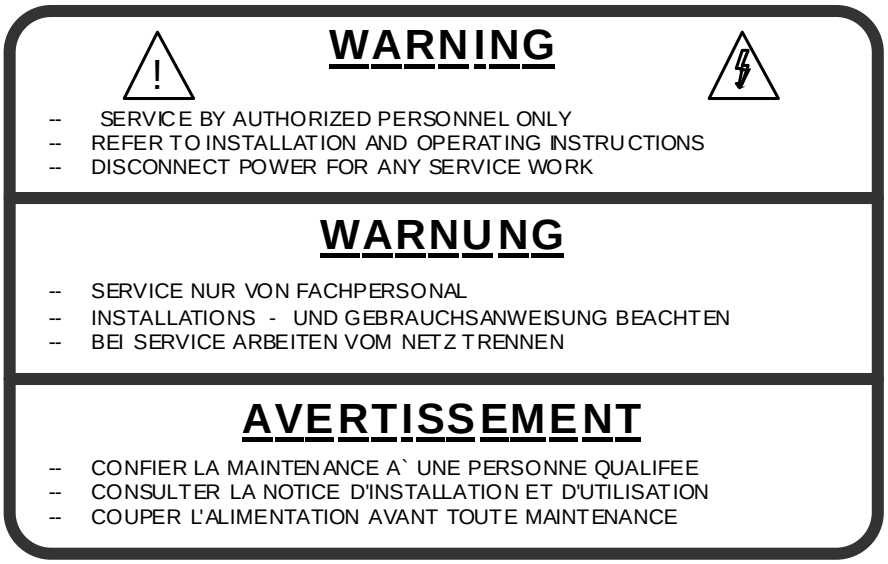
1.2.2 Shock Hazard Warnings



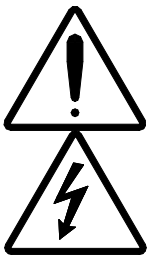
The warning label is used in this manual to warn the reader of a procedure or practice that could result in personal injury if not followed carefully.

The lightning bolt within a triangle is used to alert operating and service personnel to the presence of un-insulated voltage within the enclosure of sufficient magnitude to cause dangerous electric shock. Only authorized service personnel with a schematic diagram and knowledge of the voltages existing within the equipment shall remove covers or panels bearing this symbol.

1.2.3 Service



Service Warning Marking
Figure 1.2.3



MKS, ENI Products is responsible for safety, reliability, and performance of the equipment only if:

- *Assembly operations, extensions, readjustments, modifications, or repairs are carried out by authorized personnel.*
- *The electrical installation is made in accordance with the installation instructions provided and the room in which the equipment is installed complies with the environmental requirements.*
- *The equipment is used in accordance with the instructions for use.*

1.2.4 Safety Labels

RF Radiation Warning Label

This label is used to caution the user that the unit produces RF radiation that can be harmful.

Heavy Object Warning Label

This label is used to caution the user that the unit weighs over 35 lbs (16 kg) and should be moved by two people.

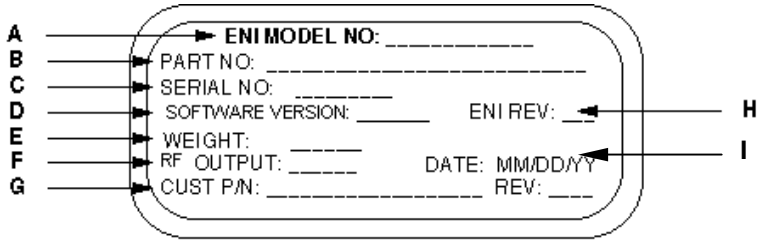
1.2.5 Technical Support

On the back of the generator is a label with an "800" number for MKS, ENI Products' Technical Support. Should you have any difficulties with your generator and have exhausted all possibilities in the Troubleshooting Chapter, please feel free to call us.

Technical Support Label
Figure 1.2.5

1.3 Nameplate

The GMW-25 Plasma Generator can be identified by a nameplate on the back of the unit that contains the following information:



GMW-25 Serial Tag Label

Figure 1.3

A. **ENI MODEL NUMBER:**
The model number that uniquely identifies the unit.

B. **PART NO:**
The assembly number that uniquely identifies the product configuration. (See section 1.4 for more information on the model number.)

C. **SERIAL NO:**
The number that is sequentially assigned as the product is manufactured.

D. **SOFTWARE VERSION:**
The version number that identifies the software configuration.

E. **WEIGHT:**
The weight of the unit.

F. **RF OUTPUT:**
The output of the unit in watts and its operating frequency.

G. **CUST P/N:**
A number that is specific to the customer who ordered the unit and that contains the customer's own part number and revision level.

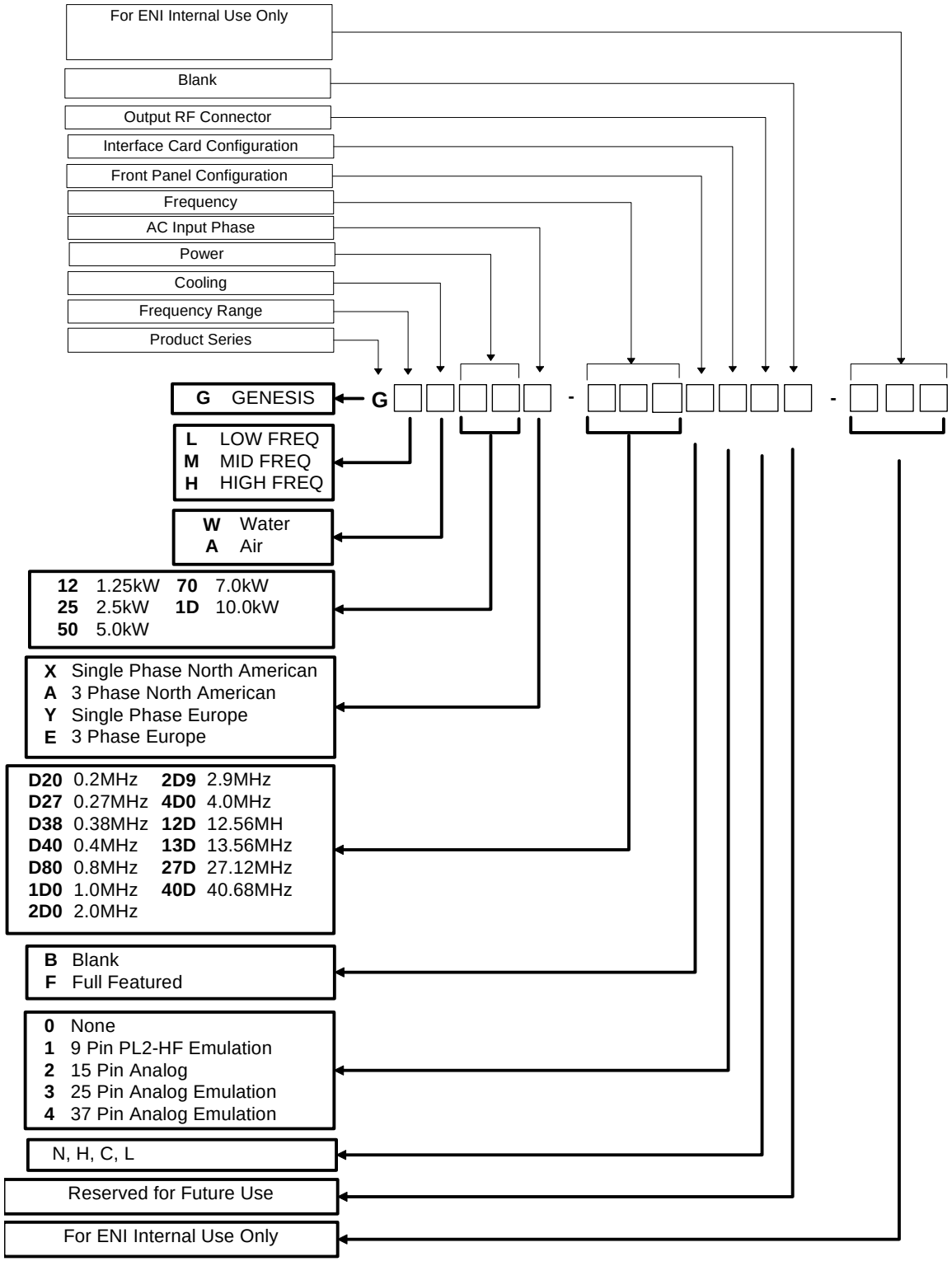
H. **ENI REV:**
The revision letter that identifies the product configuration. Revision A is the initial revision level.

I. **DATE:**
The date of manufacture in MM/DD/YY format.

1.4 Generator Options at a glance

Before the unit is installed and powered up, it is important to ensure that the correct unit was received. The model numbers of the Genesis line of generators have been configured in such a way that it is easy to tell what option has been installed on a specific unit. The number generated from this matrix defines the configuration of that unit and results in a part number that will be utilized throughout the manufacturing process.

This matrix should be used to compare the configuration of the unit that was initially ordered to the configuration of the unit received. If they are different, contact the nearest MKS, ENI Products' Sales or Service location for assistance.



Genesis Part Number Interpreter

Figure 1.4

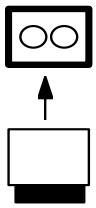
This part number interpreter is comprised of 18 separate fields. In these fields, letters and numbers are used to define the final configuration of a unit.

The unit you have received should have the value “25“ in the fourth and fifth fields of the final part number. Check the serial tag on the back of the generator. If it doesn’t have “25” in the part number, contact the nearest MKS, ENI Products’ Sales or Service location for assistance.

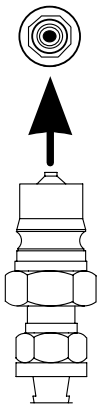
1.5 Getting Started Quickly

This section is intended to provide you with a set of instructions to enable you to quickly set up and start running your generator. References to more detailed information are provided at the end of each step.

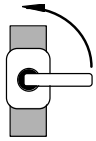
To quickly set up your GMW-25 generator, follow the procedure below:



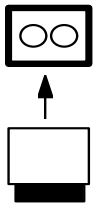
1. Connect the solenoid valve plug.
   (See section 2.10 for a description of the solenoid valve.)



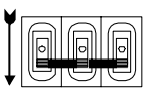
2. Connect the water inlet and outlet hoses securely to the water inlet and outlet connections on the rear panel of the generator.
   (See section 2.10 for more information on the connectors.)



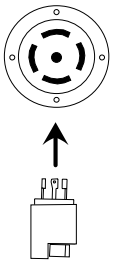
3. Once they are securely connected, turn both water valves to the open position.



4. Insert the External Interlock plug into the interlock connector on the rear panel marked “INTERLOCK.” AC Power will not engage until this interlock is defeated (plugged).
   (See section 2.7 for more information about the safety interlocks.)

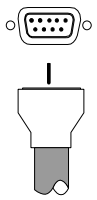


5. Make sure the AC Mains Circuit Breaker is in the OFF position (The **O** symbol should be showing).



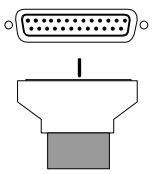
6. For units without a hard-wired line cord, plug the AC Main line cord into the AC receptacle in the back of the unit. Make sure the line voltage matches the voltage you selected when the unit was ordered.

   (See section 1.4 for the available line voltages and section 2.9 for more information on AC Power Requirements.)



7. Connect the 9-pin male serial digital interface to the female serial interface connector on the rear panel.

   See Table 2.5.1 for pin outs.

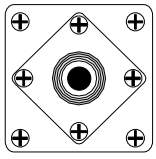


8. Connect an analog control cable, if you're not running a remote front panel, to the analog interface connection on the rear panel.

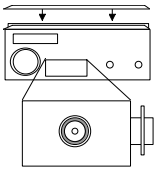
   There is a safety interlock in Pins 10 and 23. This interlock must also be defeated (in this case shorted) for the unit to work (see section 2.4 for Interlock Pin Outs). The AC power contactor will not engage unless this interlock is defeated.

   This interface will vary depending on what type of interface was selected when the unit was ordered.

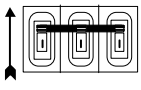
   If your unit does not have a fully functional front panel or you are using a remote front panel or a terminal, connect the interface input. This connection is either a 9-pin, 15-pin, 25-pin, or 37-pin plug. (See section 2.4 for analog interface types.)



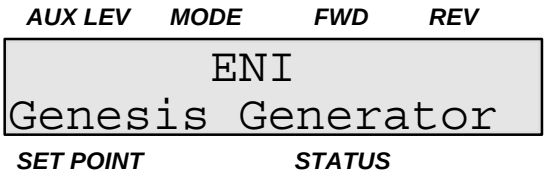
9. Connect the load from the plasma chamber to the RF output connection. This will vary depending upon the application you are using.



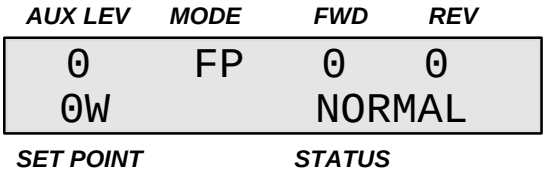
10. Make sure that the unit covers and the RF output cover are on. There are safety interlocks in all these locations that must be engaged or the unit will not work. (See section 2.7 for more information about the safety interlocks.)



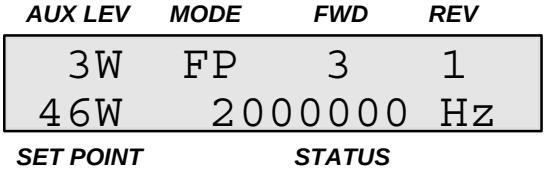
11. Flip the AC mains switch up to the ON position (The **I** symbol should be showing). You should hear the contactor engage. The front panel display should appear like the following:



The display will clear and show the following:



or:



(This display is only shown on auto-tune generators)

12. From the terminal, you should see the following message:

Power up delay in effect-please wait

Then the terminal will show the following:

ENI monitor on

13. The generator is now ready to run RF.

Chapter 2

System Installation

2.1 Unpacking/Inspection

2.1.1 Mechanical Inspection

If damage to the shipping carton is evident, request the carrier's agent be present when the unit is unpacked. Check for equipment damage and inspect the cabinet and panels for dents and scratches.

2.1.2 Claim for Damage

Please notify MKS, ENI Products directly or your authorized MKS, ENI Products' representative if the product is mechanically damaged or fails to meet specifications upon receipt. Retain our shipping carton and packing material for the carrier's inspection, as well as for subsequent use to return the unit should this become necessary.

2.1.3 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-lb. test material.

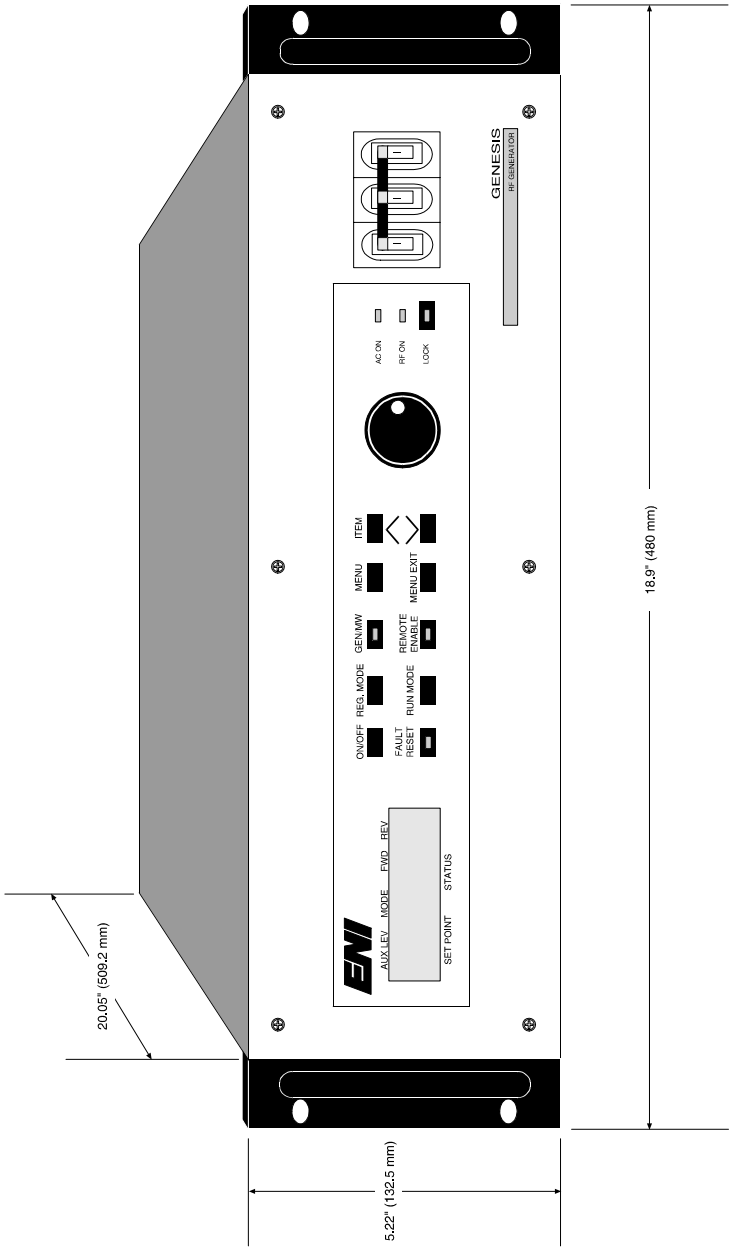
Use shock-absorbing material around all sides of the instrument to provide a firm cushion and to prevent movement inside the container wall on each side. Protect the front panel by means of cardboard spacers inserted between the front panel and the shipping carton. Make sure that the instrument cannot move in the container during shipping. Seal the carton with a good grade of shipping tape and mark the container: **FRAGILE! ELECTRONIC INSTRUMENT**

Drain water before shipment.

2.2 Installation Requirements

2.2.1 Dimension Requirements

The following figure shows the dimension requirements for standard 19-inch rack mountings.



Front & Side Dimension Requirements w/ Fully Functional Front Panel

Figure 2.2.1

2.3 Rack Installation

To ensure proper operation of the GMW-25, it is important to provide correct mechanical support within a rack installation.

2.3.1 Installing into a Cabinet Assembly

The GMW-25 generator can be installed in a cabinet assembly. The procedures for this depend upon the type of cabinet used. At the time the unit was ordered, the cabinet type was specified. Information is given below on installing the unit into the most common cabinet assembly.

19-inch Cabinet

The front panel can be ordered with a hole pattern for mounting in a 19" EIA rack. However, the generator must be supported on a rack shelf since the front panel is not strong enough to support the weight of the generator. Ground braid must be connected from the generator ground stud to the chassis ground on the cabinet.

Because of the weight of the generator, extreme caution should be used during installation. Steps should be taken to ensure that the rack will not tip when the unit is extended out of the rack.

2.4 System Interconnect

The GMW-25 generator is available with four options for the analog interface:

- No interface card
- 25-pin analog
- 37-pin analog emulation
- 9-pin emulation for ENI's PL-2HF generator

In order to maintain EMC compliance, I/O cables should be constructed using shielded cable (Alpha Supra-Shield or equivalent) and metallized backshells providing 360° shield termination.

Each of these options is described in detail below and the appropriate pin out table is also given.

2.4.1 Standard 25-pin Analog I/O Interface (ENI P/N: 1050-235)

The analog I/O Interface for the GMW-25 generator provides:

Pin	Name	Type	Description
1	Max. Power (E)	DO	Emitter side of isolated transistor switch. (See Note 1) Transistor ON - Indicates a max. reverse power or max. current fault. Transistor OFF - No fault.
2	Reflected power (+)	AO	A linear DC voltage that represents the reflected power output level. 0 V = 0 W and the max. value is adjustable between 0 and 12 VDC. Typically calibrated to 10 VDC = Maximum Reflected Power Limit.
3	Forward power (+)	AO	A linear DC voltage that represents the forward power output level. 0 V = 0 W and the max. value is adjustable between 0 and 12 VDC. Typically calibrated to 10 VDC = Maximum Rated Power.

DI = Digital Input DO = Digital Output AI = Analog Input AO = Analog Output

25-pin Analog I/O Interface Pin Outs

Table 2.4.1

Pin	Name	Type	Description
4	RF ON/OFF Control (+)	DI	A voltage between this and Pin 17 will turn RF power ON. Leaving it open or applying zero voltage will turn RF power OFF. The nominal voltage to turn RF ON is selectable between +5 V or +24 V via a jumper on the control board, however it should not exceed 30 VDC.
5	Power set point (+)	AI	A linear DC voltage to set the output power level. 0 V = 0 W and the max. value is adjustable between 0 and 12 VDC. Input impedance is 100 k ohms balanced differential to ground.
6	+28 VDC		User voltage for interface purposes. Rated 50 mA max.
7	RF ON (E)	DO	Emitter side of isolated transistor switch. (See Note 1) Transistor ON - RF ON. Transistor OFF - RF OFF.
8	Analog remote enable	DI	Ground referenced logic input. (See Note 2) LOW - Selects analog remote control mode. HIGH - Disables analog remote control mode. Leaving this pin disconnected will ensure a configurable HIGH or LOW state (Rev. A Interface only). Note: If the generator is in digital remote mode, it cannot switch to analog remote mode until the digital remote mode is disabled. Therefore, setting this pin low will have no effect until the digital remote mode is disabled.
9	Overheat (E)	DO	Emitter side of isolated transistor switch. (See Note 1) Transistor ON - Overheat fault. Transistor OFF - No fault.
10	Interlock		This pin should connect to Pin 23 to complete the interlock chain. If the interlock chain is broken, the AC contactor will open. External circuit should be capable of switching 100 mA at 24 VAC.

DI = Digital Input DO = Digital Output AI = Analog Input AO = Analog Output

25-pin Analog I/O Interface Pin Outs (Cont'd)

Table 2.4.1

Pin	Name	Type	Description
11	Leveling select	DI	Ground referenced logic input. (See Note 2) LOW - Selects forward-power leveling. HIGH - Selects an alternative power-leveling mode. Leaving this pin disconnected will ensure a configurable HIGH or LOW state. Note: The alternate power-leveling mode is selected via a software switch in a CALIBRATION menu. Either load-power leveling or an external source such as DC Bias may be selected. The default is Load Power Leveling.
12	Load power (+)	AO	A linear DC voltage that represents the load power output level. 0 V = 0 W and the max. value is adjustable between 0 and 12 VDC. Typically calibrated to 10 VDC = Maximum Rated Power.
13	+15 VDC		User voltage for interface purposes. Rated 10 mA max.
14	Max. power (C)	DO	Collector side of isolated transistor switch for Pin 1.
15	Reflected power return (-)	AO	Signal return for Pin 2.
16	Forward power return (-)	AO	Signal return for Pin 3.
17	RF ON/OFF Control (-)	DI	Signal return for Pin 4.
18	Power set point return (-)	AI	Signal return for Pin 5.
19	GND		Signal / Chassis ground.
20	RF ON (C)	DO	Collector side of isolated transistor switch for Pin 7.
21	GND		Signal / Chassis ground.

25-pin Analog I/O Interface Pin Outs (continued)

Table 2.4.1

Pin	Name	Type	Description
22	Overheat (C)	DO	Collector side of isolated transistor switch for Pin 9.
23	Interlock		This pin should connect to Pin 10 to complete the interlock chain. If the interlock chain is broken, the AC contactor will open.
24	Option V		User voltage for interface purposes. This voltage is configurable for +5 VDC or -15 VDC via a jumper on the control board. Rated 10 mA max.
25	Load power return (-)	AO	Signal return for Pin 12

DI = Digital Input DO = Digital Output AI = Analog Input AO = Analog Output

Note 1: *For all isolated transistor outputs.*
Transistor OFF (switch open) - VCEmax = 40 VDC (IC < 500 µA)
Transistor ON (switch closed) - ICmax = 10 mA (VCE < 1 V)

Note 2: *For all ground referenced logic level inputs.*
HIGH = 2 VDC min. to 30 VDC max.
LOW = -0.2 VDC min. to 1 VDC max.

25-pin Analog I/O Interface Pin Outs (continued)

Table 2.4.1

2.4.2 37-pin Analog I/O Interface (ENI P/N: 1050-295)

The 37-pin Analog I/O Interface is optically insulated from the generator at the interface board interconnect point. Therefore, to use this interface card, the customer system needs to source power to the interface board on Pins 36 and 37.

Pin	Name	Type	Description
1	MAX POWER (E)	DO	Emitter side of isolated transistor switch. (See Note 1) Transistor ON - Indicates a max. reverse power or max. current limit. Transistor OFF - No limit reached.
2	REFLECTED POWER (+)	AO	A linear DC voltage that represents the reflected power output level. 0 V = 0 W and the max. value is adjustable between 0 and 12 VDC. Typically calibrated to 10 VDC = Maximum Reflected Power Limit.
3	FORWARD POWER (+)	AO	A linear DC voltage that represents the forward power output level. 0 V = 0 W and the max. value is adjustable between 0 and 12 VDC. Typically calibrated to 10 VDC = Maximum Rated Power.
4	RF ON/OFF RETURN	DI	Signal return for Pin 29.
5	POWER SETPOINT (+)	AI	A linear DC voltage to set the output power level. 0 V = 0 W and the max. value is adjustable between 0 and 12 VDC. Input impedance is 100 k ohms balanced differential to ground.
6	No Connect	N/A	NONE
7	GENERATOR READY (E)	DO	Emitter side of isolated transistor switch. (See Note 1) Transistor ON - GENERATOR READY Transistor OFF - GENERATOR NOT READY Signal Definition: Generator Ready = interlock chain complete (see Pins 10 & 35) as well as no present generator overheat condition.

DI = Digital Input DO = Digital Output AI = Analog Input AO = Analog Output

37-pin Analog I/O Interface

Table 2.4.2

Pin	Name	Type	Description
8	REMOTE CONTROL SELECT	DI	Connect to Pin 31 to enable analog remote control. Leave disconnected to disable analog remote control. **Note:** If the generator is in digital remote mode (via 9-pin port for RS-232), it cannot switch to analog remote mode until the digital remote mode is disabled. Therefore, setting this pin low will have no effect until the digital remote mode is disabled.
9	GENERATOR FAULT (E)	DO	Emitter side of isolated transistor switch. (See Note 1) Transistor ON - Generator fault Transistor OFF - No fault Signal Definition: Generator Fault = generator overheat condition or interlock broken.
10	INTERLOCK		This pin should connect to Pin 35 to complete the interlock chain. If the interlock chain is broken, the AC contactor will open. External circuit should be capable of switching 100 mA at 24 VAC.
11	15 VDC RETURN		Isolated 15-volt return from customer system.
12-25	No Connect	N/A	NONE
26	MAX POWER (C)	DO	Collector side of isolated transistor switch for Pin 1.
27	REFLECTED POWER RTN (-)	AO	Signal return for Pin 2.
28	FORWARD POWER RTN (-)	AO	Signal return for Pin 3.
29	RF ON/OFF CONTROL	DI	Connect to Pin 4 to turn RF ON. Leaving this pin open will turn RF OFF.
30	POWER SETPOINT RTN (-)	AI	Signal return for Pin 5.
31	REMOTE CONTROL SELECT	DI	Signal return for Pin 8.

DI = Digital Input DO = Digital Output AI = Analog Input AO = Analog Output

37-pin Analog I/O Interface (Cont'd)

Table 2.4.2

Pin	Name	Type	Description
32	GENERATOR READY (C)	DO	Collector side of isolated transistor switch for Pin 7.
33	No Connect	N/A	NONE
34	GENERATOR FAULT (C)	DO	Collector side of isolated transistor switch for Pin 9.
35	INTERLOCK		This pin should connect to Pin 10 to complete the interlock chain. If the interlock chain is broken, the AC contactor will open.
36	ISOLATED +15 VDC		Isolated +15 VDC supplied by customer system to maintain isolation. 200mA max.
37	ISOLATED -15 VDC		Isolated -15 VDC supplied by customer system to maintain isolation. 200 mA max.

37-pin Analog I/O Interface (Cont'd)

Table 2.4.2

DI = Digital Input DO = Digital Output AI = Analog Input AO = Analog Output

Note 1: *For all isolated transistor outputs.*
Transistor OFF (switch open) - VCEmax = 40 VDC (IC < 500 µA)
Transistor ON (switch closed) - ICmax = 10 mA (VCE < 1 V)

Note 2: *For all ground referenced logic level inputs.*
HIGH = 2 VDC min. to 30 VDC max.
LOW = -0.2 VDC min. to 1 VDC max.

2.4.3 9-pin PL-2HF Analog I/O Interface (ENI P/N: 1050-290)

The 9-pin PL-2HF Analog I/O Interface is available to provide a proper interface to a system previously connected to ENI's PL-2HF Plasmaloc Generator.

Pin	Function	Type	Description
1	FAULT	DO	Provides contact between Pins 1 and 8. Contacts will close if a fault is detected. If fault is detected, Pins 1 and 8 will be shorted. No fault is open between Pins 1 and 8. Fault Conditions: 1 if AC Power is Lost 2 if RF is OFF 3 if Overheat Condition
2	LOAD POWER READ BACK	AI	Output, load power output, cal at 1.00 volt per kilowatt.
3	FORWARD POWER READBACK	AO	Output, forward power output cal at 1.00 volts per kilowatt.
4	GROUND		
5	GROUND		
6	+10 VDC	AO	Used for Set Point Generation in conjunction with potentiometer.
7	POWER SETPOINT	AI	Input, RF power set point, 0 - 10 VDC, 8.57 V=1200 W, 10.00 V=1200 W, for example.
8	FAULT RETURN		See Pin 9.
9	RF ON REMOTE ENABLE	DI	Digital Input, ground reference logic input, LOW-selects analog remote and turns on RF power. HIGH-disables analog remote; leaving pin disconnected will ensure a HIGH state

9-pin PL-2HF Analog I/O Interface

Table 2.4.3

DI = Digital Input DO = Digital Output AI = Analog Input AO = Analog Output

Note: *PL-2HF emulation requires the interface board to be configured for Load Leveling mode only. This is now a jumper, J4, which will allow for forward-leveling mode upon installation.*

2.4.4 15-pin Analog I/O Interface

The 15-pin Analog I/O Interface is an option to provide a proper interface to a system previously connected to an ENI generator with a 15-pin Analog Interface.

PIN	FUNCTION
1	+24 V from user tool. Used for DeviceNet Led isolation.
2	*Output:* Reflected Power Sense 0-10 VDC = 0 to maximum reflected power linear.
3	*Output:* Forward Power Sense 0-10 VDC = 0 to maximum rated power linear.
4	*Input:* Enables the RF output with a contact closure between Pins 4 and 9.
5	*Input:* RF Power Set Point 0 to 10 VDC = 0 to maximum rated power linear.
6	Analog signal common for Pins 5, 3, and 2.
7	*Output:* RF ON readback; contact closure between Pin 7 and Pin 8 means that the RF power is on.
8	RF ON readback common.
9	RF Output enable common.
10	Module Status LED output (Green).
11	Input: Safety interlock; enables the AC input power contactor with an external contact closure to Pin 12.
12	Safety interlock common.
13	Network Status LED output (Green).
14	Module Status LED output (Amber).
15	Network Status LED output (Amber).

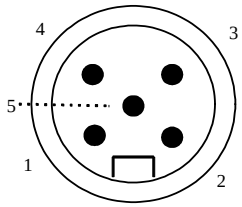
15-pin Analog I/O Interface

Table 2.4.4

2.4.5 DeviceNet Pin Out

The device will use a 12 mm “Micro” connector (or an equivalent) for its DeviceNet interface:

The connector will have the following pin out:



Male (pins)

1 - Drain	bare
2 - V+	red
3 - V-	black
4 - CAN_H	white
5 - CAN_L	blue

2.5 Remote Digital Interface

The digital interface provides control and monitoring of the generator using standard RS-232 or RS-422 voltage levels in a 7- or 8-bit serial packet. The interface also supports parity and either 1 or 2 stop bits. Data rates may be up to 115.2 k baud.

In order to maintain EMC compliance, cables should be constructed using Alpha Supra-Shield or equivalent cable and metallized backshells providing 360° shield termination.

There is a default communication jumper that is used to provide a starting point if the communication parameters are unknown when the unit is first powered up. Since it is necessary to open the unit up for installation of the default communication jumper, it is only there as a last resort. The default communication parameters are 9600 baud, no parity, 8 data bits and 2 stop bits.

2.5.1 Communication Configuration

The GMW-25 generator is normally shipped with RS-232 communications selected. RS-422 operation is selected by the insertion of one two-pin jumper, JP3, on the control board. The jumper is labeled with RS422 on the silk-screening. The control board contains the circuitry necessary to communicate using the RS-232/RS-422 protocols via the rear panel of the generator.

A standard 9-pin, female, filtered, type D connector provides the electrical connection as defined in the table below:

Pin	Function	Description
1	TX-	RS 422 TX LO.
2	TX RS232	RS-232 Tx data output.
3	RX RS232	RS-232 Rx data input.
4	RX-	RS 422 RX LO.
5	Digital Ground	This pin is connected to the digital ground of the controller.
6	TX+	RS 422 TX HI.
7	AUX+	Spare RS 422 input HI.
8	AUX-	Spare RS 422 input LO.
9	RX+	RS 422 RX HI.

Hardware Configuration for Remote Digital Interface

Table 2.5.1

The communications protocol used depends upon the Jumper JP3 and the cable connected to it. The 9-pin D connector is common to both 232 and 422 communications. The pins connected to differentiate the protocols are in conjunction with JP3.

2.5.2 RS-422 Bussing

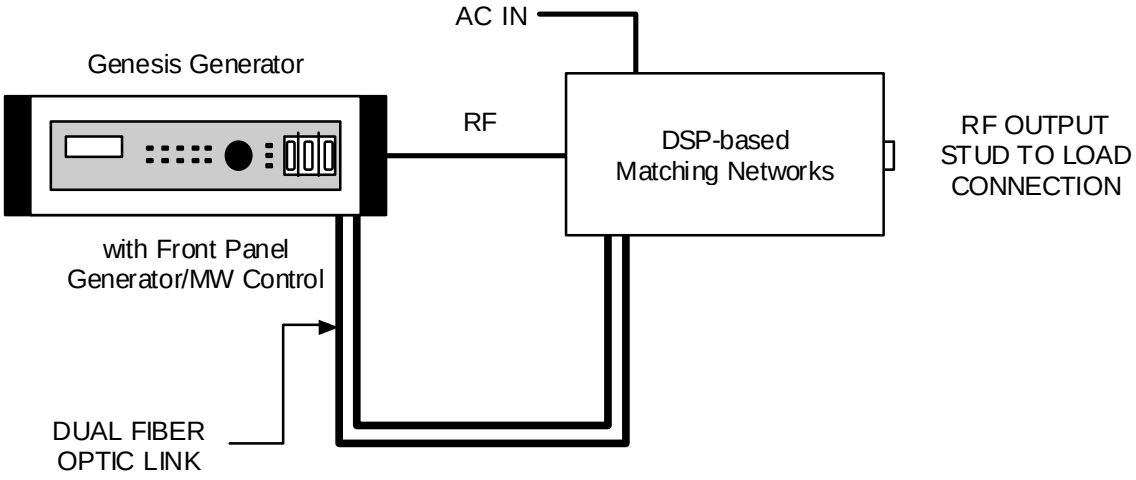
The introduction of RS-422 communication capabilities made possible the concept of a *bussed* system of generators being controlled from one central control point. See Figure 2.5.2 below for the *RS-422 System Diagram*. Each generator is assigned an address, and control of that address is achieved via the identity (**IDE**) command. The **IDE n<cr>** command selects an address corresponding to the **n** value, which is a hex number from **0 - FFH**. When the command is asserted, the corresponding device at that address is the only device on the bus, and all other devices tri-state their transmitters. The **IDE** address of a generator is configurable within the **CAL8** menu.

The link release **[!!] <cr>** is another command used in the realization of the RS-422 *Bus Architecture*. This command will remove all devices from the bus and put all devices into ***listen mode***. This command is only active until the next **IDE n <cr>** command, which will enable one of the still listening devices to activate its transmitter.

RS-422 System Diagram
Figure 2.5.2

2.6 MATCHWORK® Interconnection

The following diagram shows the typical interconnection of a GMW-25 generator using ENI's DSP-based matching networks with an optional MW local control and a generator front panel MW control. The interconnect consists of three types of cabling: AC power, RF power, and control.



GMW-25 System Interconnection
w/ local front panel MW control from generator
Figure 2.6

2.6.1 MATCHWORK® Power Requirements

The matching networks can operate from a range of AC input voltages at either 50 or 60 Hz. AC voltage input may be any voltage in the range from 100 V to 240 V. No setups or adjustments such as transformer tap changes are necessary.

AC power and ground are brought to the unit via the IEC connector labeled AC INPUT.

AC Mains is supplied directly to the matching network. A separate AC mains supply is required for the RFC-6 remote controller, which has a voltage selector on the rear panel. Each unit uses standard IEC connectors for power input.

AC Power Connection
For Advanced MATCHWORK and RFC-6

Figure 2.6.1

The DSP-based matching networks consume about 100 W of power while tuning and about 50 W in "idle" mode (both capacitors stationary). They use one metric glass fuse (5 x 20 mm). The recommended fuse rating is 4 A.

2.6.2 AC Power Cable Connections

The function of each of the three pins in the matching network's AC input connector is listed below.

Pin 1	AC Input (L)	100-240 VAC RMS LINE
Pin 2	AC Input (N)	100-240 VAC RMS NEUTRAL
Pin 3	Earth Ground (G)	Connects to chassis internally.

Incorrect connection of these wires can cause damage to the MATCHWORK.

2.6.3 RF Power Connections

The matching network tuner unit should be located as near to the plasma chamber as possible. Connection to the chamber is made via a stud on the tuner unit output panel.

Connection is made from the GMW-25 generator to the RF input connector on the tuner unit input panel. An RG-393/U 50-ohm coaxial cable (or equivalent) should be used.

2.6.4 Fiber Optic Control and Debug Cables

Connection between the tuner unit and the remote interface unit is made with a pair of dual fiber optic cables. The connectors that the cables plug into are color-coded: blue for receiving data and gray for transmitting data.

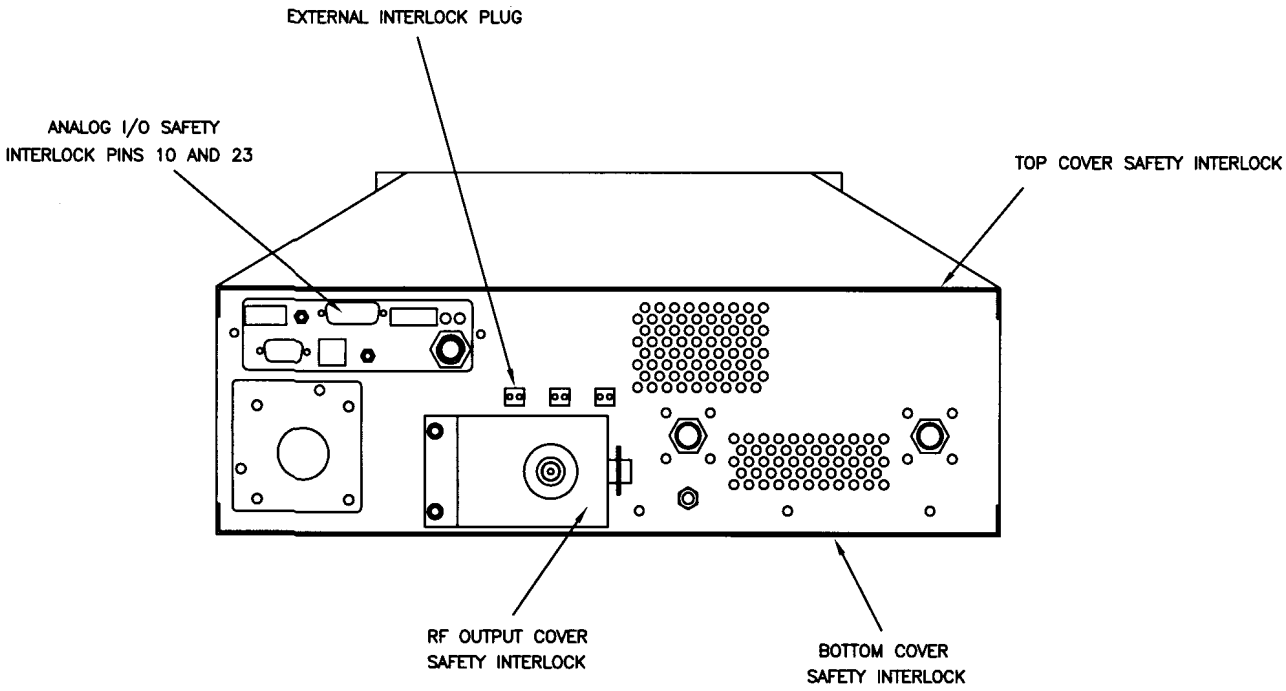
2.7 Safety Interlocks

For user safety, the GMW-25 generator is equipped with a complete interlock system consisting of three switches, an RF output enclosure, an external interlock plug, and a circuit closure.

The first switch is on the top cover to the rear, and the second switch is on the bottom cover to the rear. Another interlock is under the cover for the RF output. The external interlock plug is located on the rear panel above the RF output cover and is labeled. The final interlock is the Analog I/O Interface, and the circuit closure is via Pins 10 and 23 on the Analog Remote Interface. All five interlocks must be engaged before power to the generator can be activated – both the top cover and the RF cable cover must be fully installed, the external interlock plug has to be in place, and a connection must be made between Pins 10 and 23 of the Analog Interface.

If any of the five interlocks open during operation, the main AC contactor will trip. The contactor cannot be closed until all of the safety interlocks are once again closed.

In order to maintain EMC compliance, wires to external interlock plugs must be wound 3 times through a suitable ferrite assembly [FerriShield Part No. SS28B2033 (or equivalent)], positioned as close to the rear panel as possible.



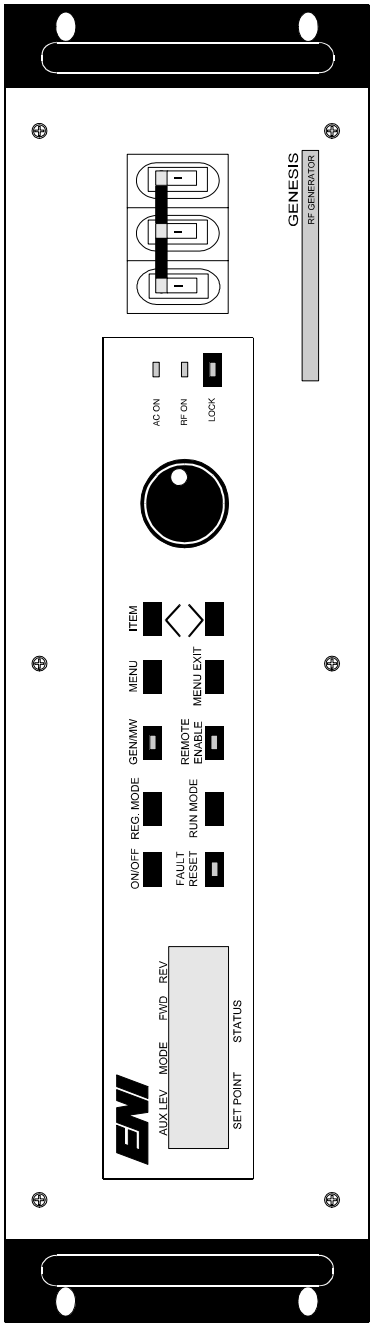
Safety Interlock Locations - Rear View

Figure 2.7

2.8 Panels and Controls

This section describes in detail all the front and rear panel controls and connections that are used on your generator.

Figure 2.8 shows the front panel for the generator with a fully functional front panel.



GMW-25 with a Fully Functional Front Panel
Figure 2.8

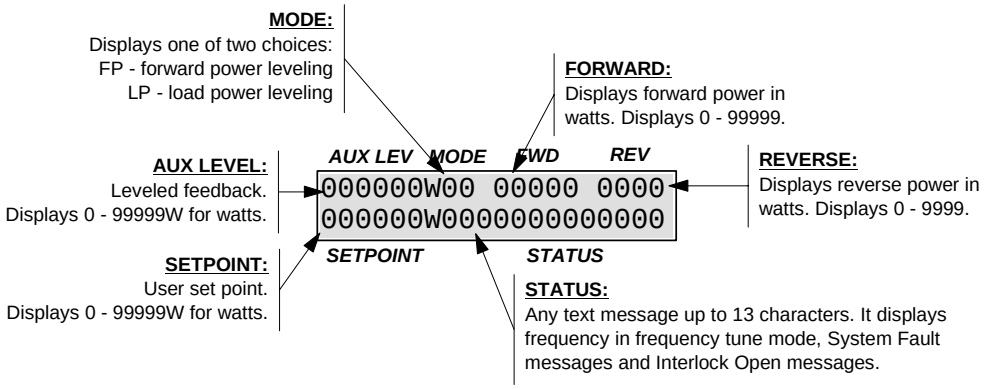
2.8.1 Front Panel

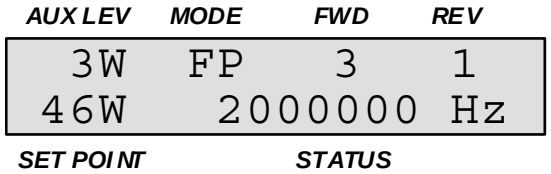
Eleven buttons and a digitizing knob are provided for normal control and setup of the generator.

Display

The display is a Liquid Crystal Display that can display two rows of 20 characters. Items that are shown on the display are grouped into two main categories. The top line of the display is used to show the output of the GMW-25 RF Generator regardless of the controlling source (i.e. front panel or ENI monitor). The AUX LEV, FWD, and REV fields cannot be changed by the user. These fields will change, however, depending upon the status of the generator. The AUX LEV will show the auxiliary level (i.e. load power leveling). The FWD field shows the amount of power in watts that is applied as forward power. The REV field shows the amount of power in watts that is applied as reverse power. The MODE field is used to show the Leveling mode that is currently in use. The possible choices for this field read FP for forward power and LP for load power.

The second line shows the set point in watts and the frequency presently selected by the generator. The frequency can be changed by the user if the configuration of the generator allows the frequency to be changed; otherwise, the generator is configured as a fixed-frequency generator, in which case the status portion of the display will indicate “NORMAL” rather than a frequency.





Example of display

Figure 2.8.1a

LEDs

There are a total of six LEDs in the front panel. Three are positioned to the right of the digitizer knob (AC ON, RF ON, and in the LOCK button) and the other three are located in three of the buttons on the front panel (Fault Reset, Gen/MW and Remote Enable) that are between the LCD display and the digitizer knob.

Controls

Buttons for Normal Operation

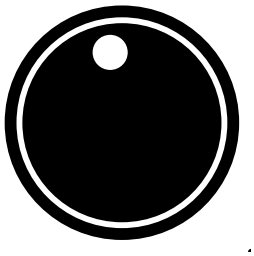
Eight buttons are used for normal control of the GMW-25 RF Generator. These buttons allow control of the following functions:

- Display the status of the generator or the attached matching network.
- RF output On/Off
- Fault Reset
- Selection of Menu and Menu Exit
- Item menu up and down
- Front Panel lock

Button	Description
GEN/MW 	This button is used when the generator is connected to a matching network. When the LED in the button is extinguished, the front panel is controlling and monitoring the generator, and when the LED is lit, the front panel is controlling and monitoring the matching network. Control and monitoring of the generator and the matching network is toggled by pressing this button.
ON/OFF 	This button is used to enable and disable the RF output from the generator. Pressing the button will turn the RF ON LED (to the right of the digitizer knob) on, and pressing it again will turn the RF ON LED off, disabling RF output.
FAULT RESET 	This button is used to clear any faults that occur in the generator. When a fault occurs, the FAULT RESET LED will illuminate. To clear the fault, the button should be pressed. If the fault can be cleared, the LED will extinguish.
MENU 	This button is used to access the menu(s) to change system and generator settings.
MENU EXIT 	This button is used to exit the menu(s) and return to the normal display.
ITEM 	These two buttons move the menu option selection up or down.
LOCK 	This button will lock the front panel to prevent any changes using the front panel digitizer knob and the other buttons except for the LOCK button. To unlock the front panel, the LOCK button should be pressed again and the LED will extinguish.

Chapter 3 will go into more detail on how to use these controls to change the settings of the generator.

Digitizer Knob



Front Panel Digitizer Knob
Figure 2.8.1b

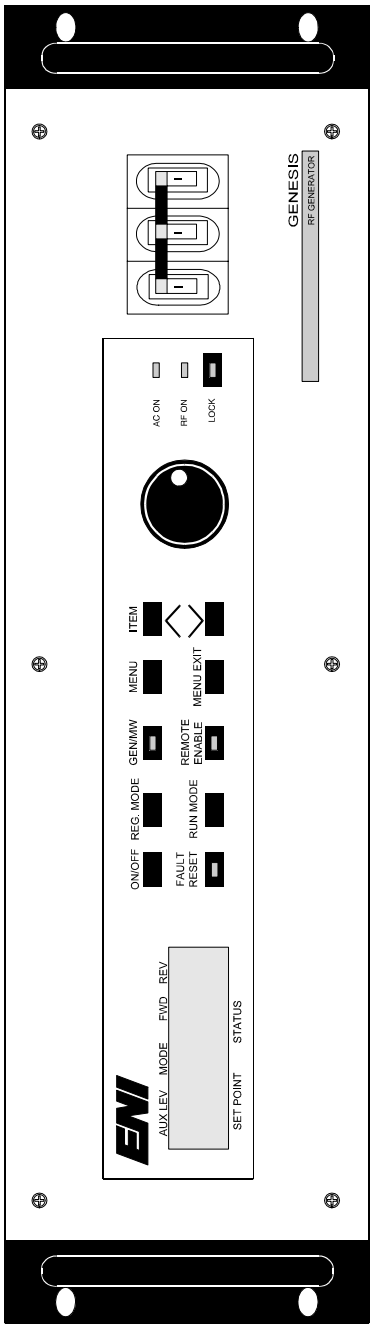
The Adjustment Knob (also known as the digitizer knob) is used to select a certain value in the menu options or on the normal display. It is only available on the Fully Functional Front and Remote Front Panel. Without entering any of the menus, the digitizer knob can only be used to change the value of the set point from 0 W to 2500 W. The faster the knob is turned, the greater the jump in value selection; the slower the knob is turned, the finer the change in value.

2.8.2 Front Panel Options

The front panel for your generator comes in two variations: fully functional or remote. The type of front panel is specified when the unit is ordered from MKS, ENI Products. Pictures of the two types of front panels are shown on the following pages.

Fully Functional Front Panel

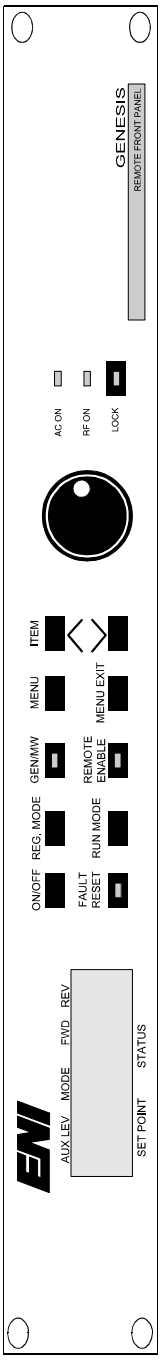
The user can control and operate the GMW-25 generator directly if the unit has a fully functional front panel.



Fully Functional Front Panel
Figure 2.8.2a

Remote Front Panel

A remote front panel allows the user to place the generator in a rack system and control the generator remotely. It has the same controls and operates in the same way as a generator with a fully functional front panel.



Remote Front Panel
Figure 2.8.2b

2.8.3 Rear Panel

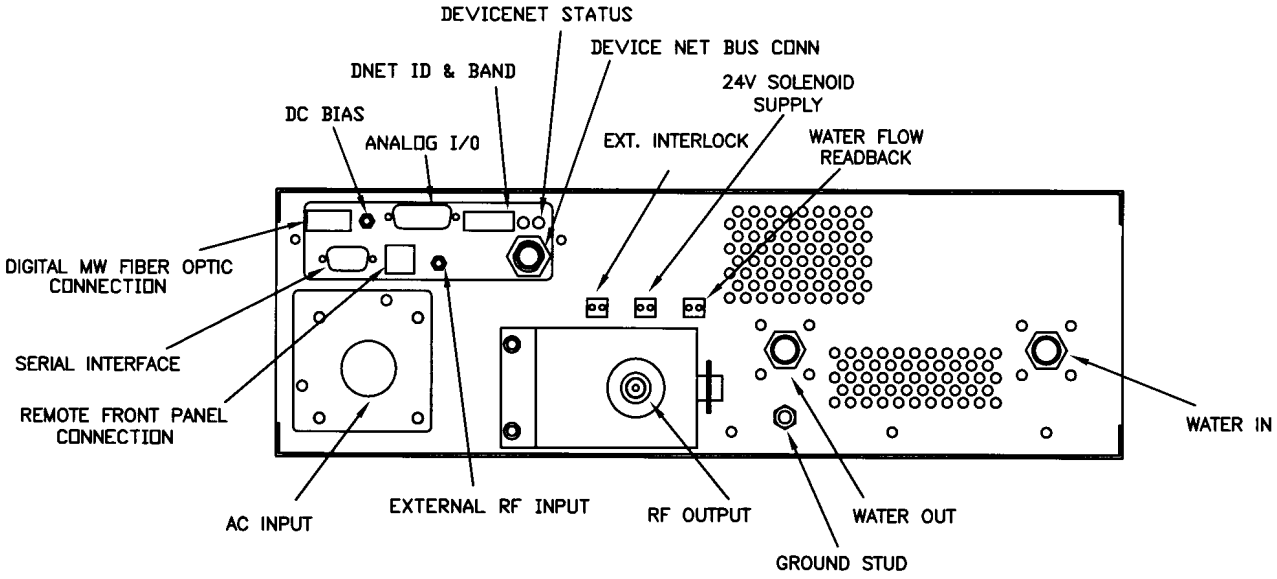
Connections

The following table briefly describes all of the rear panel connections for the GMW-25 Generator.

Connector	Description
Water In	This connection provides for water to flow into the generator for cooling purposes. It is designed for ¼" male (NPT) pipe thread.
Water Out	This connection provides for water to flow out of the generator for cooling purposes. It is designed for ¼" male (NPT) pipe thread.
RF Output	Provides RF power to the plasma chamber. The type of connector is specified at the time the unit is ordered (see section 1.2).
Water Flow Readback	This two-pin connection is provided to enable the DSP controller to monitor the condition of water flow into and out of the generator.
24 V Solenoid Supply	This two-pin connection is provided for use with the optional solenoid kit.
External Interlock	This two-pin safety interlock must be shorted to allow the generator to operate. A plug is provided in the accessories kit to allow the interlock to be shorted. Removal of the plug disables the interlock.
Analog I/O Interface	The analog interface uses a 25-way DB25F connector. A safety interlock exists in Pins 10 and 23 (other interfaces are supported).
DC Bias Input	This connector has an SMB-type jack for DC Bias Leveling feedback.
AC Input	This connection is used to provide the AC power to the unit. The following AC Input Ratings apply: 3/PE ~ 200 - 208 V 15 A 50 - 60 Hz
Digital MW Fiber Optic	These two connections are for two optional fiber optic cables (one to send data and one to receive data) to connect the generator to an optional remote front panel.
Remote Front Panel	This connection is a six-pin modular connector.
Serial Interface	This interface is used to connect the generator to a remote front panel. The standard is a Subminiature Type D, 9-pin digital connection. Customized interface cards can be installed.
External RF Input	This connection is optional and is an SMB jack used for an external RF source.

Rear Panel Drawing

Figure 2.8.3 shows the rear panel for the GMW-25 Generator and calls out each of the connectors as described in the table to the left. In order to maintain EMC compliance, wires to external interlock plugs (Ext. Interlock, 24 V Solenoid Valve, and Water Flow Readback) must be wound 3 times through a suitable ferrite assembly [FerriShield Part No. SS28B2033 (or equivalent)] positioned as close to the rear panel as possible.



GMW-25 Rear Panel View

Figure 2.8.3

2.9 Power Requirements

The AC Input Ratings for the GMW-25 Generator are indicated on a label attached to the back panel of the generator.

2.9.1 AC Mains Connection

The GMW-25 Generator has an AC Input Line Cord Assembly that comes equipped with a NEMA Type L15-30P plug. The center pin of the AC Input Plug is connected to the generator chassis and serves as the Protective Earth (Ground) connection for the generator. This AC Input Center Pin must be correspondingly connected to frame ground through the AC distribution panel of the system.

The AC Input Ratings of the GMW-25 Generator are as follows:

3/PE ~ 200 - 208 V 15 A 50 - 60 Hz

2.10 Cooling Water Requirements

The safe operating ambient temperature range for the GMW-25 generator is a minimum of 5° C and maximum of 40° C. The generator requires water to cool the unit during operation. The recommended flow of water into and out of the generator is a minimum of 2.0 gallons (7.6 liters) per minute at a maximum pressure of 60 psi. The temperature of the cooling water must be between +5° C and +35° C. The water inlet and outlet fittings are ¼" female NPT pipe on the rear panel and have been designed to accept ¼" male (NPT) pipe thread.

If conditions exist where the water coolant temperature is below the ambient dew point temperature, MKS, ENI Products recommends that either 1) in-line solenoid valves be installed on the water connections to the generator and be closed when generator RF power is off or 2) coolant water temperature be adjusted to prevent condensation.

Follow this recommendation to prevent condensation from forming when the generator is off; failure to do so may result in extensive damage to the generator! Contact MKS, ENI Products' Service for more information.

There is a solenoid valve kit (ENI P/N: 1050-050) that is included with all GMW-25 generators. Its contents are listed below:

Item	ENI Part Number
24 VDC Solenoid Valve	731027
Solenoid Valve Hex Nut (2)	731030

2.10.1 Water Fittings Connection

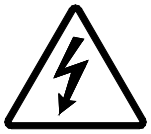
Leak-free water connections are necessary for generator reliability. To ensure this, the following procedure must be followed for all ¼-inch NPT pipefittings. The materials and parts needed for this procedure are:

- Teflon tape, 0.5 in. (ENI P/N: 521257)
- Torque wrench as specified below

1. Check fittings' and water ports' pipe threads for metal splinters, signs of cross threading (e.g., channel cut across the threads), impact damage, or signs of excessive wear. Repair or replace parts as necessary. Remove all pieces of used Teflon pipe tape.
2. Wrap Teflon pipe tape around the threaded male portion of the fittings.
   - Use new tape each time you make a connection.
   - Wrap the tape so it will tighten into the threads when you screw in the fittings. Pointing the fitting towards yourself, make the tape wrap in a clockwise (CW) direction.
   - Wrap tightly and make two (2) layers of tape around the fittings' threads.
3. Screw in fittings carefully by hand, "hand-tight" only.
4. Ensure that the unit's water ports will not twist when the connections are tightened further. If the unit does not have a built-in hex bracket or water guard retrofit for the water ports, brace the ports with an open-end wrench.
5. Use a torque wrench to tighten fittings to **150 to 170 lb-in or 12.5 to 14.2 lb-ft range.** (Metric equivalents: 1.73 kg-m to 1.96 kg-m and 16.9 N-m to 19.2 N-m.) MKS, ENI Products Factory and Service Center personnel use calibrated 150 lb-in torque wrenches.
6. If water leaks through the connection just made, **do not tighten fitting further! Undo the connection and repeat** the procedure with an extra layer of Teflon tape on the fitting.

2.11 Maintenance & Cleaning

The GMW-25 generator is designed and built to require only a minimum of cleaning and maintenance. Occasionally, however, it is recommended that the unit be wiped down on the outside with a damp cloth to remove any build-up of dust and dirt.



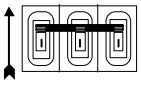
To minimize the risk of accidental shock, turn off the AC mains breaker before wiping off the unit and around the rear panel connections.

2.12 System Check

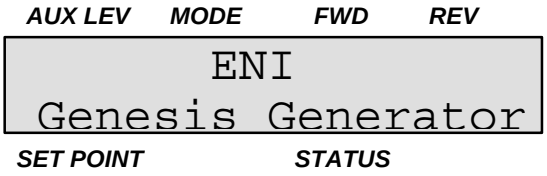
Before the GMW-25 generator can be used, it is imperative that the following procedure be followed to ensure optimal and safe operation.

1. If you've purchased your generator with the optional solenoid valve kit (as mentioned in section 2.8.3), make sure the solenoid plug is attached to the solenoid connector on the rear panel marked “SOLENOID.”
2. Check that the water hoses are securely connected to the water connectors on the rear panel. (See section 2.10 for more information on the connectors.)
3. Be certain the external interlock plug is inserted in the interlock connector on the rear panel marked “INTERLOCK.” AC Power will not engage until this interlock is satisfied (plugged). (See section 2.7 for more information about the safety interlocks.)
4. Assure that the AC line cord is plugged into 208 VAC, 3-phase power. (See section 2.9 for more information on AC Power Requirements.)
5. Make sure the RS-232 serial cable is connected to the 9-pin, D-type serial connector on the rear panel.
6. Check that the Analog Interface is connected to the 25-pin, D-type analog I/O connector on the rear panel. (See section 2.4 for more information on the types of analog interfaces available.) This may vary depending upon the type of analog interface that was ordered.
7. Be sure the RF output cable is connected to the RF Output connector on the rear panel.
8. Make certain the RF output cover is on, defeating the RF interlock. AC Power will not engage until this interlock is satisfied (plugged).

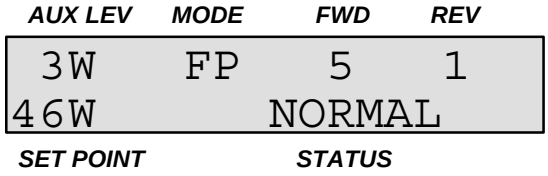
2.13 Initial Power Up



1. Flip the AC mains switch up to the ON position (The **I** symbol on the circuit breaker handles should be visible). The front panel display should appear as follows:



After the contactor is engaged, the front panel should look like the following:



Chapter 3

GMW-25 Operation

Two modes of operation (basic and advanced) have been designed into the GMW-25 generator to accommodate various plasma applications. Some require just a fixed frequency and a set number of watts, while others require fine-tuned frequencies and other parameters.

- **Basic operation** is intended for application of RF power and a set number of watts to fixed frequency processes.
- **Advanced operation** allows custom configuration of various parameters for variable and sensitive frequency processes.

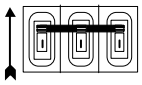
3.1 Basic Operation

The GMW-25 generator is designed to be used with minimal input from the user.

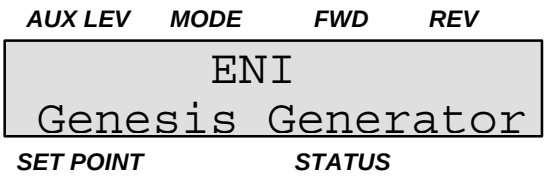
3.1.1 Generator Operation through the Front Panel

Turning on AC Mains Power

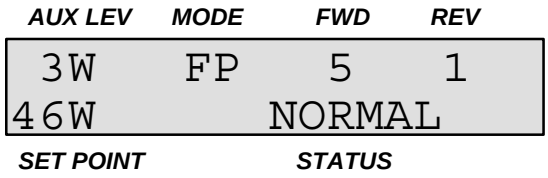
Before operation of the front panel begins, make sure the system check has been performed in section 2.12. After that has been done, the generator should be turned on following the procedure below:



1. Flip the AC mains switch up to the ON position (The **I** symbol on the circuit breaker handles should be visible). You should hear the contactor engage. The front panel display should appear as follows:



After the contactor is engaged, the front panel should look like the following:



Ensuring that the Front Panel/Remote Front Panel is unLOCKed

LOCK

1. The LOCK LED must be off to use the front panel. If not, push the LOCK button to turn the LED off.

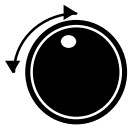
   The LOCK button prevents all front panel controls (except the Lock button itself) from working. This provides protection against inadvertent movement of the rotary knob. An LED inside the button is turned on to indicate that the lock function is active. The LOCK condition, when active, locks out the entire front panel (except for the LOCK button itself).

Setting the RF power

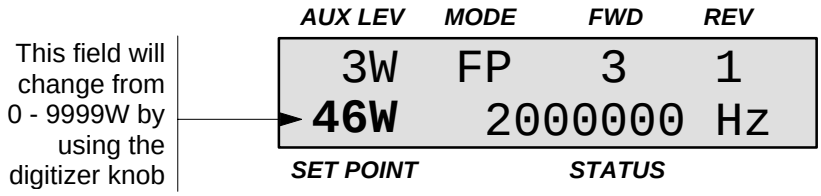
Next, the amount of power in watts has to be set and RF power has to be requested.

To request RF power, do the following:

1. Press the ON/OFF button first to enable and disable the RF power output. The RF ON LED (located to the right of the Digitizer Knob and to the left of the circuit breaker) will illuminate.



2. Use the Digitizer Knob to set the amount of power in watts from 0 to 2500 W. Watch the display until the desired wattage appears on the second line above the set point field.

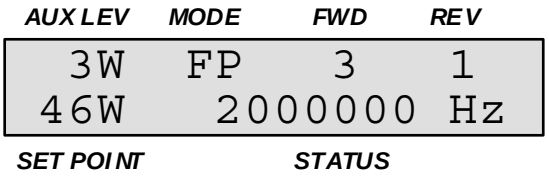


If this is not a variable frequency unit, “NORMAL” will be displayed in the STATUS field rather than a frequency.

Entering the frequency menu

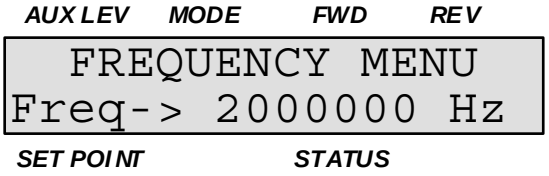
The first step in setting up the frequency menu is entering the menu(s) from the front panel. This is done by the following steps:

1. This is the normal display on the generator.



If this is not a variable frequency unit, “NORMAL” will be displayed in the STATUS field rather than a frequency.

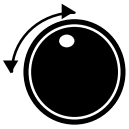
2. To enter the menu, press the MENU button and the display changes to this:



3. To change the RF output frequency, press the MENU button again until the "TUNE MODE>" field appears. Use the Digitizer Knob to

change the value from "AUTO" to "MAN."

4. Press the ITEM down button until the "FREQ> XXXX" (XXXX is the frequency the generator is currently registering) field appears. The frequency can now be adjusted using the Digitizer Knob.



If the configuration of the generator is fixed-frequency, you will not be able to change the frequency value. If it is not, then use the Digitizer Knob to change the frequency.

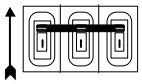
However, if the unit is a variable frequency unit, it will be in the auto-tune mode and will have already tuned to the best frequency.

3.1.2 Generator Operation through the ENI Monitor

This section details how to operate the GMW-25 Generator using the ENI Monitor.

Turning on the generator

Before any of the various settings can be set, the generator should be turned on.



1. Flip the AC mains switch up to the ON position, if it is not on already. The terminal display should appear as follows:

   `Power Up Delay in effect, please wait`

   The display will clear then display the following

   `ENI MONITOR ON`

Ensuring that the ENI Monitor has control

e

*****

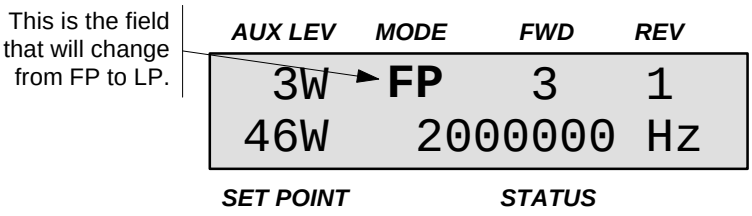
1. A prompt (*****) should appear after a carriage return is entered. If the unit is <u>in</u> remote mode, the terminal should <u>not</u> have control. A question mark (**?**) should be returned at the terminal.

Selecting the mode of operation

Presently there are two modes of operation supported by the generator. The choices are: FP for forward power leveling and LP for load power leveling. They are not accessible through the front panel and can only be changed through the ENI monitor.

To select the mode, do the following:

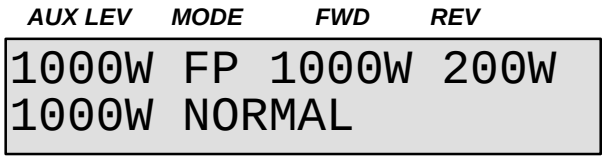
1. At the command prompt (*****), type the LLT command with a 0 or 1 and press ENTER.



LLT0

e

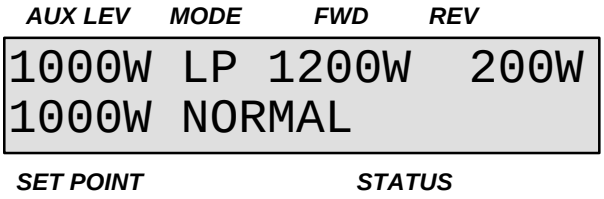
Typing LLT0 forces the mode into forward power leveling. The following example uses FP for the MODE. The front panel will display the following, assuming a set point of 1000 W and 200 W reflected is set.



LLT1

e

Typing LLT1 forces the mode into load power leveling. The following example uses LP for the MODE. In this case, load can mean forward or reverse power. The front panel will display the following, assuming a set point of 1000 W and 200 W reflected is set.



Changing the requested power

Once the ENI monitor has established control of the generator, the requested power can be entered.

OEM XXXX

e

1. Type the command **OEM XXXX** from the ENI Monitor keyboard and press Enter. You can enter in place of XXXX any value from 0 to 2500. This is the number of watts you want the generator to be set to produce. The value you entered should appear on the Front Panel display under the SET POINT field.

RSE <->

e

2. Type the command **RSE** to return the set point to the ENI monitor. The escape key can be used to escape the continuous real-time monitoring.

To request RF power, do the following:

TRG

e

1. Type the command **TRG** from the ENI Monitor keyboard and press Enter. The RF ON LED will illuminate (located to the right of the Digitizer Knob and to the left of the circuit breaker). To turn off the RF power, you would type **OFF** from the ENI Monitor keyboard.

3.1.3 Matching Network Configuration for Generator Control

Operating the Matching Network through the ENI Monitor is possible with the entire line of GMW-25 generators.

Setting the MATCHWORK® up for Generator control

Control of the MW is possible through the generator upon setting the MATCHWORK into generator control mode. To do this, you must establish communications with MATCHWORK and perform the following steps.

KEY1234 **e**

1. To enter the CAL menu, the Level B commands must be accessed. Type KEY1234 and press ENTER.

CAL

2. At the command prompt, type the command CAL.
   Note: Do not type CAL9 directly; you will not be able to save any of the changes.
   The matching network will attempt to communicate with the generator immediately, even though there is no connection between the two, and a flurry of information will appear across the screen disabling any further communications.

3. A menu of numbered options appears.

```
*CAL
MATCH WORK SETUP PROCEDURE 6-13-96


[ MATCHWORK CALIBRATION MENU ]
[ Press :
   1    - For Cal Starting point

   3    - For Matchwork DC Bias Cal
   4    - For Matchwork Vp-p Cal
   5    - For Matchwork V protect Cal
   6    - For Matchwork Sensors Cal
   7    - For Matchwork Low Power Cal
   8    - For C1 and C2 Capacitor Position Cal

   9    - For Switch Selection

   E    - To  View Calibration Settings
   F    - To  Save Calibration Permanently & Exit

{ENTER} - to EXIT now ]
```

9 **e**

4. Select and enter number 9 - Switch selections.

```
[ SWITCH SELECTION ]
[ Press :
   1    - To Toggle Control Type,  Host/Front/Gen/Aux
   2    - To Roll Matchwork Type,  MW10LD/MW20LD/40MHz

{ENTER} - to EXIT now ]
```

1 **e**

5. Select option 1, the Gen control option, following the menu directions and then press ENTER.

F

6. You will see the CAL menu again. Type F to save the changes and exit.

```
*CAL
MATCH WORK SETUP PROCEDURE 6-13-96


[ MATCHWORK CALIBRATION MENU ]
[ Press :
   1    - For Cal Starting point

   3    - For Matchwork DC Bias Cal
   4    - For Matchwork Vp-p Cal
   5    - For Matchwork V protect Cal
   6    - For Matchwork Sensors Cal
   7    - For Matchwork Low Power Cal
   8    - For C1 and C2 Capacitor Position Cal

   9    - For Switch Selection

   E    - To  View Calibration Settings
   F    - To  Save Calibration Permanently & Exit

{ENTER} - to EXIT now ]
```

   A flurry of information will be seen until you disconnect the communication line.

7. Now connect the fiber optic link from the MW to the generator's MW interface connector.

8. The MATCHWORK® is now in generator control mode.

Note: *Communications with the MATCHWORK require an RS-232-to-Fiber-Optic converter (ENI P/N: MWI-232-01).*

3.1.4 Matching Network Operation through the Generator

The GMW-25 Generator can control and view the status of the matching network on the generator's front panel once the MATCHWORK® is set up in generator control mode.

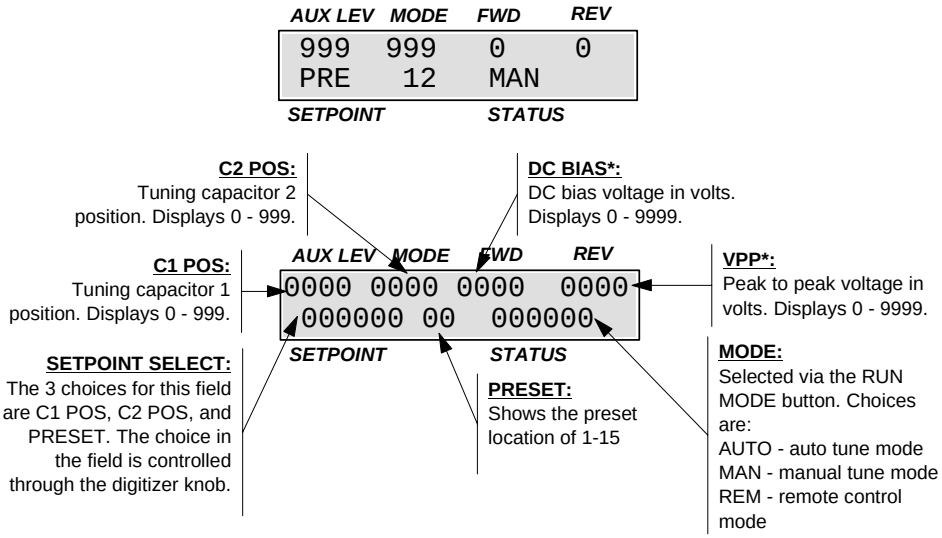
Activating the front panel to display MW status/Readbacks

To display the status of the connected matching network, complete the following steps:

GEN/MW

1. Press the GEN/MW button on the front panel to switch the display from showing the status of the generator to that of the matching network.

   The display should look like this:



   * = These fields are for readback status. They cannot be changed by the user.

GEN/MW

Pressing the GEN/MW button again will return the display to showing the status of the generator.

3.1.5 Changing the Matching Network parameters

In setting up the MATCHWORK® fields, it is possible to do the following from the front panel:

- Manually tune the position of C1 or C2.
- Manually recall any previously saved presets.

Note: *Preset values cannot be created at this time.*

- Toggle between the three control modes: (MAN) Manual, AUTO and REM (Remote) mode.
- View DC Bias or Vpp fields while RF is on.

Note: *The DC Bias and Vpp fields are simply reporting fields and the values cannot be changed.*

The specifics for these fields will depend upon the application you are using.

3.2 ENI Monitor Software Commands

ENI Monitor is the name for MKS, ENI Products' proprietary serial protocol that can operate over RS-232 or on a multi-dropped RS-422 network (RS-485 is *not* supported). The ENI Monitor allows total access to all of the generator's features.

The commands available to the user using the ENI monitor for the GMW-25 Generator are grouped into five different categories:

- Basic Monitor
- Generator Control
- Generator Readback
- MATCHWORK® Control
- MATCHWORK Readback

3.2.1 Basic Monitor

The basic monitor commands allow the user limited access to the Controller software.

Command	Option	Description
HEL	<n>	Decimal values of n from 0 to 9 display each of the ten possible help screens. Any value of n outside this range will show help screen 0.
CHK		The result of this command is the display of the software checksum. This checksum will be calculated each time the CHK command is initiated.
IDE	<ident>	The ident may have values from 0 to 255. This command works in association with the generator's RS422 address. When the ident in the command is the same as the address in an RS422 configured generator, it is possible to communicate with the DSP. If the ident does not match the address, communication is disabled. This command is designed to work only while communicating on an RS422 bus.
EKO	<n>	This command sets the echo mode of the digital communications. While in echo mode, all characters sent to the generator via the serial link are echoed back down the link to the sender. n = 0 turns echo mode on (characters are echoed) n = 1 turns echo mode off (characters are not echoed) *NOTE: When echo mode is off, though characters are not seen on a terminal as they are typed, they are indeed being sent to the generator.

Basic Monitor Commands

Table 3.2.1

***** *These commands are available in version 1.1 of the software and any versions that follow it.*

3.2.2 Generator Control

The generator control commands allow the user to control some of the operation of the generator from the external monitor.

Command	Option	Description
FRE		All internal faults will be reset. Take note, however, that if a fault persists, it will only be cleared for a fraction of a second until it is detected again and set. In this case, the fact that the fault was actually cleared will not be observable to the user.
FTU	< n >	n = 1, The generators frequency tuning feature is turned on. n = 0, The generator's frequency tuning feature is turned off.
KEY	< key >	Depending on the value of key, different access levels into the generators software will be granted. These higher access levels (B and C) allow different digital commands to be accessible to the user (i.e. calibrations, direct memory access, etc.).
LIT		This will disable link integrity checking. The link integrity feature is turned on automatically when a ^w (Control W) is received over the serial link.
LLT	< n >	n = 0, Forward power leveling is enabled. n = 1, Load power leveling is enabled
OEM	< power >	The result will be to set the generator's output power set point to the value specified as power. In the event that power is greater than the maximum allowable set point, the set point will be equal to the maximum power output set point.
TRG		If RF is currently off in the generator, it will be switched on. If RF is already on, this command has no effect.
OFF		If RF is currently on in the generator, it will be switched off. If RF is already off, this command has no effect.
SBD	< n >	This command will change the baud rate at which the generator is currently communicating. **n BAUDRATE** 0. 300 1. 600 2. 1200 3. 2400 4. 4800 5. 9600 6. 19200 7. 38400 8. 76800 9. 115200

Generator Control Commands

Table 3.2.2

Note: *These commands are available in Version 1.1 software and any versions that follow it.*

3.2.3 Generator Readback

These commands are used to read back operating status information on the generator. Commands that show the optional dash parameter **<->** can read back continuously if this option is used. Pressing the **ESC** key, or sending an escape character (1Bh) will break the continuous loop.

Command	Option	Description
ACT	< - >	The result of this command is the display of power set point, forward power, reverse power, PSU voltage, and output frequency. When a dash is present in the command (ACT-), this result will be updated continuously until the escape key is sent.
PAI	< - >	The result of this command is the display of the Current through the PA of the generator. When a dash is present in the command (PAI-), this result will be updated continuously until the escape key is sent.
PAV	< - >	The result of this command is the display of the Voltage rail of the generator's PA. When a dash is present in the command (PAV-), this result will be updated continuously until the escape key is sent.
RFV	< = >	The result of this command is a 16-bit integer. Each bit in this integer represents a fault. If a bit is set, then the fault condition that is associated with that bit exists. When this command is specified with the equal sign (RFV=), each fault that exists is displayed in a more verbose manner, one fault per line. **BIT FAULT DESCRIPTION** 0. RF Overheat 1. Fan Fault 2. Driver Fault 3. PSU Voltage Limit 4. Forward Power Limit 5. Reverse Power Limit 6. PSU Current Limit 7. Dissipation Power Limit 8. Link Integrity Fault 9. Failed Ignition 10. Undefined 11. Undefined 12. Undefined 13. Undefined 14. Undefined 15. Undefined
ROD	< - >	The result of this command is the display of the dissipated power. When a dash is present in the command (ROD-), this result will be updated continuously until the escape key is sent.

Command	Option	Description
ROF	< - >	The result of this command is the display of the forward power. When a dash is present in the command (ROF-), this result will be updated continuously until the escape key is sent.
ROL	< - >	The result of this command is the display of the load power. When a dash is present in the command (ROL-), this result will be updated continuously until the escape key is sent.
ROR	< - >	The result of this command is the display of the reverse power. When a dash is present in the command (ROR-), this result will be updated continuously until the escape key is sent.
RPS	< = >	The result of this command is a 16-bit integer. Each bit in this integer represents a status flag. If a bit is set, then the status condition that is associated with that bit is true. When this command is specified with the equal sign (RPS=), then each fault that exists is displayed in a more verbose manner, one Status description per line **BIT STATUS DESCRIPTION** 0. Analog Remote Mode 1. Load Power Leveling 2. System Fault 3. Interlock Open 4. Max Power Condition 5. RF On 6. Digital Remote Mode 7. External RF Used 8. Auto Fault Reset Mode 9. Echo Off Mode 10. Link Integrity Mode 11. Continuous Calibration Update Off 12. Frequency Tune Mode 13. Power Sequencing Mode 14. Pulse Power Mode 15. Generator Protection Disabled
RVE	< = >	The result of this command is to display the version number of the software along with a very brief description and the date that the software was compiled. When the equal sign is specified with this command (RVE=), the time that the code was compiled is displayed along with the date.
RSE		The result of this command is to display the current set point of the generator. This result will continuously update itself until the escape key is sent.
RUT	< - >	The result of this command is to display the total amount of time that the generator has been powered up since its factory calibration. The format is hhhhh:mmmmm:sssss. When a dash is present in the command (RUT-), this result will be updated continuously until the escape key is sent.

Command	Option	Description
ROT	< - >	The result of this command is to display the total amount of time that the generator has had RF turned on since its factory calibration. The format is hhhhh:mmmmm:sssss. When a dash is present in the command (ROT-), this result will be updated continuously until the escape key is sent.
RKH	< - >	The result of this command is to display the total amount of energy that the generator has supplied since its factory calibration in kilowatt-hours. The format is +#.####e+## When a dash is present in the command (RKH-), this result will be updated continuously until the escape key is sent.
TIM		The result of this command is a report of the real time date and time. The format of the result is “hh:mm:ss mm/dd/yy” The real time date and time of the generator can be set by the following command TIM - YYMMDD = HHMMSS.
MON	<-n>	The result of this command is the display of certain probes within the generator. Available probes are Fan Current and PA temperature. When a dash is present in the command (MON-n), this result will be updated continuously until the escape key is sent. **N MONITOR POINT** 8 Fan Current D PA1 Temperature 1
RPB		Returns the baud rate at which the generator is communicating to the VIProbe. The value of this number will match those of the SBD command. This command is only valid when communications to the VIProbe is enabled via CAL 80.
PSR		Returns the sampling rate in Samples / Second that the generator is getting from the VIProbe. This command is only valid when communication to the VIProbe is enabled via CAL 80.
RAM		Performs a test on non-volatile memory and reports the results.

Generator Readback Commands

Table 3.2.3

3.2.4 MATCHWORK® Control

The following commands allow the user to directly control the Matching network using the ENI Monitor:

Command	Options	Description
AUT		Forces the MATCHWORK into Auto Tune mode.
MAN		Forces the MATCHWORK into Manual Tune mode.
RCL	**< 1-30 >** **< A - F >**	Causes one of 36 stored capacitor positions to be recalled. This command can only be used in Manual Tune mode.
SCO	**<0-999>**	Sets the C1 tuning capacitor position. The number following SCO represents a percentage (0 - 99.9%) of the full range of the capacitor. This command can only be used in Manual Tune mode.
SCT	**<0-999>**	Sets the C2 tuning capacitor position. The number following SCT represents a percentage (0 - 99.9%) of the full range of the capacitor. This command can only be used in Manual Tune mode.
SDT	**<0-999>**	Causes the MATCHWORK to delay before auto tuning begins. The time is set in 100 ms steps allowing a maximum time of 99.9 s before tuning begins.
STO	**< 1-30 >** **< A - F >**	Causes the current capacitor positions to be stored into one of 36 preset locations. This command can only be used in Manual Tune mode.

MATCHWORK Control Commands

Table 3.2.4

Note: *The Matching Network needs to be connected to the generator per Figure 2.6 and set up according to section 3.1.3.*

3.2.5 MATCHWORK® Readback via the Generator

These commands are used to cause information to be read back from the MATCHWORK. Commands that show the optional dash parameter **<->** can read back continuously if this option is used. Pressing the **ESC** key, or sending an escape character (1Bh) will break the continuous loop.

Command	Options	Description
POW	**<->**	Causes the forward power through the MATCHWORK to be returned.
RCO		Causes the C1 capacitor position to be read back. A value for 0-999 will be returned representing the percentage (0-99.9%) of the full tuning range of the capacitor.
RCT		Causes the C2 capacitor position to be read back. A value for 0-999 will be returned representing the percentage (0-99.9%) of the full tuning range of the capacitor.
RDC	**<->**	Causes the DC Bias value to be returned (calibrated in Volts).
RMG	**<->**	Causes the magnitude error at the input of the MATCHWORK to be returned.
ROT	**<=>**	Returns the amount of time that RF has been passed through the MATCHWORK. If ROT is typed alone, the value returned is the amount of time in hours only. If the <=> option is used, the value returned will be in the HH.MM.SS format.
RPH	**<->**	Causes the phase error at the input of the MATCHWORK to be returned.
RPP	**<->**	Causes the peak-to-peak voltage measured at the output stud to be returned. This command is only useful if the optional Vpp circuit is installed in the controller unit. If the circuit is not installed, random values may be returned.
RUT	**<=>**	Returns the amount of time the MATCHWORK has been powered on. If RUT is typed alone, the value returned is the amount of time in hours only. If the <=> option is used, the value returned will be in the HH.MM.SS format.

MATCHWORK Readback Commands

Table 3.2.5

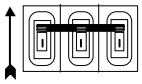
Note: *The Matching Network needs to be connected to the generator per Figure 2.6 and set up according to section 3.1.3.*

3.3 Advanced Operation

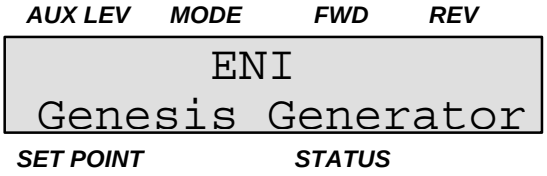
Advanced operation of the GMW-25 generator allows a tighter control over the individual parameters in the operation. For sensitive processes, advanced operation is an ideal way to maximize the operation of the generator.

3.3.1 Generator Front Panel Operation

Before any of the various settings can be set, make sure the system check has been performed in section 2.12. After that has been done, the generator should be turned on following the procedure below:



1. Flip the AC mains switch up to the ON position, if it is not on already (The **I** symbol should be showing). The display should appear as follows (only during the initial power-up of the generator):



Changing between Auto-Tune and Manual Tune Mode

Auto-Tune Mode

This software option enables the generator to vary its operating frequency to achieve the lowest possible reflected power for a given load condition.

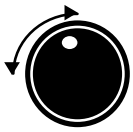
1. Press the MENU button to access the Frequency Menu.

2. Press the Item Up button to change the display to the next menu item. The display should look like this:

AUX LEV *MODE* *FWD* *REV*

```
  FREQUENCY MENU
Tune Mode->  Auto
```

SET POINT *STATUS*



3. Use the digitizer knob to select between manual (MAN) or automatic (Auto). Manual Tune Mode allows the operator to control the tuning of the generator. This option may not be available depending on whether the unit is fixed-frequency or not.

Setting the Minimum Search Threshold

Minimum Search Threshold

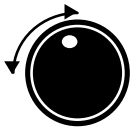
This software parameter refers to a pre-defined value that prevents the Auto-Tune algorithm from searching for a frequency when the reflected power is below the pre-defined limit.

1. Press the Item Up button to change the display to the next menu item. The display should look like this:

AUX LEV *MODE* *FWD* *REV*

```
  FREQUENCY MENU
Threshold->   10W
```

SET POINT *STATUS*



2. Use the digitizer knob to select a minimum search threshold. The range is from 0.0 W to 1.0 W.

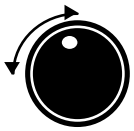
Setting the delay time

1. Press the ITEM UP button to change the display to the next menu item. The display should look like this:

AUX LEV *MODE* *FWD* *REV*

```
  FREQUENCY MENU
Delay->      670ms
```

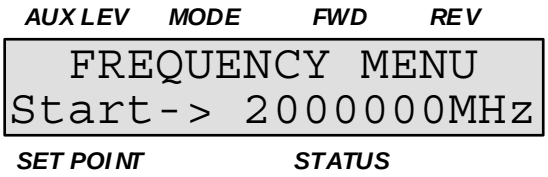
SET POINT *STATUS*

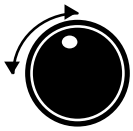


2. The delay time sets the time for which the algorithm remains at the start frequency. The delay should be chosen to ensure that ignition is achieved reliably and the plasma is stable before the frequency starts to move. Use the Digitizer Knob to select a delay time from 100 ms to 8000 ms.

Setting the start frequency

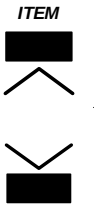
1. Press the ITEM UP button to change the display to the next menu item. The display should appear as follows:





2. The start frequency defines the frequency at which the tuning process starts. This frequency should be chosen to give good ignition. To ensure the best tune time, the frequency should also be chosen so that tuning proceeds towards the ignited tune point. Use the Digitizer Knob to select the optimal frequency. Selecting the start frequency is not available with fixed-frequency units.

Menu Navigation and Exit



1. Pressing the ITEM UP button will not return to the first menu option. To do that, you must press the ITEM DOWN button to get to other menu options.

2. When finished with setting the frequency menu, press the MENU EXIT button to return the display to the normal setting.

3.3.2 ENI Monitor Generator Operation

This feature has not been defined at this time.

3.3.3 MATCHWORK® Network Operation using the Generator Front Panel

This option has not been defined at this time.

3.3.4 MATCHWORK Operation using the ENI Monitor

This option has not been defined at this time.

3.4 Remote Control Interface Communication Protocol

Data is transferred to and from the CPU using a simple ASCII protocol that functions with a standard terminal.

All ENI monitor commands are composed of three ASCII characters followed by numbers where applicable and terminated by a carriage return. All three command characters must be correct for a command to be accepted. All characters sent to the GMW-25 Generator over the ENI Monitor port are echoed by the generator. Thus, if the serial port is being driven by a computer, the computer can verify that the generator received the characters that were sent to it.

Commands containing numerical fields will only be accepted if the numerical portion is in a specified range.

Upon receipt of a carriage return (0x0D), the controller returns a carriage return and a line feed (0x0A) so that the terminal screen is correctly formatted. In addition, an asterisk (*) is used to indicate that the command has been accepted and executed. If an unrecognized command is received, a question mark (?) and bell character (0x07) are returned instead. The response is ordered as follows:

```
CR LF *     or
CR LF BEL ?
```

The ENI Monitor always returns one of these two responses after command execution. In addition, with the exception of the power up messages, there are no unprompted responses.

The following commands give an example of the types of messages that are available and their format:

HEL3	Causes help screen number 3 to print.
RFV	Causes a 16-bit fault vector to be reported showing the system health.

3.4.1 Space Characters

Commands sent to the generator may include space characters (0x20) as desired. The generator will echo such characters back to the sender, but will otherwise ignore them. Space characters are not saved in the software's internal receive buffer.

3.4.2 Illegal Commands

Unrecognized commands or illegal parameters are ignored and enunciated by the return of a question mark character and a bell character. The same response occurs if the limits of the line buffer are exceeded (16 characters). Note that a carriage return on its own is a valid command that does nothing (no-op).

3.4.3 Leading Zeros and Missing User Arguments

The numerical part of the field sent by the terminal need not contain leading zeros, although leading zeros will be echoed if they are sent. Numbers sent to the terminal from the generator will generally have leading zeroes suppressed. If a required user argument is *omitted*, the generator will generally assume a value of zero for that argument.

3.4.4 Special Characters

Five characters have a special purpose and are the only characters **not echoed** on the serial link.

ESC	The ESC character (0x1B) allows the operator to break out of continuous loops that were initiated with a dash character in the command line.
control-W	∧W (0x17) is used to maintain link integrity.
control-Q	∧Q (XON, 0x11) is used to resume serial output (from the generator) that was suspended via XOFF.
control-S	∧S (XOFF, 0x13) is used to suspend serial output from the generator.
!	The exclamation mark (0x21) is used to cause an immediate release of the RS-422 buffer if two consecutive exclamation marks are received in a row.

3.4.5 Power-up Message

The normal power-up text is shown below. ASCII control characters are shown in boldface:

CR is 0x0A, **LF** is 0x0D, and **BEL** is 0x07.

CR LF ENI Monitor on, type **HEL <CR>** for help.

CR LF Power-Up Delay in effect for next 15 seconds.

CR LF BEL *

If the power-up delay was caused by a watchdog reset (or from the WAT command), the text above will be *preceded* by the message:

CR LF [WATCHDOG RESET]

After 15 seconds have elapsed, the generator sends the following text. The asterisk enclosed by curly braces is a unique string that the generator sends *only* on power-up. A host computer can use this string to detect and verify power-up of the generator.

CR LF Power-Up Delay Complete.

CR LF BEL {*}

The messages described in this section are the *only* cases where the generator sends unsolicited characters to the terminal.

3.4.6 Backspace Characters

Backspace or delete characters (0x08 or 0x7F) allow limited editing. When one of these characters is received, the last character in the line buffer is deleted and the following three characters are returned. (**BS** is the backspace char, 0x08, and **SP** is the space char, 0x20.)

BS SP BS

This ensures that a terminal screen backspaces its cursor and removes the last character.

3.4.7 Escape from Indefinite Loops

Some commands continue indefinitely. The escape character is used to exit from this condition. Upon receipt of the escape character, the controller will terminate the loop and respond with the standard command completion string, **CR LF** *.

3.4.8 Link Release Character

This feature is not available.

3.4.9 XON and XOFF

When XOFF character (13h) is received (^S), transmission of RS-232 output data from the generator is halted. When XON character (11h) is received (^Q), transmission of RS-232 output data will resume from the generator.

3.4.10 Key Level

Each command in the GMW-25 Generator repertoire is assigned to one of two **key levels**. Most commands are at key level A. This means that they are enabled by default on power-up of the GMW-25 Generator.

The remaining GMW-25 Generator commands are at key level B. These commands are for serious hardware and software debugging, and for factory test or setup of the GMW-25 Generator. Level B commands do not appear in the Operation Manual for this generator. Level B access is not granted to customers, but is only for MKS, ENI Products personnel. This is because level B commands have the potential for damaging the GMW-25 Generator (not to mention the user's equipment or process). The help screens reflect the commands that are available with the present level of security.

In this document, the key level of each command is identified as either 0, A, or B. If you attempt to enter a command at an unauthorized access level, the system responds with:

```
*ACCESS DENIED
```

3.4.11 Link Integrity Checking

The generator has a built-in function that detects the loss of the RS-232 serial link on the digital interface. This is called link integrity. If the RS-232 link seems to have been broken, the generator will shut off the RF power and not allow the RF to be turned back on until the link is restored.

The generator always defaults at power-on with this function disabled. To enable the function, a **[^W]** must be sent from the host. Once the host initiates this function, the generator will expect to see **[^W]** sent from the host on a continuous basis. If another **[^W]** is not received within one second of the last one sent, the generator will assume the host is no longer connected and produce a link integrity error, thereby shutting off the RF power.

If link integrity checking has been enabled by the host, you may later disable it with the **LIT** command.

Check for proper link integrity control in the following manner:

1. Turn the generators AC power ON via the main AC breaker switch.
2. Turn the RF power on via the front panel.
3. Send a **[^W]** by pressing the **W** key while holding down the **CTRL** key. Within one second, the RF power should go off because another **[^W]** was not sent.
4. Try to turn the RF power back on via the front panel. It should not go on.
5. Enter the command **RFV=**. The generator should return a Link Integrity fault.
6. Enter the command **LIT**. Again enter the **RFV=** command. The generator should now show no faults, and you should be able to turn RF power on via the front panel.
7. With the RF power on, send many **[^W]**s in succession. Make sure you send at least one every second and ensure the RF power stays on while you are sending the **[^W]**s. Once you stop sending the **[^W]**s, the RF should go off as it did before. Reset the generator with the **LIT** command again.

Chapter 4

Troubleshooting

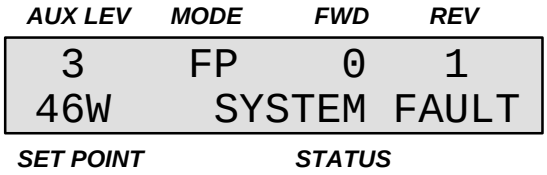
This chapter lists solutions for the common problems a user may encounter when using the GMW-25 generator. If the problem doesn't match any of those on the following pages, please contact the nearest MKS, ENI Products' Service location for assistance.

4.1 Hardware Faults

Symptoms	Probable Cause	Recommendations
AC ON does not light	No AC line voltage	Contact an authorized MKS, ENI Products' Service location for assistance.
No RF Output	Defective Control Board	Contact an authorized MKS, ENI Products' Service location for assistance.
	Broken or disconnected control to driver cable	Contact an authorized MKS, ENI Products' Service location for assistance.
	Broken strap at LPF or VSWR bridge assembly	Contact an authorized MKS, ENI Products' Service location for assistance.
	Interlock string open	Check cabinet and RF interlocks; check that the interlock pins of analog interface are connected together. Refer to the Analog Interface, Table 3.3.1.
Circuit Breaker Trips	Short circuit	Contact an authorized MKS, ENI Products' Service location for assistance.
Front Panel display: *AUX LEV MODE FWD REV* Genesis waiting for MAIN CPU *SET POINT STATUS*	Control Board not booting up.	Contact an authorized MKS, ENI Products' Service location for assistance.

4.2 System Faults

A fault that occurs within the unit will show up as the following on the front panel display:



These faults can only be diagnosed using an external control device such as the ENI Monitor. When the system fault occurs, a SYSTEM FAULT LED will illuminate on the front panel. Use the **RFV** and the **RPS** command (see section 3.2.3) on the ENI monitor to determine the fault. Using the equal sign (=) after the **RFV** command will show the fault in words instead of a numerical value.

This way of diagnosing a fault is only available if the unit has a fully functional front panel and the Analog Remote Interface is connected to a terminal to use the ENI Monitor.

Otherwise, if and when a system fault occurs, only the SYSTEM FAULT LED will illuminate.

Interlock status is shown on the front panel if the unit is open. "INLK OPEN" will be displayed on the STATUS line.

4.3 Analog Remote Interface Faults

If the unit is connected to a test fixture, such as ENI's UTF-10, two more faults can be detected. One is indicator driven (also known as a "Hard Fault") and the other appears on the display (also known as a "Soft Fault").

4.3.1 RF OVERHEAT (Hard Fault)

This fault occurs when the RF temperature is above the limit. The RF OVERHEAT lamp will light up on the front panel of the test fixture.

4.3.2 MAX POWER (Soft Fault)

This fault occurs when the maximum power limit has been reached. The message will appear on the digital readout of the test fixture.

Appendix A

GMW-25 Specifications

This appendix lists the complete physical and electrical characteristics for the GMW-25 Plasma Generator.

GMW-25 Specifications

RF Output Frequency

1.80 - 2.17 MHz
(auto-tunes within this range to optimize match with load impedance)

RF Output Power Rating into Matched Load

2500 W into a 50 Ω load

RF Output Power Rating into Mismatched Load (All Phases)

Load Power	Load VSWR
2500 W	1.5:1
2000 W	2.0:1
1500 W	3.0:1
500 W	∞ :1

Dynamic Power Range

25 - 2500 W

Load Impedance Range

Unlimited

RF Stability / Spurious Output

Unconditionally stable / < -50 dBc
(for any load, within ratings)

Harmonic Output / Distortion

< -40 dBc
(within ratings)

Power Control / Regulation

AC Line-to-Power: 0.5% max. change in output power over rated line voltage range.

Regulation tolerance is referenced from Set Point. Subject to limits of Forward & Reverse Power and Current; accuracy relative to ENI Power Standard.

Power Range	Reg. Tolerance
>250W	±1%
<250W	±2.5W

Load Mismatch Protection

Automatic; forward power limits typically 0.25 ms after reverse power reaches a pre-programmed level 20% of rated power.

Primary AC Power Source

3/PE ~, 200 - 208 V ± 10%,
15 A, 50 - 60 Hz ± 3 Hz

Power Consumption

5.4 kVA

Power Factor at Maximum Output into a Matched 50Ω Load	> 0.75
Cooling System	Combination of water-cooling and forced-air cooling.
External Ambient Air:	
Temperature Rating	5 - 40 °C
Relative Humidity Rating	80% RH (max) at up to 31 °C, derated linearly to 50% RH (max) at 40 °C
Cooling Water:	
Inlet Temperature Rating	5 - 35 °C
Pressure Maximum	4 kg/cm² (60 psi)
Flow Rate Minimum	7.6 ltr/min (2 gal/min)
Connections	Accept ¼" male (NPT) pipe thread
Installation (Overvoltage) Category	INSTALLATION CATEGORY II: Local level, appliances, portable equipment, etc., with smaller transient overvoltages than distribution level and fixed equipment.
Pollution Degree	POLLUTION DEGREE 2: Normally only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation must be expected.
Electromagnetic Compatibility (EMC)	EMC compliant with standards EN 50081-2 : 1992 Group 2, Class A EN 50082-2 : 1995
Product Safety	NRTL Listed to standards CAN/CSA C22.2 No. 1010.1-92 Category 290 EN 61010-1 : 1993 Category 387 EN 61010-1 : 1993 / A2 : 1995 UL 3111-1 : 1994 Category 435
CE Compliance	CE marked

Power Indicator	Optional digital readout displays frequency and forward, reflected, & load power.
Size* (H x W x D)	5.25" x 19” rack mount x 20.5” *(133 mm x 483 mm x 521 mm)* ** including handles & connectors*
Weight	55 lbs. *(24.9 kg)*
Remote Interface Connector	Standard: Subminiature Type D, 9-pin digital; optional custom analog interface cards available.
RF Output Connector	Type N or custom
Rack Mounting	19-inch adapters supplied
Equipment Internal Fuse Ratings	Fuses F4 - F6 on Housekeeping Power Supply PCB Assy (1050-230) 3AT, 250 V

Appendix B

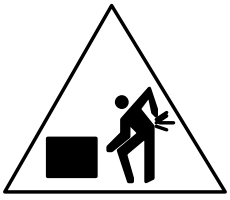
Glossary of Symbols

This appendix provides a definition of the symbols that have been used throughout this manual.

Caution Triangle
Figure B.1

Shock Hazard Triangle
Figure B.2

RF Radiation Warning Triangle
Figure B.3



Heavy Object Warning Triangle
Figure B.4

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Appendix C

Glossary of Terms

This appendix provides a definition of new terms that have been used throughout this manual.

Auto-Tune Mode	This software option enables the generator to vary its operating frequency to achieve the lowest possible reflected power for a given load condition.
Minimum Search Threshold	This software parameter refers to a pre-defined value that prevents the Auto-Tune algorithm from searching for a frequency when the reflected power is below the pre-defined limit.
NIST	National Institute of Standards and Technology

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