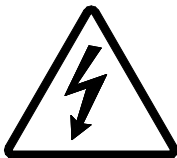




# OPERATION MANUAL

## elite™ RF Plasma Generator elite 300 / 600 Half Rack



**WARNING: POTENTIALLY LETHAL VOLTAGES ARE USED BY AND PRODUCED BY THIS UNIT.** A thorough understanding of this manual is required before attempting to install this unit into a system.



**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 CFCs. 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 CFCs 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-Quality-System-compliant facility.

### Notice

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Manual Order Number: 1041955  
Revision Level: 00A

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## Warranty

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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

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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

---

<b>ROCHESTER, NY</b>	MKS Instruments, Inc. 100 Highpower Road Rochester, NY 14623	Tel: (585) 427-8300 Fax: (585) 427-7839
	<b>Toll Free USA Sales Hotline:</b>	<b>1-800-267-5362</b>
	<b>Toll Free USA Technical Support Hotline:</b>	<b>1-877-464-2789</b>
<b>SAN JOSE, CA</b>	MKS Instruments, Inc. 134 Rio Robles San Jose, CA 95134	Tel: (408) 750-0300 Fax: (408) 428-0390
<b>AUSTIN, TX</b>	MKS Instruments, Inc. 1321 Rutherford Lane Suite 200 Austin, TX 78753	Tel: (512) 719-8000 Fax: (512) 719-8095
<b>ENGLAND</b>	1 Anchorage Court Caspian Road Altrincham, Cheshire WA14 5HH, England	Tel: 44-161-929-5500 Fax: 44-161-929-5511
<b>GERMANY</b>	Sielminger Str. 63 D-70771 Leinfelden- Echterdingen (Stetten) Stuttgart, Germany	Tel: 49-711-947700 Fax: 49-711-9477025
<b>JAPAN</b>	MKS Japan, Inc. 2-12-11 Matsubara-cho Akishima-city, Tokyo Japan, 196-0003	Tel: 042-500-8825 Fax: 042-500-8829
<b>KOREA</b>	6th Fl., Building B, Nexscien Plant, 456, Gomae-Dong, Giheung-Gu, Yongin-Si, Gyungki-Do Postal code : 446-901, Korea	Tel: 82-31-8021-1307 Fax: 82-31-8005-9324
<b>SINGAPORE</b>	Blk 4010 Techplace 1 #01-07/08/09 Ang Mo Ko Ave 10 Singapore 569626	Tel: 65-6451-1062 Fax: 65-6451-0172
<b>TAIWAN</b>	2F, No. 47, Ln. 2, Sect. 2 Kuang Fu Rd. Hsinchu 300 Taiwan, ROC	Tel: 886-3-575-3040 Fax: 886-3-575-3048
<b>P.R. of CHINA</b>	West end of 2 <sup>nd</sup> 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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# Chapter 1

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## Introduction

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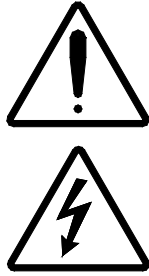
The elite™ Plasma Generator is a rugged RF power source for plasma etching, CVD and sputtering applications. Featuring precise power control and digital interfacing, this elite™ generator provides the exceptional reliability and repeatability required for today's demanding plasma processes.

Operating at the frequency of 13.56 MHz, the elite™ platform consists of products that will produce 300W or 600W into a 50Ω load. The digital-based control module automatically measures forward RF power and reflected RF power, maintaining constant power output within ±2% of set point over a Dynamic Power Range of 1 to 300 or 600 watts. The RF output can be pulsed at up to 1kHz with duty cycles from 1 to 99%.

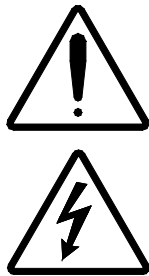
Precise power calibration is traceable to NIST (National Institute of Standards and Technology) through the ENI Power Standard. Low harmonic distortion and spurious-free performance complement the unit's RF power output control and unconditional RF stability.

A rugged RF power section ensures substantial power delivery into fixed match systems. The digital-based control constantly monitors internal subsystem status to maximize system availability.

A 9-pin digital interface as well as a standard 25-pin analog interface provide remote control, monitoring and diagnostic capability. Optional custom interface cards are also available.



*If this equipment is used in a manner not specified by the manufacturer, then the protection provided by the equipment may be impaired.*



*This equipment contains NO USER SERVICEABLE PARTS. In the event that equipment servicing is required, please contact an authorized MKS, ENI Products service center.*

## **1.1 About This Manual**

This 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 given in Chapters 2 and 3.

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.

This manual uses the output power level of the elite™ 600 as a default (600W). However where applicable, the 600W output could be replaced with 300W for the elite 300. Also, certain specifications or modes of operation may be different than the typical operation by customer request. Refer to any applicable addendum or specifications for your specific generator when ordering other than the standard elite™ unit.

### 1.1.1 Finding Your Way Around

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

<b>Chapter 1</b>	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.
<b>Chapter 2</b>	This chapter acquaints the user with the elite™ Plasma Generator. It covers major features and front and rear panel descriptions. This chapter covers everything needed to install and set up your generator from Unpacking and Inspection to Initial Power Up.
<b>Chapter 3</b>	This chapter covers in more detail how to operate your generator and take advantage of all of its features.
<b>Chapter 4</b>	This chapter details common troubleshooting situations you may encounter when using your generator, along with their solutions.
<b>Appendix A</b>	This appendix provides complete physical and electrical characteristics of your generator.
<b>Appendix B</b>	This appendix provides a glossary of terms that have been used throughout this manual.

## 1.1.2 Documentation Conventions

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

### **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.
Curly 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**

Appendix B provides a complete list of all the new terms used in this manual.

## 1.2 Safety Considerations

Certain safety-related considerations must be observed before installing, operating, or servicing this equipment. Symbolic and/or textual labels and markings are used in and/or on the equipment, as well as in this product manual, to convey and/or identify such important information. Please look for these labels and markings, and follow their direction.

The term **CAUTION** is used to indicate a potential hazard that could result in minor injury or equipment damage, and to warn against unsafe practices.

The term **WARNING** is used to indicate a potential hazard that could result in injury or death if not avoided.

The term **DANGER** is used to indicate an imminent hazard of serious injury or death if not avoided.

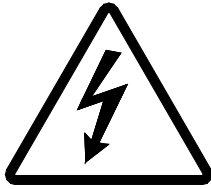
### 1.2.1 Exclamation Point Within a Triangle



**Symbol Definition:**      **Caution, refer to accompanying documents**

The “exclamation point within a triangle” symbol (reference ISO Publication 3864, No. B.3.1) is used in and/or on the equipment to alert the installer, operator, or service personnel to the presence of important related installation, operation, and/or service instructions and to direct such personnel to the product manual for that information. This symbol is also used within the product manual itself to identify important instructions.

### 1.2.2 Lightning Bolt Within a Triangle



**Symbol Definition:** Caution, risk of electric shock

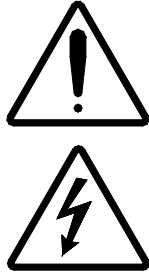
The “lightning bolt within a triangle” symbol (reference IEC Publication 417, Symbol No. 5036, and ISO Publication 3864, No. B.3.6) is used in and/or on the equipment to alert the user, operator or service personnel to the presence of uninsulated voltage within the enclosure of sufficient magnitude to constitute a risk of electric shock. Only authorized service personnel with a schematic diagram and a thorough knowledge of the voltages existing within the equipment shall remove covers or panels bearing this symbol. This symbol is also used within the product manual itself to identify important operating and/or maintenance instructions, which, if not followed carefully, could result in personal injury or even death.

### 1.2.3 Service Warning



**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 Non-ionizing Electromagnetic Radiation Warning Triangle

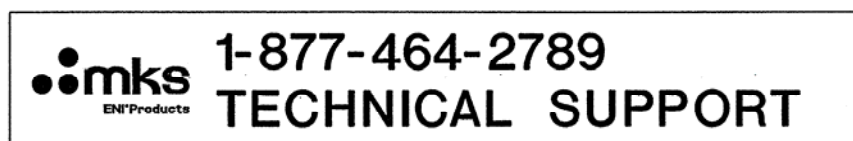


**Symbol Definition:** Caution, non-ionizing electromagnetic radiation

The “non-ionizing electromagnetic radiation warning triangle” symbol (reference IEC Publication 417, Symbol No. 5140, and ISO Publication 3864) is used on the equipment to alert the installer, operator, or service personnel that the equipment is capable of producing elevated, potentially dangerous, levels of non-ionizing electromagnetic radiation, particularly RF radiation.

#### 1.2.5 Technical Support

On the back of the generator is a label with a toll-free 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

### 1.2.6 Earth (Ground)



**Symbol Definition:** Earth (ground)

The “earth (ground)” symbol (reference IEC Publication 417, Symbol No. 5017) is used to identify equipment earth (ground) terminal(s) in cases where the “noiseless (clean) earth (ground)” symbol (reference IEC Publication 417, Symbol No. 5018) and the “protective earth (ground)” symbol (reference IEC Publication 417, Symbol No. 5019) are not explicitly required.

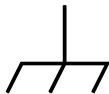
### 1.2.7 Protective Earth (Ground)



**Symbol Definition:** Protective earth (ground)

The “protective earth (ground)” symbol (reference IEC Publication 417, Symbol No. 5019) is used to identify equipment terminal(s) which are intended for connection to an external protective conductor for protection against electric shock in case of a fault or to identify the terminal of a protective earth (ground) electrode.

### 1.2.8 Frame or Chassis



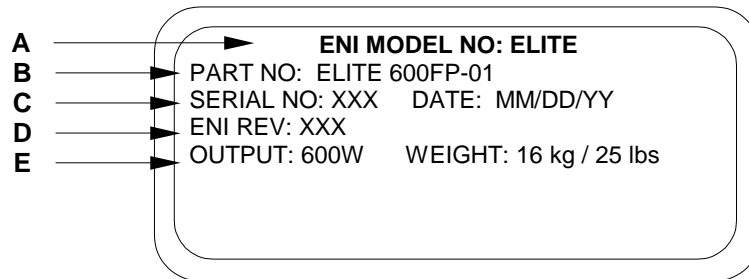
**Symbol Definition:** Frame or chassis

The “frame or chassis” symbol (reference IEC Publication 417, Symbol No. 5020) is used to identify equipment frame or chassis terminal(s).



## 1.3 Nameplate

The elite™ Plasma Generator can be identified by a nameplate at the back of the unit that contains the following information.



**Typical elite™ Serial Tag Label**

Figure 1.3

- |   |   |
|---|---|
| <p><b>A. ENI MODEL NUMBER:</b><br/>The number that uniquely identifies the unit.</p>  | <p><b>D. ENI REV:</b><br/>The revision letter identifying product configuration (Revision A is the initial revision level).</p> |
| <p><b>B. PART NO:</b><br/>The assembly number that uniquely identifies product configuration.</p>   | <p><b>E. OUTPUT &amp; WEIGHT:</b><br/>The output of the unit in watts and its weight in kilograms and pounds.</p>               |
| <p><b>C. SERIAL NO:</b><br/>A number that is sequentially assigned as the product is manufactured.<br/><b>DATE:</b><br/>The date of manufacture in MM/DD/YY format.</p> |   |

## 1.4 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 is provided at the end of each step.

To quickly set up your elite™ generator, follow the procedure below:



1. If equipped, make sure the generator's power switch is in the OFF position.

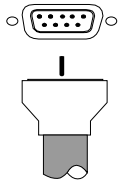


Note: On some basic models, AC power control is accomplished through the removal of the AC line cord. In this case, ensure the AC linecord is disconnected from the rear of the generator



2. Attach the AC Mains line cord to a 110 – 253V, single-phase, 15 A outlet.

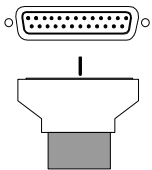
(See section 2.9 for more information on AC Power Requirements.)



3. If applicable, connect the 9-pin male serial digital interface to the female serial interface connector on the rear panel.

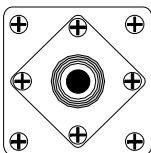
See section 3.1 for instructions to set up your computer.

See Table 2.5.1 for pin outs.



4. If applicable, connect the 25-pin male analog interface cable to the female connectoe on the rear of the generator. If the analog interface will not be used, connect P/N 1019388-001 interface jumper to defeat the analog interface interlock circuit.

See Table 2.5.1 for pin outs.



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



6. Make sure that the RF output cover is in place. This cover is designed to prevent removal of the RF output cable without the need for a tool. It is not designed to remove power from the generator if removed. Observe all precautions when RF power is active.



7. If the generator is equipped with an ON/OFF switch, move the switch to the ON position. If the switch has no ON/OFF switch, simply plug in the IEC linecord to the rear of the unit to active power. When the unit is ready to operate, the LEDs on the rear panel will be active.

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

```
-----  
      ENI MONITOR  
MKS Instruments ENI Products  
-----
```

9. The generator is now ready to operate.

---

---

## 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**

## 2.1.4 Accessories Available

Items from the following list (varying with configuration) are available as accessories or attached to the elite™ RF Generator.

<b>Category / Item</b>	<b>ENI Part Number</b>
<b>Documentation</b>	
Operation Manual	1041955
Mounting and Outline drawing (Basic Full Rack)	1037079
Mounting and Outline drawing (Full rack with LCD)	1036481
Mounting and Outline drawing (Basic Half Rack)	1037303
Mounting and Outline drawing (Half Rack with LCD)	1037304
<b>Hardware</b>	
Adapter bracket for rack mounting two half rack units	1037463-001
Rack handle (full rack)	331012
Rack handle (half rack)	1039014
<b>RF Connectors / Cover</b>	
RF Output Connector cover	1036305-001
<b>Connectors / AC Cord</b>	
Interlock Jumper	1019388-001
Basic AC linecord, IEC 60320 C-13 to NEMA 5-15P, 3m	1040434
Basic AC linecord, IEC 60320 C-13 to flying lead, 1.5m	1040435-001

## 2.1.5 Instructions for Lifting and Carrying

Because the elite™ generator weighs 11 kg (25 lbs.), lifting and carrying this unit can be performed by a single person (properly trained in the lifting and moving of equipment).

## 2.2 Installation Requirements

### 2.2.1 elite™ Airflow Requirements

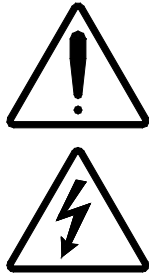
A minimum space of 75 mm (3") should be allowed front, rear and sides for ventilation. Approximately 160 CFM (4530 liters/min) of airflow is required.

### 2.2.2 Power Requirements

The AC Input Ratings of the elite™ Generator are indicated on a label attached to its back panel. Those nominal ratings are as follows:

110 VAC – 253VAC, 50/60Hz, 15A, Single Phase

#### ***Upstream Disconnect Device***



*Safety listing of model elite™ generator requires that its installation include an upstream current-limiting disconnect device rated 50-60 Hz, 250V ~ minimum, and no more than 20A. The upstream disconnect device must be located within sight of the elite™ unit, must remain user-accessible at all times, and must be labeled so as to indicate the equipment it disconnects. During installation, removal, and/or servicing of the elite™ unit, place the upstream disconnect device into its off (open) position, and follow lock and tag (lock-out / tag-out) procedures to control hazardous energy (reference appropriate regional regulations and requirements). No circuit should be connected or wired when electricity is present.*

**For safety compliance, the elite™ must be powered with a connection that has a hardware-based EMO circuit.**

## **2.3 Rack Installation**

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

The half-rack elite™ generator has two optional rack mounting plates available (sold separately), one which allows a half-rack generator to be installed in a standard 19" EIA rack and the second which allows two half-rack generators to be installed side-by-side in the rack. When rack mounting, the generator should be supported on a rack shelf of adequate strength to support 11 kg (25 lbs). A ground wire or braid must be connected from the generator ground stud on the rear panel to the chassis ground on the cabinet.

For details, refer to the applicable Mounting and Outline Drawing as detailed in section 2.1.4.

## **2.4 System Interconnect**

The elite™ generator may be supplied with an analog or other remote control interface. For interfaces other than the standard analog interface, refer to the appropriate addendum to this manual for more information.

In order to maintain EMC compliance, cables should be constructed using Alpha Supra-Shield or equivalent cable 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.

## 2.5 Remote Digital Interface

The digital interface provides control and monitoring of the generator using standard RS-232 voltage levels in an 8-bit serial packet. The serial communications data rate is fixed at 115 kbaud.

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

### 2.5.1 Communication Configuration

A standard, 9-pin female Type “D” connector provides the electrical connection as defined in the table below.

Pin	Function	Description
1		Not used.
2	TX RS232	RS-232 Tx data output.
3	RX RS232	RS-232 Rx data input.
4		Not used.
5	Digital Ground	This pin is connected to the digital ground of the controller.
6		Not used.
7		Not used.
8		Not used.
9		Not used.

#### Hardware Configuration for Remote Digital Interface

Table 2.5.1



## 2.6 RF Power Connections

The Type N RF output connector on the elite™ generator is not field replaceable. The use of adapters is **not** recommended, as that may extend the connection beyond the RF cover, allowing a user to access the connection without the use of a tool and thereby defeating this safety feature.

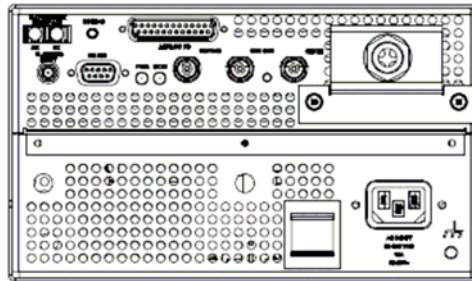
An appropriately rated mating connector and coaxial cable must be used for the RF output connection.

## 2.7 Safety Interlocks

The analog interface version of the elite™ generator is equipped with an RF interlock system accessed through pins 10 and 23 of the 25-pin D-sub connector on the rear panel. Until this interlock circuit is completed, RF output will be disabled.

Satisfying this interlock circuit can be accomplished via a contact closure on the customer tool, or by simply attaching an interlock defeat jumper (see section 2.1.4).

Pins 10 & 23 of the Analog I/O provide control of the internal interlock circuit

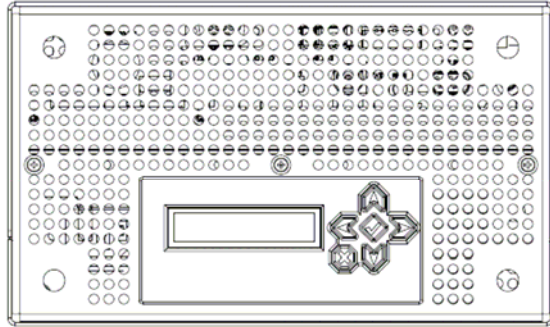


elite™ Safety Interlock Location - Rear View, Analog Version

Figure 2.7

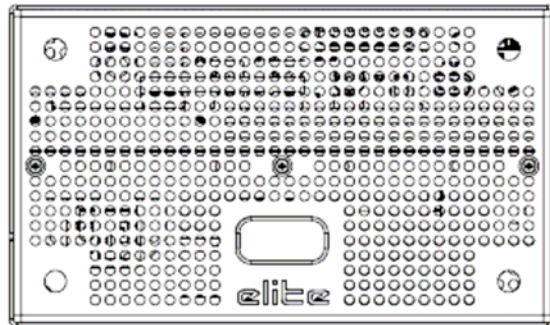
## 2.8 Panels and Controls

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



**elite™ (LCD) Front View**

Figure 2.8a



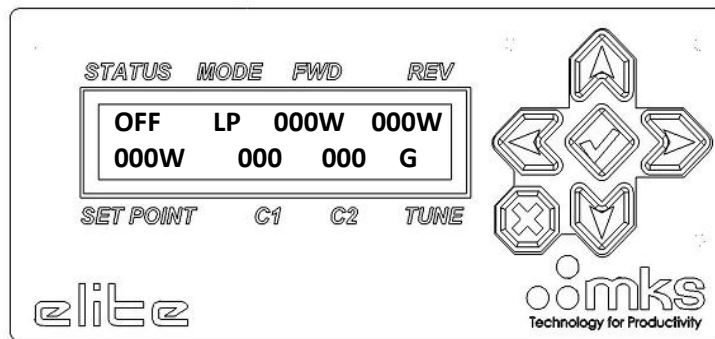
**elite™ (Basic) Front View**

Figure 2.8b

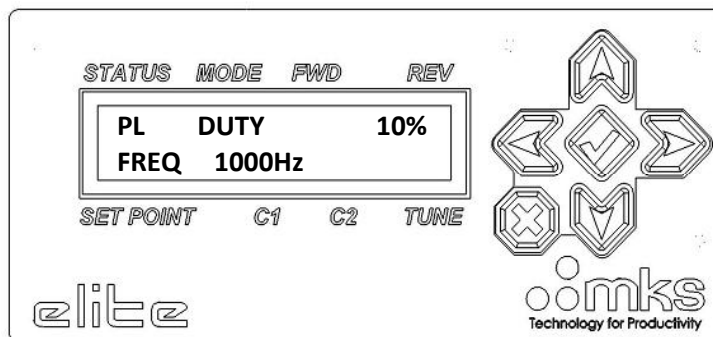
## 2.8.1 Front Panel

On some models, the elite™ generator may be supplied with a front panel LCD display and integral keypad. The LCD provides information on the operating parameters for the generator and where applicable, the attached MKS Matchworks. The six-button keypad can be used to setup the generator and Matchworks operating parameters and control the RF output.

The LCD has two different menus that can be displayed. After boot-up, the LCD will display basic generator and Matchwork data as shown below:

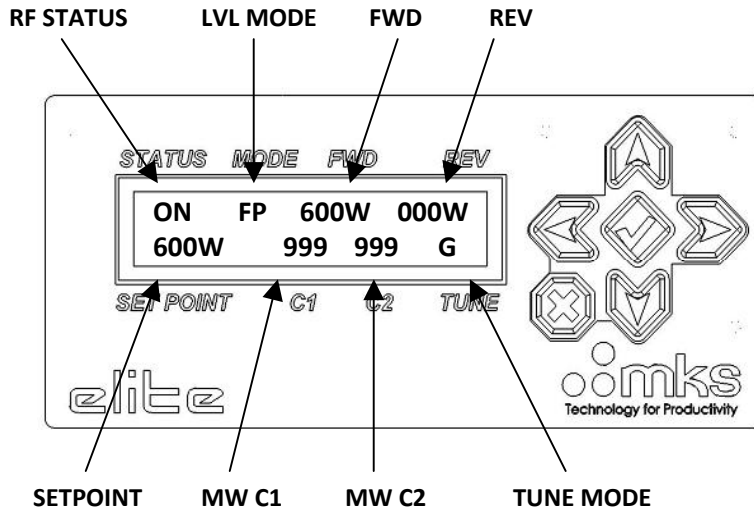


By using the Down key on the keypad, the main menu can be switched to the Pulsing menu.



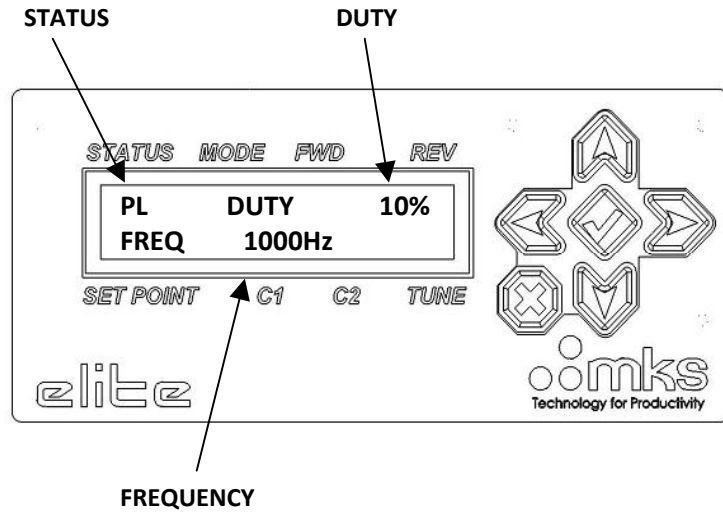
The following shows the various information and controls available in the two menu screens:

**Main Menu:**



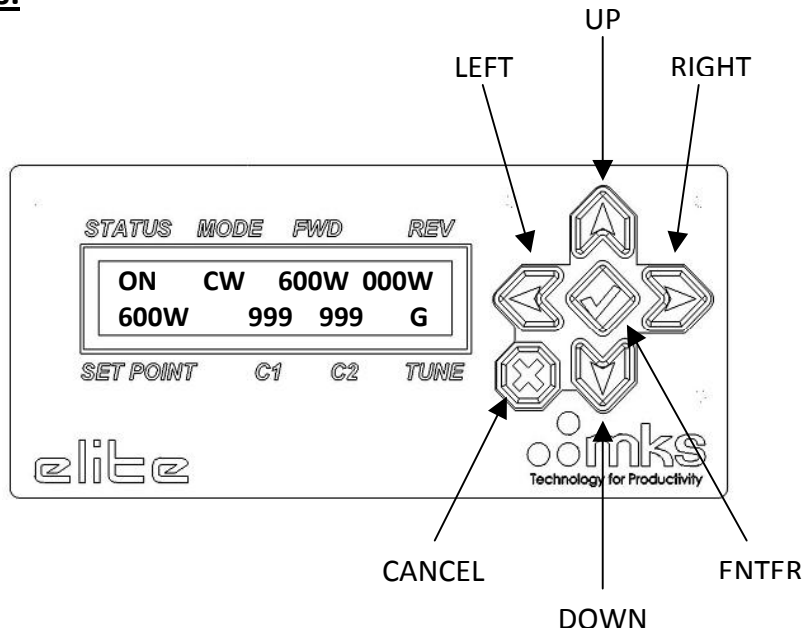
MENU ITEM	ENTRY	DESCRIPTION
RF STATUS	ON	RF is ON
	OFF	RF is OFF
LVL MODE	FP	Forward Power Leveling Mode
	LP	Load Power Leveling Mode
	EX	External Leveling Mode (DC Bias)
FWD	0-600	Forward Power (Watts)
REV	0-600	Reflected Power (Watts)
SETPOINT	0-600	Setpoint (Watts)
MW C1	0-999	Matchwork C1 Position (when used with certain MKS Matching Networks)
MW C2	0-999	Matchwork C2 Position (when used with certain MKS Matching Networks)
TUNE MODE (when used with certain MKS Matching Networks)	G	Generator controls Matchwork tune mode
	M	Manual Matchwork tune mode
	T	Automatic Matchwork tune mode

**Pulse Menu:**



MENU ITEM	ENTRY	DESCRIPTION
STATUS	CW	RF output is CW (continuous wave)
	PL	RF output is pulsing
DUTY	1-99	Pulsing duty cycle (%)
FREQUENCY	7.6 - 1000	Pulsing frequency (Hz)

**Keypad controls:**



UP	In cursor mode, push to increment value of the selected control parameter. When cursor mode is disabled, the UP key can be used to switch from the Pulse menu to the Main menu.
DOWN	In cursor mode, push to decrement value of the selected control parameter. When cursor mode is disabled, the DOWN key can be used to switch from the Main menu to the Pulse menu.
LEFT	In cursor mode, push to move to the next control parameter
RIGHT	In cursor mode, push to move to the next control parameter
ENTER	Push to enter / exit cursor mode. In cursor mode, the cursor can be moved between menu items to change operating parameters of the generator and / or Matchworks.
CANCEL	In cursor mode, push to cancel any changes made while in control mode

## 2.8.2 Rear Panel

### Connections and indicators

The following table briefly describes all of the rear panel connections for the elite™ Generator.

<b>On all models</b>	
<b>Connector</b>	<b>Description</b>
<b>AC Input (Type IEC 60320 C-13)</b>	This connection is used to provide the AC power to the unit. While typical applications utilize one 'Hot' conductor and one 'Neutral' conductor, both lines are internally fused and therefore if necessary, the generator may be supplied from two 'Hot' conductors that meet the AC voltage range for the unit (i.e. 220V single phase, two phases of 208V 3ph)
<b>Chassis Ground (6mm Stud)</b>	This 6mm ground lug provides a chassis ground point for the generator. A braided ground strap or other suitable ground conductor should be attached before operating the RF generator. The M6 nut on the ground stud should be torqued to 40-46 in-lbs.
<b>Analog Interface (Type DB25F)</b>	This interface connects the generator to an analog control signal. This interface allows control of the generator through various analog voltages (0 – 10Vdc). See section 3.2.1 for more information.
<b>RS-232 Interface (Type DB9F)</b>	This interface is used to connect the generator to a terminal. Generator control and readback can be accomplished through a standard terminal emulation program or through any system that can provide the necessary commands. See section 3.1 for more information.
<b>Status LEDs</b>	These LEDs provide information as to the operating status of the generator. See Status LEDs table in this section for additional details.
<b>DC Bias (Optional) (Type BNC-F)</b>	<i>Future Option</i> - allows for an external leveling mode to control the output power of the unit.
<b>Matchworks Interface</b>	<i>Future Option</i> - this fiberoptic transmit / receive pair is used to communicate to a MKS Matchwork when the optional Profibus Interface Board is <u>not</u> being used.
<b>RF Output (Type N)</b>	Type N RF connector.
<b>CEX Output (Type BNC-F)</b>	Provides an RF / pulse synchronization signal for a second RF generator. This signal is directly tied to the main 13.56MHz source of the generator.
<b>CEX Input (Type BNC-F)</b>	Input for RF / pulse synchronizatoin. When in CEX mode, the drive signal for the generator's power amplifier will come from this source versus the internal 13.56MHz source.
<b>Blanking Input</b>	This connection allows for an external blanking signal to be supplied to the generator to enable RF pulsing. See section 3.3 for more information.

<b><i>With Optional Profibus Interface installed</i></b>	
<b>Connector</b>	<b>Description</b>
<b>Profibus Debug Port (Type DB9F)</b>	This port provides direct access to the Profibus Interface board software. <i>This port should only be used by qualified service personnel.</i>
<b>Matchworks Interface</b>	This fiberoptic transmit / receive pair is used to communicate to a MKS Matchwork when the optional Profibus Interface Board is installed. This allows the generator to control the Matchworks capacitor positions via the generator front panel control.
<b>Profibus Connector (Type DB9F)</b>	This digital interface is used to connect the generator to a Profibus communications bus. See the Profibus User Manual (P/N 1037458) for more information on the interface protocol.
<b>Profibus Address Dipswitch</b>	This 8-position dipswitch sets the Profibus address of the generator. See the Profibus User Manual (P/N 1037458) for more information on the interface protocol.



## Status LEDs

All versions of the elite™ generator utilize two LEDs on the rear panel to provide information on the generator status as well as any faults or warnings. Under normal operating conditions, the PWR and STAT LEDs will be solid or flash green. Under fault or warning conditions, these LEDs will turn amber or red and flash in a pattern indicating what fault is active. In the case of multiple faults or warnings, there will be a one second OFF period between codes.

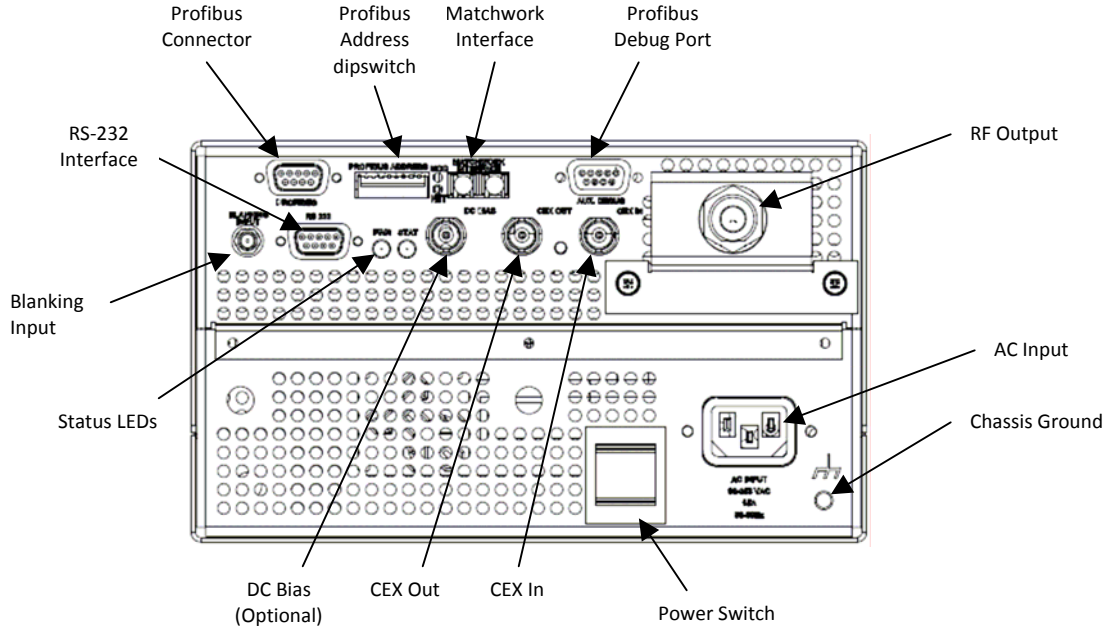
Status	PWR LED	STAT LED
AC ON	Solid Green	-----
System Ready	Solid Green	Solid Green
RF On	Flashing Green (2Hz)	-----
RF within regulation	Flashing Green (2Hz)	Flashing Green (2Hz)
Interlock fault	Solid Amber	-----
Warning		Flashing Amber (see below)
Fault	Solid Red	Flashing Red (see below)

## Fault Codes

Fault	RED STAT LED flash pattern (250ms between flashes)
Overheat Fault	ON-OFF
VIF Link Integrity Fault	ON-OFF-ON-OFF
Profibus Master lost with RF ON	ON-OFF-ON-OFF-ON-OFF
Profibus Link Integrity	ON-OFF-ON-OFF-ON-OFF-ON-OFF

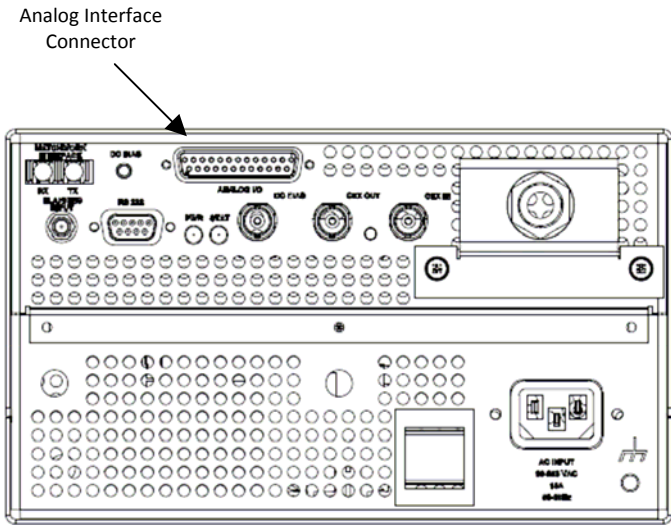
### Rear Panel Drawing

Figure 2.8.2 shows the rear panel for the elite™ Generator and calls out each of the connectors as described in the table from the previous page.



### elite™ w/ Optional Profibus Rear Panel View

Figure 2.8.2a



### elite™ w/ Basic Analog Interface Rear Panel View

Figure 2.8.2b

## **2.9 Power Requirements**

The elite™ generator is designed to operate from a single-phase AC supply. The universal input allows any line voltage from 110V to 253V at 50Hz or 60Hz. While the typical application will utilize one 'Hot' conductor and one 'Neutral' conductor, both lines are internally fused and therefore if necessary, the generator may be supplied from two 'Hot' conductors that meet the AC voltage range for the unit (i.e. 220V single phase, two phases of 208V 3ph)

### **2.9.1 AC Mains Connection**

An IEC 60320 C-13 style AC appliance inlet is supplied on the rear panel of the generator. This allows connection of any number of linecords meeting the IEC standard.

NOTE: Many off-the-shelf IEC 60320 linecords are not properly rated for the current that the elite™ generator may draw at nominal line voltages and full power output. To maintain safety compliance, any linecord utilized should be able to carry at least 15amps.

## 2.10 Maintenance & Cleaning

The elite™ generator is designed and built to require only the following minimal cleaning and maintenance. It is recommended that the unit be periodically wiped down on the outside with a dry cloth to remove any build-up of dust and dirt.

When operated in dusty areas, dust may build up in the front air intakes. A hand-held vacuum cleaner can be used to remove any dust build-up that occurs, or it can be brushed off with a cloth.

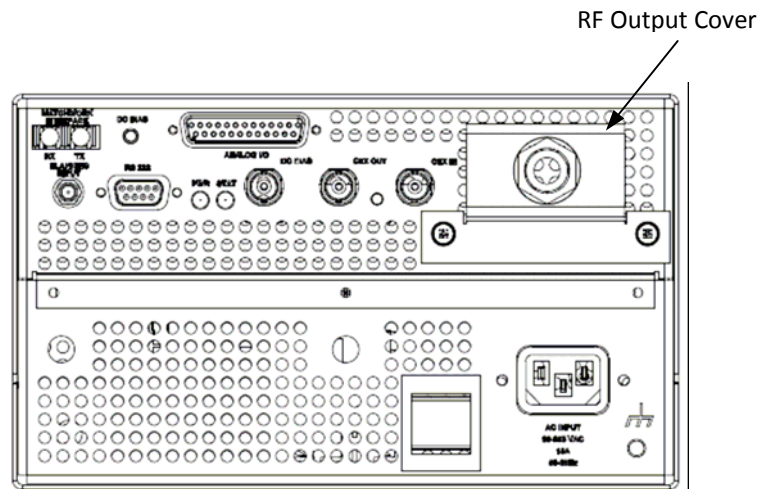


**WARNING:** To minimize the risk of accidental shock, turn off the AC mains breaker before wiping off the unit and around the rear panel connections. Do not use a damp cloth for cleaning unless AC power is disconnected

## 2.11 System Check

Before the elite™ generator can be used, it is imperative that the following procedure be followed to ensure optimal and safe operation. Make sure that:

1. The AC line cord is connected to the AC mains. Verify that AC input power is correct. (See section 2.9 for more information on AC Power Requirements.) Inspect the AC power connector and cable before use – replace if damaged.
2. The RS-232 serial cable, if used, is connected to the 9-pin D-type serial connector on the rear panel.
3. The Analog Interface Cable, if used, is connected to the analog I/O connector. (See section 2.4 for more information on the analog interface.)
4. The RF output cable is connected to the RF Output connector on the rear panel. Ensure that the RF cable and connectors are in good condition – replace if damaged.
5. The RF output cover is on.



**RF Output Cover**

Figure 2.11

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## Chapter 3

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# *elite*<sup>TM</sup> Operation

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The elite<sup>TM</sup> generator was designed with simplicity in mind. Therefore, the generator can be operated with a simplified command set consisting of one-letter commands issued from a standard terminal emulation program. Alternately, because of the simplicity of the command set, applications can be built in any number of scripting or automation languages to control the generator.

### **3.1 Basic Operation through the RS-232 Interface**

The elite<sup>TM</sup> generator is designed to be used with minimal input from the user. In the most basic case, all that is required from the user is an RF setpoint and the RF ON command. In more advanced situations, other commands can be used to control and monitor the generator.

#### **3.1.1 Required Items**

In order to use the RS-232 interface, you will need the following items:

1. A computer with a free COM port capable of communicating at 115200 baud (default), with 8 data bits, 1 stop bit, and no parity. Software flow control should be enabled as well.
2. An RS-232-compliant cable to connect the computer to the unit.
3. A software program that emulates a simple terminal interface. A custom program may be used as well.

### 3.1.2 Command Prompt

The command prompt is an asterisk (the character above the 8 on any standard PC keyboard). In order to ensure you are properly connected to the unit, you should press the ENTER key on your keyboard a few times. You should see the following echoed to the terminal:

```
*  
*
```

This indicates that the software inside the unit is running and your setup is sufficient to communicate via this interface.

The asterisk is never actually entered by the user. In the examples that follow, it will be shown to indicate command entry at the terminal and is only included for completeness.

### 3.1.3 Startup Message

If you are connected to the unit prior to its being turned on, and your setup is correct, then you will see an initial message print out at the terminal once the unit is turned on. It should look like this:

```
-----  
ENI MONITOR  
MKS Instruments ENI Products  
-----
```

```
*  
*
```

### 3.1.4 General Command Syntax of One Letter Commands (OLC)

The elite™ generator control system has been designed with simplicity in mind. Therefore, only single letter commands are necessary to control the generator and obtain data from it.

**ACK**      <CR><LF>“\*”                      ASCII 0x0D 0x0A 0x2A

This is an acknowledgment of a completion of a valid command.

**NAK**      <CR><LF>“?”    ASCII 0x0D 0x0A 0x3F

This is used to indicate that the command sent was invalid or unavailable.

### 3.1.5      **Optional Argument Data Entry**

- Integer Numbers are entered as just #, where the number is made up of 0 to 9s, with a range of 0 to 999999.
- Out-of-range arguments will result in the **NAK** response above.



### Supported OLC Commands (User Level)

Command		Parameters	Description
<b>K</b>	Access Level	Key code	Enables access to advanced generator controls. <i>Only used by MKS Trained Field Service and Applications personnel</i>
<b>E</b>	RS-232 Enable	None	Enables RS-232 control of the generator
<b>I</b>	RS-232 Disable	None	Disables control of the generator through the RS-232 port. Even when control is disabled, readbacks can still be obtained via this interface.
<b>N</b>	RF ON	None	Enables RF Output
<b>F</b>	RF OFF	None	Disables RF Output
<b>A</b>	Forward Power Leveling	None	Sets the controller leveling mode to forward leveling. In this mode, forward power will match the setpoint, except when the generator exceeds the reverse power limit.
<b>V</b>	Delivered Power Leveling	None	Sets the controller leveling mode to delivered leveling. In this mode, the load power (forward – reflected) will match the setpoint, except when the generator exceeds the reverse power or forward power limits.
<b>G</b>	External Power Leveling	None	<i>Future use – sets the controller leveling mode to external leveling. In this mode, an external readback signal (i.e. DC bias) sets the level the generator will attempt to achieve.</i>
<b>P</b>	Power Setpoint	XXXXXX	Sets the power setpoint for the generator. After the ‘P’ command is issued, the generator will respond with “Enter New Setpoint (AAAAAA - BBBBBB):”. The power setpoint must be entered as a six digit value (i.e. 000600 for 600W. Note - the leading zeros are required)
<b>C</b>	CEX Enable	None	Activates CEX mode. In this mode, the generator receives its drive signal from the source attached to CEX IN. Please review the specifications section for CEX signal requirements.
<b>J</b>	CEX Disable	None	Disables CEX mode. When disabled, the generator uses its internal 13.56MHz source.
<b>Q</b>	Set Pulse High Time	XXXXXX	When utilizing pulse mode, this command sets the pulse high time in microseconds. After the ‘Q’ command is issued, the generator will respond with “High Pulse Time:”. The pulse high time must be entered as a six digit value (i.e. 005000 for 5000us. Note - the leading zeros are required).
<b>X</b>	Set Pulse Low Time	XXXXXX	When utilizing pulse mode, this command sets the pulse low time in microseconds. After the ‘X’ command is issued, the generator will respond with “Low Pulse Time:”. The pulse low time must be entered as a six digit value (i.e. 005000 for 5000us. Note - the leading zeros are required)
<b>U</b>	Enable Pulsing	None	Enables internal pulsing of the RF output.
<b>Y</b>	Disable Pulsing	None	Disables internal pulsing and allows CW operation of the generator.

<b>S</b>	Save Configuration	None	Saves changes made to the following configuration items for future boot-ups: Pulse mode, pulse parameters, leveling mode, CEX mode
<b>L</b>	Reload Boot Configuration	None	Restores the as-shipped configuration for configuration items such as pulse mode, pulse parameters, leveling mode and CEX mode.
<b>M</b>	Monitor Data	None	Continuously displays generator data. When issued, the following data is displayed: RF Status : Off CEX : DISABLE SetPoint : 000000 Fault vector : 0000000000000000 Status Vector : 0000000000001000 Forward Power : 000056 Reverse Power : 000024 Delivered Power : 000032 Controller Output : 000000 Leveling mode : Forward Power Interface : NONE
<b>T</b>	Display Data	None	Displays raw generator data in string format. This data can be easily used by a user-built script or macro. The data is returned in the following format:  000000 000000 0000000000000000 0000000000001000 000056 000024 000032 000000 000005 00004E20 00004E20  Data (from left to right): 1. RF_ON/OFF in decimal a. RF_ON is indicated by 000001 b. RF_OFF is indicated by 000000 2. SETPOINT in decimal 3. FAULT in binary. a. Each digit represents a bit position in the fault vector 4. STATUS in binary a. Each digit represents a bit position in the status vector 5. FORWARD_POWER in decimal 6. REVERSE_POWER in decimal 7. DELIVERED_POWER in decimal 8. CONTROLLER_OUTPUT in decimal 9. INTERFACE in decimal 10. PULSE_HIGH_TIME in hexadecimal 11. PULSE_LOW_TIME in hexadecimal
<b>Z</b>	Firmware Revision	None	Returns the generator software revision information. Build revision : XXXXXX Software memory core revision : XXXXXX Software interface core revision : XXXXXX
<b>H</b>	Help	None	Displays the help menu showing the commands from this list.

### 3.1.7 Example Operation of the System via OLC

An example of operation during which we send a set point, turn RF on, enable pulse mode, wait for some time, and then turn RF Off:

User Entry	Description
E	Enable RS-232 control
P	Set power set point to 600W
000600	
N	Turn RF on
Q	Set pulse high time to 50 us
000050	
X	Set pulse low time to 500us
000500	
U	Enable pulsing
[Wait for some time]	
F	Turn RF off
I	Return control to the default interface

## 3.2 Operation through Optional Interfaces

### 3.2.1 25-pin Analog Interface

PIN	NAME	TYPE	DESCRIPTION
1	MAX POWER (E)	DO	Emitter side of isolated transistor switch. (See Note 1.) Transistor ON - indicates max reverse power.
2	REFLECTED POWER (+)	AO	A linear DC voltage that represents the reflected power output level. 0 V = 0 W, 1 V = 20 W
3	FORWARD POWER (+)	AO	A linear DC voltage that represents the forward power output level. 0 V = 0 W, 1 V = 60 W (30W for 300W units)
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 <i>nominal</i> voltage to turn RF ON is selectable between +5 V or +24 V (default) via a jumper. Input 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 1 V = 60 W (30W for 300W units). Input impedance is 100 k $\Omega$ balanced differential to ground.
6	NOT USED	—	
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 (or OPEN) - Disables analog remote control mode.
9	OVERHEAT (E)	DO	Emitter side of isolated transistor switch for Pin 22.
10	INTERLOCK (+)	—	This pin should connect to Pin 23 to complete the interlock chain.  If the interlock chain is broken, the power supply will be disabled.
11	LEVELING SELECT	DI	Ground referenced logic input. (See Note 2.) LOW (or OPEN) - Selects forward-power leveling. HIGH - Selects an alternative power-leveling mode.
12	LOAD POWER (+)	AO	A linear DC voltage that represents the load power output level. 0 V = 0 W, 1 VDC = 60 W (30W for 300W units).
13	+12 VDC	—	User voltage for interface purposes. Rated 10 mA max.
14	MAX POWER (C)	DO	Collector side of isolated transistor switch for Pin 1.

PIN	NAME	TYPE	DESCRIPTION
15	REFLECTED POWER RTN (-)	AO	Signal return for Pin 2.
16	FORWARD POWER RTN (-)	AO	Signal return for Pin 3.
17	RF ON/OFF CONTROL (-)	DI	Signal return for Pin 4.
18	POWER SET POINT RTN (-)	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.
22	OVERHEAT (C)	DO	Collector side of isolated transistor switch. (See Note 1.) Transistor ON—Overheat fault. Transistor OFF—No fault.
23	INTERLOCK	—	This pin should connect to Pin 10 to complete the interlock chain.
24	+5Vdc	—	User voltage for interface purposes. Rated 10 mA max.
25	LOAD POWER RTN (-)	AO	Signal return for Pin 12.
Shell	SHIELD	—	Cable shield.

DI = Digital Input DO = Digital Output

AI = Analog Input AO = Analog Output

**Note 1:** For all isolated transistor outputs.  
Transistor OFF (switch open) -  $V_{CEmax} = 40 \text{ VDC}$  ( $I_C < 500 \mu\text{A}$ )  
Transistor ON (switch closed) -  $I_{Cmax} = 10 \text{ mA}$  ( $V_{CE} < 1 \text{ V}$ )

**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.

**Note 3:** Analog outputs will drive a load impedance  $> 100 \text{ K}$

### 3.2.2 CEX (Common EXciter) IN / OUT

For synchronizing two RF generators, a cable can be connected between CEX OUT of the master generator to CEX IN on a slave generator. Any RF generator can be used in either master or slave mode. When operating in CEX mode, the slave generator's frequency will be locked to the master generator. RF on/off control and RF setpoint remain independent between the two generators. The CEX cable's electrical length can be chosen to provide a specific phase shift between the two RF generator outputs.

Note: When a generator is placed in CEX mode and RF is turned on, if a valid CEX signal is not present at the CEX IN connector, the generator will issue an Out of Regulation warning. Depending on the RF setpoint, a momentary overshoot of RF power may occur if a CEX signal is applied after RF is already turned on.

## 3.3 Pulsed Operation

The elite™ generator is capable of both CW and pulsed operation. Different interface options allow for different pulse control methods. For instance, when utilizing the RS-232 interface, the pulse parameters and activation of internal pulse mode can be done using the appropriate OLC commands (see section 3.1). Internal pulse mode can also be controlled via the front panel LCD on generators so equipped.

Pulsing can also be controlled by supplying an external signal to the Blanking Input connector on the rear panel of the generator. With this pin set low or open, the RF output will be CW. By applying a logic high to this pin, the RF output will be inhibited. Therefore, by applying a TTL pulse stream to this pin, the RF output can be pulsed at a rate consistent with the external source.

# Chapter 4

## Troubleshooting

This chapter lists the common problems a user may encounter when using the elite™ generator, along with recommended solutions. 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	Possible Cause	Recommendations
Unit does not power up when plugged in and / or power switch in ON position	No or incorrect AC line voltage.	Ensure that correct line voltage is being supplied.
	Internal fuse open	Contact an authorized MKS, ENI Products Service location for assistance.
INTERLOCK fault	Interlock string open.	Check cabinet and RF connector interlocks; check that pins 10 & 23 of the Analog Interface connector are tied together, either through the tool interlock string or through the interlock defeat jumper
Out of Regulation condition (generator unable to meet setpoint and not	Low AC line voltage	Ensure that correct line voltage is being supplied.
	Internal power sensor issue	Contact an authorized MKS, ENI Products Service location for assistance.

---

## ***Appendix A***

# ***elite<sup>TM</sup> Specifications***

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This appendix lists the complete physical and electrical characteristics for the elite<sup>TM</sup> Plasma Generator.



# elite™ Specifications

(See Spec Doc # 1037990 for complete generator specifications)

<b>Frequency</b>	13.56 MHz fixed	
<b>Rated Output Power</b>	300W or 600W into 50 ohm	
<b>Mismatched Power Rating (Typical for 600W generator)</b>	<b>Load VSWR</b> 1.1:1 1.5:1 2.0:1 3.0:1 ∞:1	<b>Min FWD PWR</b> 600W 600W 486W 384W 200W
<b>Load Mismatch Protection</b>	Automatic; forward power typically folds back within 0.5ms when reflected power exceeds 200W	
<b>Commanded Power Accuracy</b>	±2W (1W - 100W), ±2% (101W – rated power)	
<b>Same Generator Repeatability</b>	1%	
<b>Dynamic Power Range</b>	1W to rated power	
<b>RF Stability / Spurious Output</b>	Unconditionally stable for any load within operational limits / -20 dBc	
<b>Harmonics</b>	-30 dBc, maximum	
<b>Pulsed Operation (Typical specs – some models may have expanded capabilities)</b>	<b>Frequency</b> 1Hz – 1kHz (When controlled via Blanking Input)  7.6Hz – 1kHz (When controlled internally or via alternate interface)	<b>Minimum Pulse High Time</b> 20us <b>Pulse Rise Time</b> 5us
<b>Common Exciter (CEX) I/O</b>	<b>Connection</b> BNC <b>CEX IN Amplitude</b> 0 – 10dBm <b>CEX IN Frequency</b> 13.56MHz ± 5kHz <b>CEX OUT Amplitude</b> 0 – 5Vdc <b>CEX Out Frequency</b> 13.56MHz ± 5kHz	

<b>AC Input</b>	<b>Connection</b> <b>Input Range</b> <b>Line Frequency</b> <b>Power Consumption</b> <b>Current @ 120Vac</b> <b>Power Factor</b>	IEC 60320 C-13 110Vac – 253Vac 50Hz – 60Hz 1.2kW 9A > 0.90
<b>Operating Ambient Temperature</b>	+5C to +40C	
<b>Size</b>	8.6”W x 15”D x 5.10”H	
<b>Weight</b>	25lbs (11kg)	
<b>Rack Mounting</b>	With optional rack mounting plate	
<b>RF Output Connection</b>	Type N	
<b>Interfaces</b>	RS-232 (Std) Analog (Opt) Profibus (Opt)	DB9F DB25F DB9F
<b>Internal Fuse Ratings</b> <b>(Not user replaceable)</b>	F1, F2 – 15A, 3AG style	

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# Appendix B

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## Glossary of Terms

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

<b>CVD</b>	Chemical Vapor Deposition
<b>Caution</b>	Indicates a potentially hazardous situation that, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.
<b>Clearance</b>	The shortest distance in air between two conductive parts.
<b>DSP</b>	Digital Signal Processor
<b>Danger</b>	Indicates an imminently hazardous situation that, if not avoided, will result in death or serious injury.
<b>EMC</b>	Electromagnetic Compatibility
<b>Enclosure</b>	A part providing protection of equipment against certain external influences and, in any direction, protection against direct contact.
<b>Equipment</b>	The system equipment, its component parts, and auxiliary or peripheral equipment.
<b>Fault</b>	The state of an item characterized by inability to perform a required function, excluding the inability during preventive maintenance or other planned actions, or due to a lack of external resources.
<b>Fixed Equipment</b>	Equipment fastened to a support or otherwise secured in a specific location.

<b>Installation Category (Overvoltage Category)</b>	Classification of parts of installation systems or circuits with standardized limits for transient overvoltages, dependent on the nominal line voltage to earth.
<b>Interlock</b>	A mechanical, electrical or other type of device or system, the purpose of which is to prevent or interrupt the operation of specified machine elements under specified conditions.
<b>LED</b>	Light-Emitting Diode
<b>Mains</b>	The electricity supply that is available to the consumer from the distribution system or systems for which the equipment concerned is designed.
<b>Maintenance</b>	Planned or unplanned activities intended to keep equipment in good working order.
<b>NIST</b>	National Institute of Standards and Technology
<b>NRTL</b>	Nationally Recognized Testing Laboratory
<b>Operator</b>	Person operating equipment for its intended purpose.
<b>Pollution</b>	Any addition of foreign matter, solid, liquid, or gaseous (ionized gases), that may produce a reduction of dielectric strength or surface resistivity.
<b>Pollution Degree</b>	For the purpose of evaluating clearances, the following two degrees of pollution in the micro-environment are recognized: Pollution Degree 1: No pollution or only dry, non-conductive pollution occurs. The pollution has no influence. Pollution Degree 2: Normally only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation must be expected.
<b>Portable Equipment</b>	Equipment intended to be carried by hand.
<b>Rated (value)</b>	A quantity value assigned, generally by a manufacturer, for a specified operating condition of a component, device, or equipment.
<b>Risk</b>	The expected losses from a mishap, expressed in terms of severity and likelihood.
<b>Service</b>	Unplanned activities intended to return equipment that has

failed to good working order.

<b>Severity</b>	The extent of the worst credible loss from a mishap caused by a specific hazard.
<b>Terminal</b>	A component provided for the connection of a device (equipment) to external conductors. It may contain one or several terminal contacts.
<b>Tool</b>	An external device, including keys and coins, used to aid a person to perform a mechanical function.
<b>Warning</b>	Indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury.

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