USER MANUAL

RFG 2000 2V Generator

5705064-C

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User Manual

RFG 2000 2V Generator

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ADVANCED ENERGY®

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WARNING:

Read this entire manual and all other publications pertaining to the work to be performed before you install, operate, or maintain this equipment. Practice all plant and product safety instructions and precautions. Failure to follow instructions can cause personal injury and/or property damage. If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. All personnel who work with or who are exposed to this equipment must take precautions to protect themselves against serious or possibly fatal bodily injury.

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Introduction

READ THIS SECTION!

To ensure safe operation, read and understand this manual before attempting to install or operate this unit. At a minimum, read the safety instructions and follow the safety practices under the heading “Safety” on page 1-3.

INTERPRETING THE MANUAL

The following sections explain the type conventions, icons, and symbols that appear in this manual.

Type Conventions

To quickly identify certain words and phrases in type that differ from the rest of the text, please note the following type conventions:

- Pin and signal names appear in capitalized italics (*DUTY CYCLE.A*).
- Technical terms appear in italicized text when first introduced.
- Unit labels (switches, indicators, etc.) generally appear in boldface letters as they are labeled on the unit (**MODIFY**).
- Commands (**162**) and command names (**setpoint**) appear in boldface lowercase letters.

Icons (Symbols)

This symbol represents important notes concerning potential harm to people, this unit, or associated equipment.

Advanced Energy® includes this symbol in Danger, Warning, and Caution boxes to identify specific levels of hazard seriousness.

DANGER:

This box identifies hazards that could result in severe personal injury or death.

WARNING:
This box identifies hazards or unsafe practices that could result in personal injury.

CAUTION:
This box identifies hazards or unsafe practices that could result in product or property damage.

The following symbols may appear on labels on the unit.

SAFETY

Hazardous voltage

1332

Short circuit protected

1024

High voltage

1028

Protective Earth ground

1029

Earth ground

1069

CE label

1020

Non-ionizing radiation

1030

Hot surface

1309

Warning (refer to manual)

1027

NRTL

1154

Do not attempt to install or operate this equipment without proper training.

- Ensure that this unit is properly grounded.
- Ensure that all cables are properly connected.
- Verify that input line voltage and current capacity are within specifications before turning on the power supplies.
- Use proper electrostatic discharge (ESD) precautions.
- BE CAREFUL AROUND THIS EQUIPMENT.

INTERLOCKS

The RFG 2K-2V generator provides the interlock capabilities listed below. This series-wired loop is provided to shut down the RF output in the case of an equipment malfunction or improper system configuration. A series resistance of less than 15 ohms is required to satisfy the interlock criteria.

RF connector interlock (mounting plate)

Shuts off or prevents turn on of the RF output power if the RF mating connector cover is not present or is not fully seated on the rear of the unit.

Generator User Port Interlock

These pins may be used to tie the generator's interlock loop to a system interlock string.

PRODUCT SAFETY/COMPLIANCE

Certain options of this unit have been tested for and comply with the following Electromagnetic Compatibility (EMC) standards.

Directives and Standards

The following tables list the electromagnetic (EMC) and safety directives and standards.

Table 1-1. *Electromagnetic Compatibility (EMC) Directives*

Directive	Description
89/336/EEC	EC Council directive on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive)

Table 1-2. *Electromagnetic Compatibility (EMC) Standards*

Standard	Description
47 CFR Part 18	Code of Federal Regulations—Limits and methods of measurement of radio interference characteristics of industrial, scientific, and medical equipment
EN 55011	Limits and methods of measurement of radio disturbance characteristics of industrial, scientific, medical (ISM) radio frequency equipment (Class A, Group 2) (CISPR 11)
EN 61000-6-2	Electromagnetic Compatibility - Generic Standards - Immunity for Industrial Environments

Table 1-3. *Safety Directives*

Directive	Description
73/23/EEC	EC Council directive on the harmonization of the laws of the Member States relating to electrical equipment designed for use within certain voltage limits (LVD - Low Voltage Directive)

Table 1-4. *Safety Standards*

Standards	Description
EN 50178	Electronic Equipment for use in power installations Overvoltage Category III; Pollution Degree 3

Table 1-5. *SEMI Guidelines*

Standard	Description
SEMI S2-0200	Environmental, health, and safety guidelines for semiconductor manufacturing equipment
SEMI S8-0600	Safety Guidelines for Ergonomics Engineering of Semiconductor Manufacturing

This device must be installed and used only in compliance with the directives and standards listed in addition to VDE 0113, EN 60204 (IEC 204), and applicable requirements.

Certification

Certain options of this product are certified by:

- CE marking, self addressed by AE Compliance Engineering
- EMC measurements, verified by TÜV Product Services

For more information, refer to the letter of conformance (US) or declaration of conformity (EU) accompanying the product.

Installation Requirements

Install this unit according to the following requirements.

WARNING:
Operating and maintenance personnel must receive proper training before installing, troubleshooting, or maintaining high-energy electrical equipment. Potentially lethal voltages could cause death, serious personal injury, or damage to the equipment. Ensure that all appropriate safety precautions are taken.

WARNING:
RISK OF DEATH OR BODILY INJURY. Disconnect all sources of input power before working on this unit or anything connected to it.

Conditions of Use

To be in compliance with the stated directives and standards, you must meet the following conditions of use.

- Before making any other connection to this device, connect the auxiliary Protective Earth ground terminal to a local earth ground with a copper wire that is sized according to the applicable requirements.
- Install and operate this device in an overvoltage category III or better installation.
- Install and operate this device only in a pollution degree 3 or better environment, which means an indoor location such as a factory floor where conductive pollution or non-conductive pollution occurs and becomes conductive due to condensation, which is to be expected.
- Bolt this device to the floor to prevent toppling.
- To prevent against condensation, install and operate this device with an external water solenoid valve so that water flow is interrupted when the device is not operating.
- Install and operate this device with an external water solenoid valve. Connect the solenoid control wires to the water leak detect signal from this device as described in the “Installation” section of this User manual.
- Install this device so that it is fully enclosed by a rack or other enclosure. The rack or enclosure must be metal and either reinforced, or of sufficient thickness to resist the following tests:

  4 A steady force of 445 N, applied through a steel hemisphere 12.7 mm in diameter; and

4 An impact of 7 J applied by dropping or swinging a 0.53 kg, 50 mm diameter steel sphere.

Note: Following the tests, there must still be a minimum clearance of 12.7 mm between the rack or enclosure and the power supply. There shall be no deformation of the power supply.

- Install and operate this device with an approved isolation transformer on the ac input.
- If this device does not have a circuit breaker, you must install and operate it with a 15A (max) circuit breaker switch on the ac input. The circuit breaker switch must be easily accessible and near the device.
- You must install and operate this device with a disconnect switch that conforms to the applicable requirements. The switch must be easily accessible and near the device.
- Use only a shielded cable on the input power connector.
- Use only a shielded power cable on the output power connector.
- Use only shielded cables on the Host (RS-232) and User (analog control) port connectors.
- Install this device so that the input power connection is inaccessible to the user.
- Install this device so that the output power connection is inaccessible to the user.
- Install the ac line cord so that it is fixed.
- The ac cord must be terminated according to the applicable requirements.

Theory

GENERAL DESCRIPTION

This document describes the Advanced Energy Industries, Inc. (AE) model RFG 2000-2V plasma generator. The RFG 2000-2V is a CE Marked, 13.56 MHz RF generator designed specifically for use with an AE fixed impedance matching network. The unit regulates its output power based on the delivered power (forward power minus reflected power as measured at the generator's output). The unit is designed to provide up to 1500 watts into load impedances with a VSWR of 3:1 or less. Up to 2000 watts may be supplied into load impedances with a VSWR of 2:1 or less.

The unit is controlled through a 25-pin analog/digital User Port connector with no provision for manual (operator) control of the unit. The RFG 2000-2V requires a 4 wire (3 phase plus ground), 208 volt ac input (no neutral connection is required). The unit is water cooled permitting use in clean room environments. The RFG 2000-2V provides connections via the 25 pin user port interface for a single, loop-through interlock string. A contact resistance of less than 15 Ohms between the interlock pins is required to enable the RF output of generator.

The RFG 2000-2V is configured for direct mounting to an Advanced Energy MultiFunction Adapter (MFA) or a fixed impedance matching network. The RFG 2000-2V or fixed impedance matching network and MFA combination allow the user to mount the entire RF delivery system directly to the chamber, eliminating all interconnecting cables and associated signal losses. The MFA or fixed impedance match network matches the generator's 50 Ω output to the nominal center impedance of the chamber for the given process. Using the delivered power capability of the RFG 2000-2V, the generator compensates for variations in the actual load impedance by keeping the delivered power to the process constant.

Specifications

PHYSICAL SPECIFICATIONS

Table 3-1 describes the physical specifications of the generator.

Table 3-1. *Physical Specifications*

Description	Specification
Size	4.9" H x 7.0" W x 15.0" D (12.5cm x 17.8cm x 38.1cm)
Weight	26 pounds (11.8 Kg.) maximum
Connector/Cable specifications	
AC input power	3 meter, 4 wire, 14 AWG shielded line cord with NEMA type L15-30P power connector.(3155053-007) 3 meter, 4 wire, 14 AWG shielded line cord with Harting Han-Q, 5 pin male power connector, 2.5 inches in length. (3155053-005)
Chassis (EMI) Ground	Achieved through the MFA mounting or Fixed Match Network
RF output	Custom connector for use with an AE MultiFunction Adapter or Fixed Match Network
User Port Connector	25 pin D subminiature, female
Coolant Connector	0.25 inch female NPT

ELECTRICAL SPECIFICATIONS

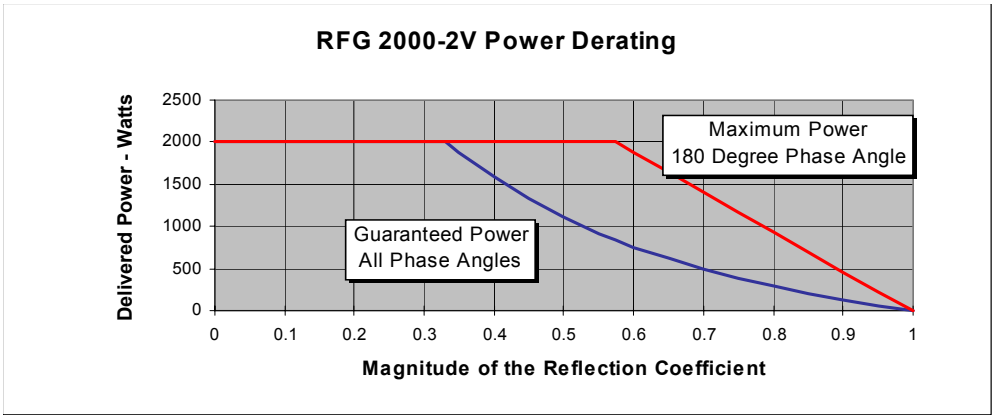
Table 3-2 describes the electrical specifications of the generator.

Table 3-2. *Electrical Specifications*

Description	Specification
Input power specifications	
Line voltage	178 to 229 VAC, 3 phase with ground, no neutral required
Source frequency	47 to 63 Hz
Line current	15 A/ϕ, maximum (at full rated RF output power).

Table 3-2. *Electrical Specifications (Continued)*

Description (Continued)	Specification (Continued)
Overcurrent protection	15 A breaker
AC Line Regulation	0.1% change in RF output for a 0% change in AC line voltage (at full rated power).
RF output specifications	
Output frequency	13.56 MHz ±0.005%
Full-rated output power	2000 watts nominal into loads of ≤2:1 VSWR 1500 watts nominal into loads of ≤3:1 VSWR See Graphic Below
Output Power Range	30 watts to 2000watts
Power Regulation	1% or +/- 3 watts of setpoint, whichever is greater into a 50 ohm resistive load.2.5% or 3 watts of setpoint, whichever is greater into ≤3:1 VSWR load into low (17 ohms) and high (150 ohms) resistance non-reactive loads.
Load Impedance Range	Up to a 3:1 VSWR circle centered at 50 ohms real.
Harmonics	50 dBc at full rated power into 50 ohms
Spurious Signals	-45 dBc at full rated power into 50 ohms
Transient Response	Less than 0.1% change in output power for a 10% step change in the AC line voltage.



COOLING SPECIFICATIONS

Table 3-3 describes the cooling specifications of the generator.

WARNING:
Do not use de-ionized water for cooling purposes. De-ionized water causes both corrosion and erosion of cooling manifolds.

Table 3-3. *Cooling Specifications*

Description	Specification
Cooling medium	Water
Temperature	+5ºC to +27ºC (+41ºF to +81ºF) inlet temperature
Flow rate	7.57 lpm (2 gpm)
Pressure	
Maximum pressure rating	6.9 Bar (100 psi) maximum inlet pressure
Contaminates	The following specifications are recommended for the water used to cool the generator: • pH between 7 and 9 • Total chlorine < 20 ppm • Total nitrate < 10 ppm • Total sulfate < 100 ppm • Total dissolved solids < 250 ppm • Total hardness expressed as calcium carbonate equivalent less than 250 ppm • Specific resistivity of 2500 Ω/cm or higher at 25° C • Total dissolved solids (TDS) as estimated by the following: $TDS \leq \frac{640{,}000}{\text{specific resistivity } (\Omega/\text{cm})}$

ENVIRONMENTAL SPECIFICATIONS

Table 3-4. *Climatic Specifications*

	Temperature	Relative Humidity	Air Pressure
Operating	Class 3K3 5°C to +40°C +41°F to +104°F	Class 3K2 10% to 85% Note 1 +2 g/m^3 to +25 g/m^3	Class 3K3 80 kPa to 106 kPa 800 mbar to 1060 mbar (approximately 2000 m above sea level)
Storage	Class 1K4 -25°C to +55°C -13°F to +131°F	Class 1K3 5% to 95% +1 g/m^3 to +29 g/m^3	Class 1K4 80 kPa to 106 kPa 800 mbar to 1060 mbar (approximately 2000 m above sea level)
Transportation	Class 2K3 -25°C to +70°C -13°F to +158°F	Class 2K3 95%Note 2 +60 g/m^3 Note 3	Class 2K3 66 kPa to 106 kPa 660 mbar to 1060 mbar (approximately 3265 m above sea level)

Note 1 Non-condensing

Note 2 Maximum relative humidity when the unit temperature slowly increases, or when the unit temperature directly increases from -25°C to +30°C

Note 3 Maximum absolute humidity when the unit temperature directly decreases from +70°C to +15°C

Controls, Indicators, and Interfaces

USER PORT (25-PIN)

The 25-pin **User** port on the RFG 2K 2V provides analog and digital signals for controlling and monitoring the unit. This section describes the **User** port on the RFG 2K 2V. It includes the electrical characteristics, cabling requirements, and pin descriptions for the interface. The figures following the pin descriptions show the electrical diagrams for the interface circuitry in the unit.

User Port (25-pin) Electrical Characteristics

Table 4-1 describes the signal types used in the RFG 2K 2V:

Table 4-1. *Remote Interface Connector Signal Types*

Signal Type	Description
Analog inputs	The setpoint signal from the user (pin 5) is a 0 to 10 volt signal scaled to represent the desired forward power from the generator (refer to the signal description table for details). The driver circuit must be capable of operating into a high capacitance load condition (cable capacitance plus 1000 pF at the EMI filter in the generator).
Analog outputs	The analog readback signals from the generator (pins 2 and 3) are driven by precision, low-offset operational amplifiers (industry type OP200GP). These devices are capable of driving high-capacitance loads such as those expected in shielded interface applications. The user's receiver must present a 10k ohm (or greater) impedance to these signals. The readback signals, which represent the forward and reflected power as measured at the output of the generator, are scaled as defined in the signal description table above.

Table 4-1. *Remote Interface Connector Signal Types (Continued)*

Signal Type	Description
Digital outputs	The status signals provided by the generator (pins 14, 20, 22, 24, and 12) are opto-coupled with NPN transistor outputs (industry type 4N37). The collector and emitter of each transistor are provided to the user interface. Each transistor can provide a minimum of 8 milliamperes of collector current and may be operated with a collector-to-emitter voltage of up to 30 volts. Refer to the attached signal description table for signal definitions.
Digital Inputs	The RF PWR ON control signal (pin 4) and the PWR REG MODE signal (pin 8) are opto-coupled (industry type 4N37). The user's signal drives the LED in the opto-coupler through a 510 Ohm resistor. A signal level of 4 volts to 30 volts applied to the input pin activates the signal.
Interlock	The interlock signals (pins 10 and 23) provide the dc power to close the ac contactor in the generator. Pin 10 is tied to the generator's +30V supply via a 5 ampere fuse. Pin 23 is series wired with the interlock switch on the RF output connector and then ties to the contactor coil driver circuit. Connecting pin 10 to pin 23 closes the contactor, enabling ac power to the RF circuits (assuming that an RF output cable is properly installed).

User Port (25-pin) Interface Cabling Requirements

The cable used to connect the RFG 2K 2V's 25-pin **User** port to the system controller must be a shielded, 25-wire I/O cable. Twisted-pair wiring may be used but is not mandatory. Signal losses should be minimized by keeping the cable length as short as possible. The maximum recommended cable length between the RFG 2K 2V and the controller is 10 meters (33´). To minimize interference from adjacent electrical equipment, the EMI shield in the cable must be terminated to the metal shells of the cable's connectors. Additionally, the chassis of the RFG 2K 2V must be tied to a local earth ground through an adequately–sized copper grounding strap.

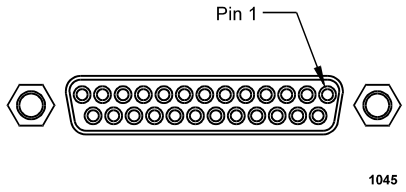


Figure 4-1. *User port connector*

The **User** port has a 25-pin, shielded, female, subminiature-D connector.

Unless otherwise specified, all analog signals are 0 to 10 V while all digital signals are 5 to 24 V, opto-coupled (open-collector signals with return lines non-referenced to ground).

User Port (25-pin) Pin Descriptions

Table 4-2 provides the connector pin descriptions for the **User** port interface.

Table 4-2. *User Port Pin Descriptions*

Signal Pin	Related Pin	Name	Signal Type	Description
14	1	*SETPOINT STATUS*	Digital output	When RF power is enabled a high impedance path between these pins indicates the generator is at setpoint.
2	15	*RFL PWR*	Analog output	This 0 to 10V signal represents the reflected power as measured at the output of the generator. This signal is scaled to represent 0 to 2000 watts. *Note:* Pin 15 must be grounded.
3	16	*DEL/PWR MONITOR*	Analog output	This 0 to 10V signal provides a linearly scaled readback of forward power when the RFG 2K 2V is operated in forward power regulation mode or the load power when operated in the load power regulation mode. 1 V = 1000 W *Note:* Pin 16 must be grounded.
4	17	*RF PWR ON*	Digital input	When a positive voltage of between 4 and 30 V is applied to this pin, the RF output is enabled. A voltage of 1.5 Vdc or less disables the RF output.
5	18	*SETPOINT*	Analog Input	This 0-10V signal defines the desired setpoint for the generator's RF output. It is scaled to represent 0-2000 watts.

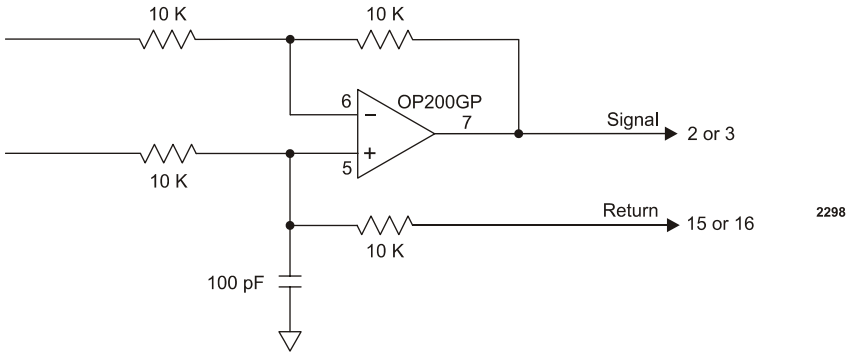
Table 4-2. *User Port Pin Descriptions (Continued)*

Signal Pin	Related Pin	Name	Signal Type	Description
6	19,21	*+24V DC*	Reference Voltage	This dc voltage may be used for controlling the RF power via pin 4 (pin 6 may be tied to pin 4 to enable the RF power). The maximum current capacity for this signal is 50 milliamperes. The voltage on this pin may vary between 22 and 26 volts.
20	7	*RF STATUS*	Digital Output	A low impedance path between these pins indicates that the RF power is present at the output of the generator. The interlock loop must be closed and the RF PWR ON signal must be active to enable RF power.
8	19, 21	*NOT USED*	Input	Pin 8 is not used in this product.
22	9	*OVERTEMP*	Digital Output	A low impedance path between these pins indicates that an over temperature condition has been detected by the generator. Refer to the troubleshooting section of the user manual for detailed information on this fault condition.
10	23	*INTERLOCK*	Input	These pins are part of a series interlock string which must be closed to enable ac power in the generator. A contact resistance of 15 ohms or less across these pins will close the loop. Pin 10 is connected to +30V in the generator via a 5 ampere fuse.
24	11	*AC ON*	Digital Output	A low impedance path between these two pins indicates that ac power is available within the generator. AC power cannot be enabled unless the interlock loop is closed.
12	25	*RESERVED*	N/A	Reserved for future use.

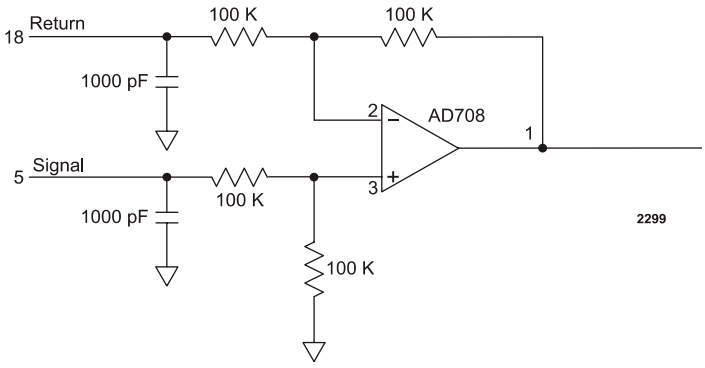
Table 4-2. *User Port Pin Descriptions (Continued)*

Signal Pin	Related Pin	Name	Signal Type	Description
13	19,21	*+15V DC*	Reference Voltage	This dc voltage has a maximum current capacity of 50 milliamperes. This signal can be used for controlling RF power (pin 13 can be jumpered to pin 4). The voltage on this pin may vary between 13-16 volts.
19,21	N/A	*GROUND*	Ground Reference	These two pins are referenced to the signal and chassis grounds in the generator.

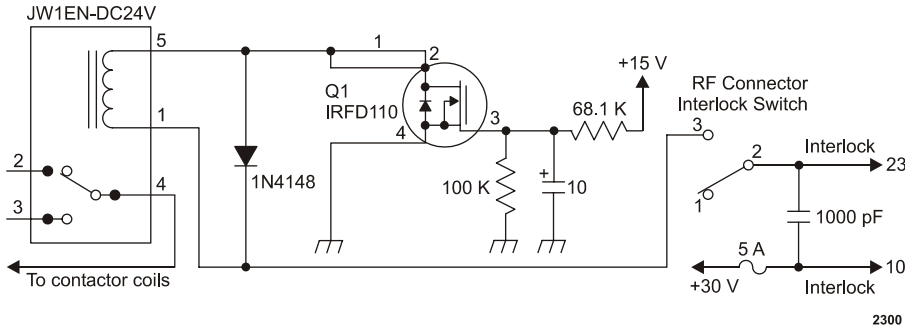
USER PORT INTERFACE SCHEMATICS



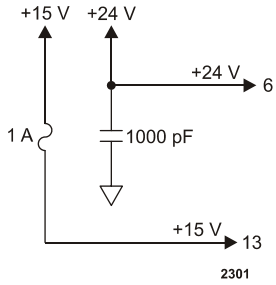
Typical Analog Output (read-backs)



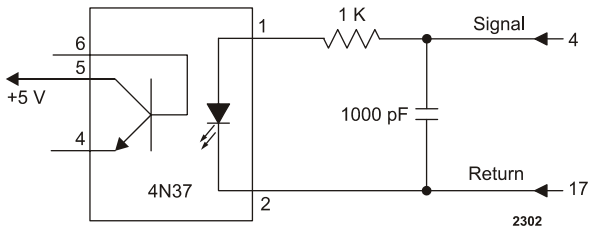
Typical Analog Input (setpoint)



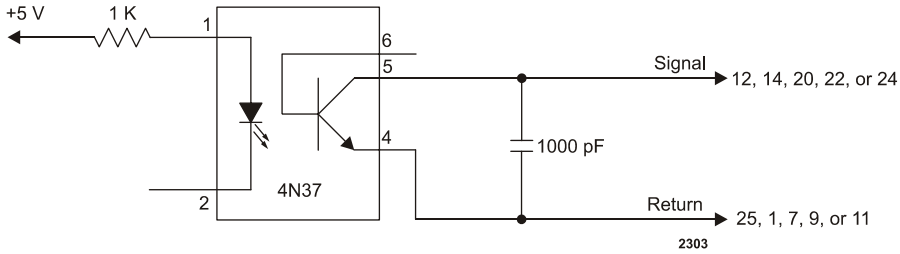
Interlock Circuit



DC Reference Voltages



Typical Digital Input



Interlock Circuit

SIDE VIEW

Figure 4-2 shows the side view of the RFG 2K 2V for water connections and user port connection.

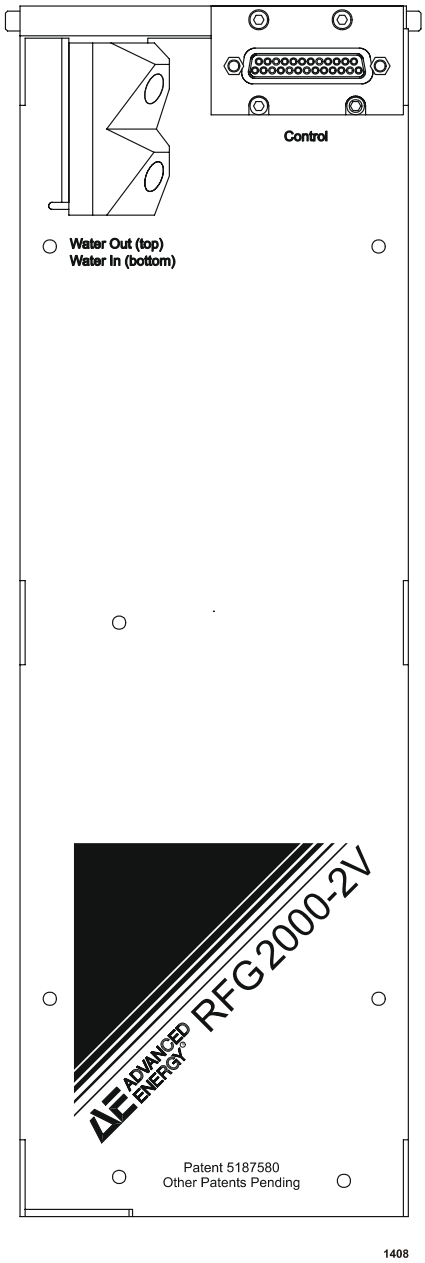


Figure 4-2. *Side view*

SIDE VIEW

Figure 4-3 shows the opposite side view of the RFG 2K 2V for input connections that need to be made for operation.

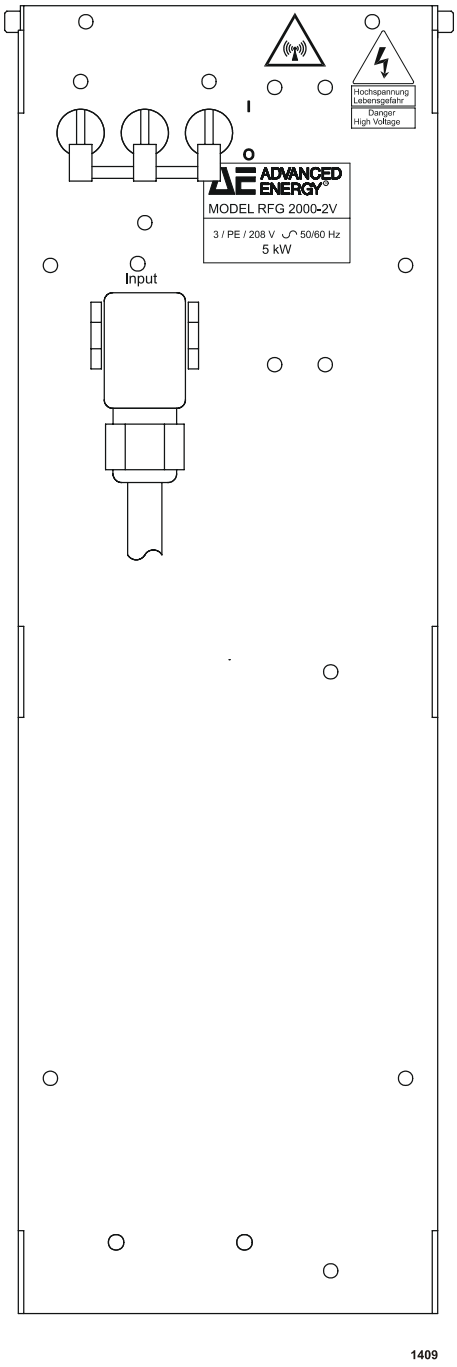


Figure 4-3. *Side view*

Installation, Setup, and Operation

Unpacking

Unpack and inspect the unit carefully. Inspect the unit, looking for obvious physical damage. If no damage is apparent, proceed with the installation. If you do see signs of shipping damage, contact Advanced Energy Industries, Inc., and the carrier immediately (see “AE Global Support” on page 6-2). Save the shipping container for submitting necessary claims to the carrier.

Grounding

⚠ WARNING:
Do not attempt to turn on power until the generator is grounded.

The unit provides two threaded grounding holes (one is a metric A-6; the other is a 5/16" x 18 US). A suitable chassis ground connection made to either of these holes prevents or minimizes radio frequency interference.

INSTALLING

After the generator is properly installed on the system and all power, interface, and cooling water connections have been verified, the following series of tests can be performed to verify proper operation of the unit. If, at any point during this test sequence, the generator does not perform as specified, an attempt should be made to identify and resolve the problem. If the problem cannot be resolved, contact AE Customer Service for assistance.

The RFG 2000-2V is designed for direct mounting to an Advanced Energy Multi Functional Adapter (MFA) or fixed impedance matching network. In this configuration, the 50 Ohm output of the generator is not directly accessible. AE provides a test instrument, known as a Counter Match or a fixed match network that may be attached to the chamber for converting the MFA’s output impedance back to 50 Ohms. The Counter Match allows a user to then use standard RF power measurement devices, such as AE’s GenCal system, to verify the output of the RF delivery system. The following test sequence assumes that such power measurement capability is available.

Before applying ac power to the unit, verify that the User Port signals are set as follows:

- ***RF PWR ON*** must be disabled (pin 4 must be open or grounded).
- The ***SETPOINT*** input (pin 5) must be set to zero volts.
- The ***INTERLOCK*** pins on the User Port (pins 10 and 23) must be connected together (maximum contact resistance of 15 Ohms).
- Apply 208 Vac power to the generator and activate the circuit breaker on the RFG 2000-2V. Verify that the green ***AC ON*** indicator is lit on the generator and that the ***AC ON*** status signal is active on the User Port (low impedance between pins 24 and 11). All other LED indicators should be extinguished at this time. The LEDs on the generator are viewable through the holes provide in the MFA housing.
- Enable the RF output by applying a 4-30 Vdc signal to pin 4 (***RF PWR ON***). Verify that the ***RF ON*** indicator lights on the generator and that the ***RF STATUS*** signal on the User Port is active (low impedance between pins 20 and 7
- Verify that the analog readback signals from the generator are indicating zero watts of forward/delivered power (pin 3) and zero watts of reflected power (pin 2). The voltages on these pins should not exceed 0.010 volts when the requested setpoint (pin 5) is zero.
- Increase the ***SETPOINT*** signal (pin 5) to 1.0 volts (equivalent to 200 watts of RF power). Verify that the ***DELV PWR MONITOR*** signal (pin 3) indicates the existence of RF power and that no error conditions are reported (check the LED indicators as well as the status signals on the User Port). If the generator is being operated into a near-50 Ohm, resistive load, the ***DELV PWR MONITOR*** signal should track the setpoint signal within 10 millivolts and the ***REFL PWR MONITOR*** signal (pin 2) should remain essentially at zero.
- Continue to increase the ***SETPOINT*** signal while verifying that no error conditions are reported and that the ***DELV PWR MONITOR*** signal tracks the setpoint value. The maximum allowable setpoint voltage is 10 volts (representing a full scale RF output of 2000 watts).
- Temporarily inhibit the RF output by clearing the ***RF PWR ON*** signal (pin 4). Verify that the ***RF ON*** indicator extinguishes, the ***RF STATUS*** signal (pins 20 and 7) goes inactive, and the RF output power goes to zero (as measured at the readback signal, pin 3). Re-enable the RF output by activating the ***RF PWR ON*** signal (pin 4). The generator should return to the conditions defined in step 6 above.
- Temporarily open the interlock loop by removing the contact closure between pins 10 and 23 on the User Port. You should be able to hear the ac contactor (relay) inside the generator open. Verify that the ***RF ON*** indicator extinguishes, and that there is no RF power being produced by the generator (***DELV PWR MONITOR*** signal should go to zero).

- Close the interlock loop again by reconnecting pins 10 and 23 on the User Port. Verify that the ***RF ON*** indicator lights and that RF power is once again present (reference step 6).
- Return the ***DELV PWR MONITOR*** signal to zero volts, disable the RF output by clearing the ***RF PWR ON*** signal (pin 4), and then turn off the generator's circuit breaker.

Connecting Cooling Water

WARNING:
If you connect the cooling water on multiple units in series, be sure that input water temperature to all units is less than the maximum input water temperature.

WARNING:
Do not use de-ionized water for cooling purposes. De-ionized water causes both corrosion and erosion of cooling manifolds.

DANGER:
Before making any input line power connection, turn off circuit breakers supplying input power to the generator.

INPUT CONNECTORS

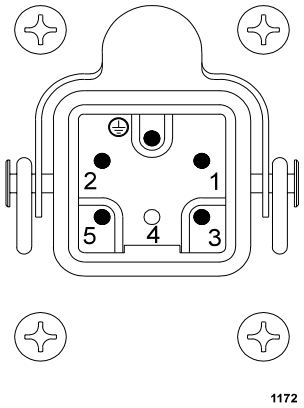


Figure 5-1. *Input connector for Option 005*

Table 5-1. *Pin Descriptions for Option 005 connector*

Pin Number	Description
1	Phase
2	Phase
3	Phase
GND	Ground

Figure 5-2. *Input connector for Option 007*

Connecting I/O and Auxiliary Connectors

WARNING:
RISK OF DEATH OR BODILY INJURY
Disconnect all sources of input power before working on this unit or anything connected to it.

WARNING:
Do not connect any power to this unit without first connecting cooling water and ensuring there are no leaks.

Connect and secure all interface connectors as well as any auxiliary connectors.

Note: Either cable connectors or interlock covers must be installed to allow the generator to operate.

Troubleshooting and Global Support

BEFORE CALLING AE GLOBAL SUPPORT

The RFG 2000-2V is designed for direct mounting to the plasma chamber using a MultiFunction Adapter (fixed impedance matching network). This integrated, RF delivery system is intended for operation on the system and does not easily accommodate component level testing off the system. If a problem arises with the RF delivery system, refer to the Operating Overview section in this manual for a sequence of tests that can be performed while the components are installed on the chamber. If these tests do not help in isolating the cause of the problem, refer to the system tests provided by the equipment manufacturer or contact Advanced Energy for assistance.

WARNING:
RISK OF DEATH OR BODILY INJURY. Disconnect all sources of input power before working on this unit or anything connected to it.

Checks With the Power Off

1. Ensure the power to the unit is off.
2. Check for visible damage to the unit, cables, and connectors.
3. Ensure all unit connectors are installed correctly and are fastened tightly.
4. Check to determine whether any system-related circuit breakers have been tripped.
5. Ensure there is input power to the unit, and ensure the input power meets specifications.
6. Ensure ground connections are adequate and secure.

Checks With the Power On

1. Check the unit's input and remote power connections to ensure the proper power is being supplied to the unit.
2. Check the LEDs on all units to determine that the proper ones are lit.

AE WORLD WIDE WEB SITE

For additional product information and troubleshooting procedures, consult Advanced Energy's World Wide Web site:

- http://www.advanced-energy.com

AE GLOBAL SUPPORT

Please contact one of the following offices if you have questions.

Note: When calling AE Global Support, make sure to have the unit serial number and part number. These numbers are available on unit labels.

Table 6-1. *Global Support Locations*

Office	Telephone
AE, World Headquarters 1625 Sharp Point Drive Fort Collins, CO 80525 USA *Note:* For returns and repairs, please call Global Support to get the correct shipping address.	Phone: 800.446.9167 or 970.221.0108 or 970.221.0156 Fax: 970.407.5981 Email: technical.support@aei.com
AE, California 491 Montague Expressway Milpitas, CA 95035 USA	Phone: 408.263.8784 Fax: 408.263.8992
AE, Austin 8900 Cameron Road Suite 100 Austin, TX 78754	Phone: 512.231.4200 Fax: 512.719.9042
AE, GmbH Raiffeisenstrasse 32 70794 Filderstadt (Bonlanden) Germany	Phone: 49.711.77927.0 Fax: 49.711.7778700
AE, Japan KK TOWA Edogawabashi Bldg. 347 Yamabuki-cho Shinjuku-ku, Tokyo Japan	Phone: 81.3.32351511 Fax: 81.3.32353580

Table 6-1. *Global Support Locations (Continued)*

Office	Telephone
AE, Korea Ltd. Gongduk Building, 4th floor 272-6 Seohyun-Dong, Bundang-Gu, Sungam Si Kyunggi, 463-050 Korea	Phone: 82.31.705.1200 Fax: 82.31.705.276
AE, United Kingdom Unit 5, Minton Place, Market Court, Victoria Road Bicester, Oxon OX6 7QB UK	Phone: 44.1869.320022 Fax: 44.1869.325004
AE, Taiwan, Ltd. 10F-6, No. 110, Chung Shan Rd. Sec. 3, Chungho City, Taipei Hsien Taiwan 235	Phone: 886-2-82215599 Fax: 886-2-82215050
AE, China Rm. 910 Anhui Building, No. 6007 Shennan Road, Shenzhen, China 518040	Phone: 86-755-3867986 Fax: 86-755-3867984

RETURNING UNITS FOR REPAIR

Before returning any product for repair and/or adjustment, ***first follow all troubleshooting procedures***. If, after following these procedures, you still have a problem, or if the procedure instructs you to, contact AE Global Support and discuss the problem with a representative. Be prepared to give the model number and serial number of the unit, as well as the reason for the proposed return. This consultation call allows Global Support to determine whether the problem can be corrected in the field or if the unit needs to be returned. Such technical consultation is always free of charge.

If you return a unit without first getting authorization from Global Support and that unit is found to be functional, you will be charged a re-test and calibration fee plus shipping charges.

To ensure years of dependable service, Advanced Energy® products are thoroughly tested and designed to be among the most reliable and highest quality systems available worldwide.

WARRANTY

Advanced Energy® (AE) products are warranted to be free from failures due to defects in material and workmanship for 12 months after they are shipped from the factory (please see warranty statement below, for details).

In order to claim shipping or handling damage, you must inspect the delivered goods and report such damage to AE within 30 days of your receipt of the goods. Please note that failing to report any damage within this period is the same as acknowledging that the goods were received undamaged.

For a warranty claim to be valid, it must:

- Be made within the applicable warranty period
- Include the product serial number and a full description of the circumstances giving rise to the claim
- Have been assigned a return material authorization number (see below) by AE Global Support

All warranty work will be performed at an authorized AE service center (see list of contacts at the beginning of this chapter). You are responsible for obtaining authorization (see details below) to return any defective units, prepaying the freight costs, and ensuring that the units are returned to an authorized AE service center. AE will return the repaired unit (freight prepaid) to you by second-day air shipment (or ground carrier for local returns); repair parts and labor will be provided free of charge. Whoever ships the unit (either you or AE) is responsible for properly packaging and adequately insuring the unit.

Authorized Returns

Before returning any product for repair and/or adjustment, call AE Global Support and discuss the problem with them. Be prepared to give them the model number and serial number of the unit as well as the reason for the proposed return. This consultation call will allow Global Support to determine if the unit must actually be returned for the problem to be corrected. Such technical consultation is always available at no charge.

Units that are returned without authorization from AE Global Support and that are found to be functional will not be covered under the warranty (see warranty statement, below). That is, you will have to pay a retest and calibration fee, and all shipping charges.

Warranty Statement

The seller makes no express or implied warranty that the goods are merchantable or fit for any particular purpose except as specifically stated in printed AE specifications. The sole responsibility of the Seller shall be that it will manufacture the goods in accordance with its published specifications and that

the goods will be free from defects in material and workmanship. The seller's liability for breach of an expressed warranty shall exist only if the goods are installed, started in operation, and tested in conformity with the seller's published instructions. The seller expressly excludes any warranty whatsoever concerning goods that have been subject to misuse, negligence, or accident, or that have been altered or repaired by anyone other than the seller or the seller's duly authorized agent. This warranty is expressly made in lieu of any and all other warranties, express or implied, unless otherwise agreed to in writing. The warranty period is 12 months after the date the goods are shipped from AE. In all cases, the seller has sole responsibility for determining the cause and nature of the failure, and the seller's determination with regard thereto shall be final.

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