Ovation 2560 Generator (Sweep Frequency)

June 2006 57020003-C

User Manual

User Manual

Ovation 2560 Generator
(Sweep Frequency)
57020003-C

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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Advanced Energy's technical writing staff has carefully developed this manual using research-based document design principles. However, improvement is ongoing, and the writing staff welcomes and appreciates customer feedback. Please send any comments on the content, organization, or format of this user manual to:

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Chapter 1

Safety and Product Compliance Guidelines

IMPORTANT SAFETY INFORMATION

To ensure safe installation and operation of the Advanced Energy® Ovation 2560 generator, read and understand this manual before attempting to install and operate this unit. At a minimum, read and follow the safety instructions and practices documented under "Safety Guidelines" on page 1-2.

INTERPRETING THE MANUAL

The following sections explain the document type conventions and the danger, warning, and caution boxes that provide information about the specific levels of hazard seriousness.

Type Conventions

Please note the following type conventions:

- Pin and signal names appear in capitalized italics (*POWER_ON*).
- New terms appear in italicized text.
- Unit labels (switches, indicators, and so on) appear in boldface text (**MODIFY**).
- Commands (**162**) and command names (**set point**) appear in boldface, lowercase text.

Danger, Warning, and Caution Boxes

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:

DANGER indicates an imminently hazardous situation that, if not avoided, will result in death or serious injury. DANGER is limited to the most extreme situations.

WARNING:

WARNING indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury, and/or property damage.

CAUTION:

CAUTION indicates a potentially hazardous situation that, if not avoided, could result in minor or moderate injury, and/or damage to property. CAUTION is also used for property-damage-only accidents.

SAFETY GUIDELINES

Review the following information before attempting to install and operate the product.

Rules for Safe Installation and Operation

Please note the following rules:

- Do not attempt to install or operate this equipment without proper training.
- Ensure that this unit is properly grounded (see also "Grounding" on page 5-8).
- Ensure that all cables are properly connected.
- Verify that input line voltage and current capacity are within specifications before turning on the power supplies (see "Electrical Specifications" on page 3-5).
- Use proper electrostatic discharge (ESD) precautions.
- Always be careful around this equipment.

Interpreting Product Labels

The following labels may appear on your unit:

1020

CE label

1069

Earth ground

1029

Protective earth ground

1332

Hazardous voltage

1028

High voltage

3054

Electrocution hazard

1101

No user-serviceable parts

Heavy object – can cause muscle strain or back injury

Heavy object – do not lift manually

1030

Nonionizing radiation

1154

NRTL: CSA is a Nationally Recognized Testing Laboratory

1027

Refer to manual for more information

2105

SEMI F47 compliant

1024

Short circuit protected

2981

SEMI S2 compliant

PRODUCT COMPLIANCE

The following sections include information about unit compliance and certification, including the conditions of use required to be in compliance with the standards and directives.

Product Certification

Certain options of this product are certified by:

- NRTL – Canadian Standards Association (CSA) International
- CE Marking – Self-declaration by AE Corporate Compliance
- EMC measurements – Verified by the AE Corporate Compliance Lab and/or an accredited third party lab

For more information, refer to the Certificate or Letter of Conformity (US) or Declaration of Conformity (EU) accompanying the product.

Safety and Compliance Directives and Standards

Certain options of this unit have been tested for and comply with the following electromagnetic compatibility (EMC) and safety directives and standards and industry guidelines.

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

Note: This equipment must be installed and used in accordance with the Conditions of Use described in this manual. If this equipment is expanded, modified, or installed into a larger system, the user is responsible to guarantee the compliance of the overall system. If this equipment is used with external components, the user must ensure that the Safety and EMC requirements are not violated.

ELECTROMAGNETIC COMPATIBILITY (EMC) DIRECTIVES AND STANDARDS

- **89/336/EEC**

  EC Council directive on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive)

- **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 immunity standard— industrial)

SAFETY DIRECTIVES AND STANDARDS

- **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)

- **ANSI/ISA 82.02.01**

  Safety standard for electrical and electronic test, measuring, controlling and related equipment—general requirements (harmonized standard to IEC publication 61010-1)

- **CSA C22.2 No. 1010.1**

  Safety requirements for electrical equipment for measurement, control, and laboratory use

- **EN 61010-1**

  Safety requirements for electrical equipment for measurement, control, and laboratory use

INDUSTRY GUIDELINES

- **SEMI F47-0200**

  Specification for Semiconductor Processing Equipment Voltage Sag Immunity

  Note: Maintains power set point through voltage sag event.

- **SEMI S2-0703**

  Environmental Health and Safety Guideline for Semiconductor Manufacturing Equipment

INSTALLATION REQUIREMENTS

In order for proper installation to be completed on the Ovation 2560 generator, please take note of the following warning boxes. Meet the criteria in these boxes to ensure proper installation of the Ovation 2560 generator.

WARNING:
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.

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

Conditions of Use

To comply with the stated directives and standards, you must meet the following conditions of use:

- Before making any other connection to this device, connect the secondary Protective Earth (ground) terminal to a local earth (ground) terminal with a copper wire that is sized according to the applicable requirements.
- For delta-connected mains, the primary and secondary Protective Earth (ground) wire must be connected.
- Install and operate this device in an overvoltage category II installation only.
- Install and operate this device only in a pollution degree 2 or better environment, which means an indoor location such as a computer room, office, or factory floor where only nonconductive pollution occurs during operation. Occasionally, condensation causes temporary conductivity when the device is not operating.
- Use only a shielded cable on the input power connector.
- Use only a shielded power cable on the RF output power connector.
- Use only shielded cables on the **AE Bus** (RS-232) and **User** port connectors.

- Install and operate this device with a 32 A (maximum) circuit breaker switch on the AC input to provide the required over-current protection. 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, near the device, and able to lockout/tagout all sources of input power.

CAUTION:
Be sure to purge all water from the generator before shipping. Failure to do so can result in damage to the generator during shipping.

INTERLOCKS AND LIMITING CONDITIONS

WARNING:
Advanced Energy Industries, Inc. products only include interlocks when required by product specification. Interlocks in Advanced Energy products are *not* intended to meet or satisfy safety requirements. Where interlocks exist, you must still meet and satisfy safety requirements. The presence of interlocks does *not* imply operator protection.

Table 1-1 lists the hardware interlocks and limiting conditions associated with the Ovation 2560 generator.

Table 1-1. *Hardware interlocks and limiting conditions*

Mechanism	Detection Method	Equipment Condition When Interlock or Limit is Unsatisfied
Interlock relay disables DC power to RF section of generator. *Note:* The auxiliary power supply is not disabled, allowing communications and indication of an open interlock.	An external or internal Interlock Switch is open.	The User port interface reports INTERLOCK_OPEN status. When the interlock is open, RF output is disabled; no RF output. An attempt to enable RF with an interlock open results in a latched fault. A subsequent RF OFF command is required to clear this fault.

Figure 1-1 illustrates the interlock and limit circuit.

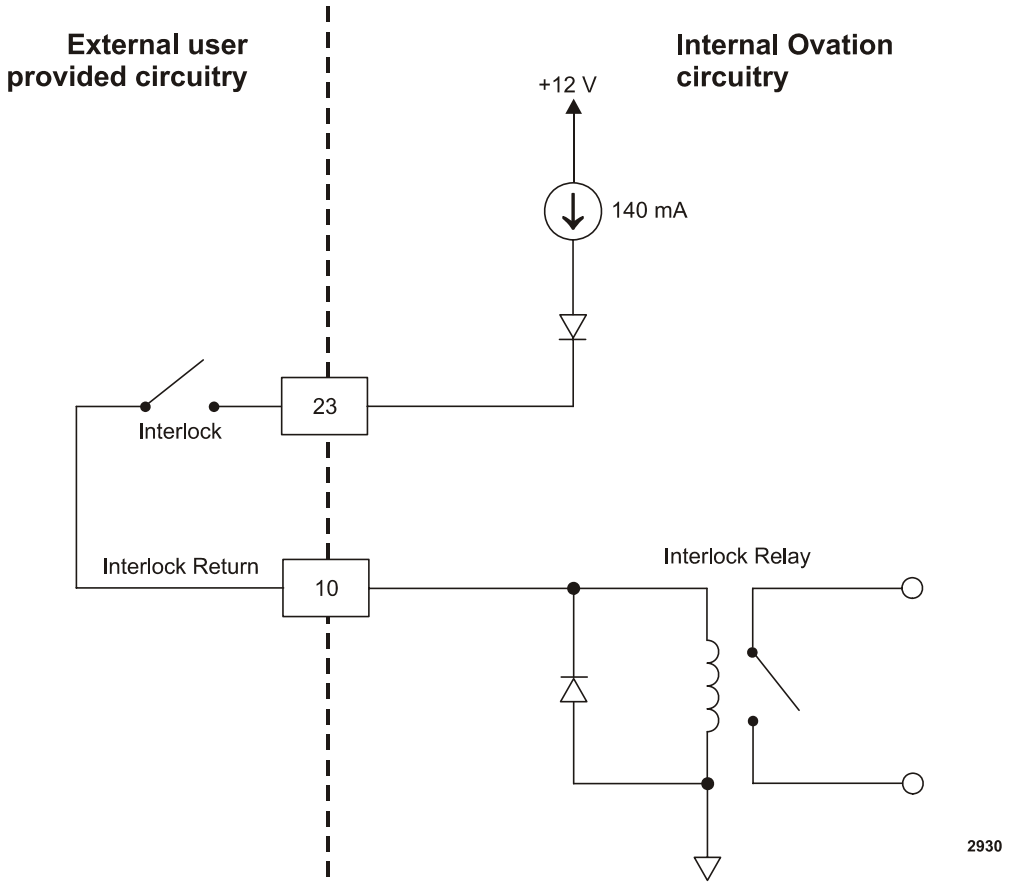


Figure 1-1. *Interlock circuit*

Chapter 2

Product Overview

PRODUCT DESCRIPTION

The following information describes the various features available in the Ovation 2560 generator.

General Description

The Advanced Energy® Ovation 2560 generator is a 60 MHz ±5% (57 to 63 MHz) RF generator capable of providing 2500 W into a 50 Ω nonreactive load. The Advanced Energy® Ovation 2560 generator is a 60 MHz ±5% (57 to 63 MHz) RF generator capable of providing 2500 W into loads up to 2:1 VSWR. The generator provides high accuracy load power regulation and incorporates internal protection limits permitting safe and reliable operation into all load conditions. The generator is designed for use with 208 VAC, 3 ϕ input power. The generator uses air and water cooling.

Interlocks

A series-wired, loop-through interlock string is provided through the **User** port interface connector. An internal power source is connected through the interlock string. Any internal or external interlock switch that opens disables RF output. An internal interlock switch is provided for the RF output connector, and the switch opens if the RF output connector shroud is disconnected. This interlock prevents the application of RF power in the event of abnormal systems conditions.

Note: For more information about the unit interlock, see “Interlocks And Limiting Conditions” on page 1-8.

Frequency Tuning Generator

The Ovation series of sweep frequency generators incorporates Direct Digital Synthesis (DDS) technology for control of its operating frequency when the generator load is mismatched. This field proven, robust technology has been incorporated in AE products since 1996. The frequency can be programmed to dither over a

predetermined range to enable plasma ignition and minimize the generator load mismatch during plasma processing. The DDS operating parameters can be set through any digital control port and are stored indefinitely in non-volatile RAM.

Protection Circuits

The generator contains circuitry to protect itself in the event of the following abnormal conditions:

- Any unmatched output load condition. Output power foldback (limiting) occurs under the control of the generator protection circuits.
- Excessive internal temperature (typically caused by the lack of cooling water or excessive ambient operating temperature).

Product Interfaces

You can control and monitor your Ovation 2560 generator using the following interfaces (depending on the unit configuration):

- An analog/digital (**User**) port
- A serial RS-232 communications (**Host**) port.

The serial communications port provides access to all operating parameters and control functions in the Ovation 2560 generator. The **User** port provides limited access to operating parameters and control functions.

THEORY OF OPERATION

The following information describes the basic theory of operation for the Ovation 2560 generator.

Operation Overview

The fundamental purpose of the generator is to take the nominal 208 VAC, 3 ϕ, 50 to 60 Hz power from the line cord and convert it to RF energy at 60 MHz ±5% (57 to 63 MHz). The generator consists of three sections: the power supply section, the RF section, and the control section (see Figure 2-1). Energy flows from the power supply to the RF section and then on to the RF output. The whole process is monitored and controlled by the control section.

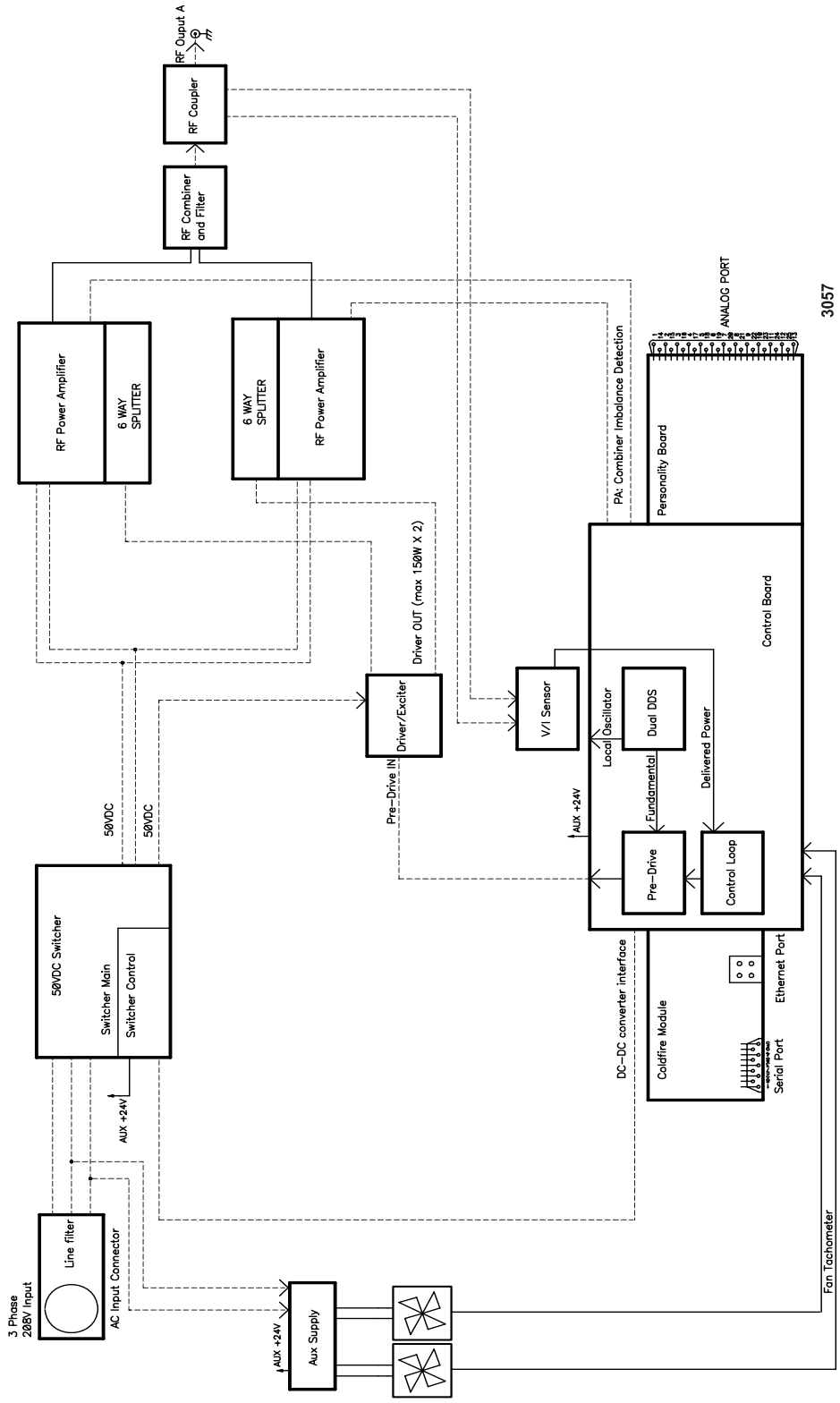


Figure 2-1. *Ovation block diagram*

Power Supply Section

The power supply section consists of the following main parts:

- One high-power switch mode power supply (SMPS).

  The SMPS is capable of 240 A at 50 VDC. The DC output of the SMPS feeds the RF amplifiers.

- A housekeeping supply.

  The housekeeping supply powers all of the low-level control circuitry as well as the cooling fans, interlock, and water solenoid valve (if applicable).

RF Section

The RF section consists of a power control circuit, a driver amplifier, driver output splitter, amplifiers, combiner, and a power measurement system. To power this section, a DDS oscillator in the control section provides a stable frequency source that is then transmitted to the driver assembly. The power control circuit feeds the driver amplifier where the RF signal is boosted. The output of the driver amplifier is split. The split outputs feed the amplifier inputs. Then, the amplifiers are combined and passed on to the power measurement system. The power measurement system takes a sample of the output power and feeds it back to the control section.

Control Section

The control section takes the sample of the RF output, compares it to the power setpoint, and makes adjustments until the output and setpoint are equal. The control section also performs other monitoring and control operation within the generator. To manage frequency tuning, a proprietary algorithm is incorporated to minimize generator load mismatches (see “Frequency Tuning Generator” on page 2-1 for more information).

Specifications

PHYSICAL SPECIFICATIONS

Table 3-1 lists the physical characteristics of the Ovation 2560 generator.

Table 3-1. *Physical specifications*

Specification	Description
Size	195.07 mm (H) x 439.55 mm (W) x 612.78 mm (L) 7.68" (H) x 17.31" (W) x 24.13" (L) *Note:* These measurements do not include connectors, covers, cable connections, or rack mounting extensions.
Weight	38.6 kg (85 lbs) maximum
Air Cooling	
Inlet	Front panel No objects within 2.5 cm (1").
Outlet	Located on the upper and lower halves of the rear panel—no objects within 50.8 mm (2") of air outlets.
Connector/Cable Specifications	
RF Output Connector	Type QRM female (TRU-1209-GNX). A shroud with a UL-approved normally open and non-defeatable interlock switch protects the output connector. The mating connector is a TRU QRM (M).
AC Input Power	Connector on rear panel, which consists of the following vendor (Harting) parts: • Housing (PN 09-14-001-0301) • Contact (PN 09-14-003-2602) This connector is rated for 40 A.

Table 3-1. *Physical specifications (Continued)*

Specification	Description
Chassis (EMI) Ground	M6 stud (located on the rear panel)
User Port Connector	25-pin, female, subminiature-D
Host Port (RS232)	9-pin, female, subminiature-D
Coolant Connectors	3/8-inch female NPT (located on rear panel).

Dimensional Drawings

The following figures illustrate the dimensions of the Ovation 2560 generator.

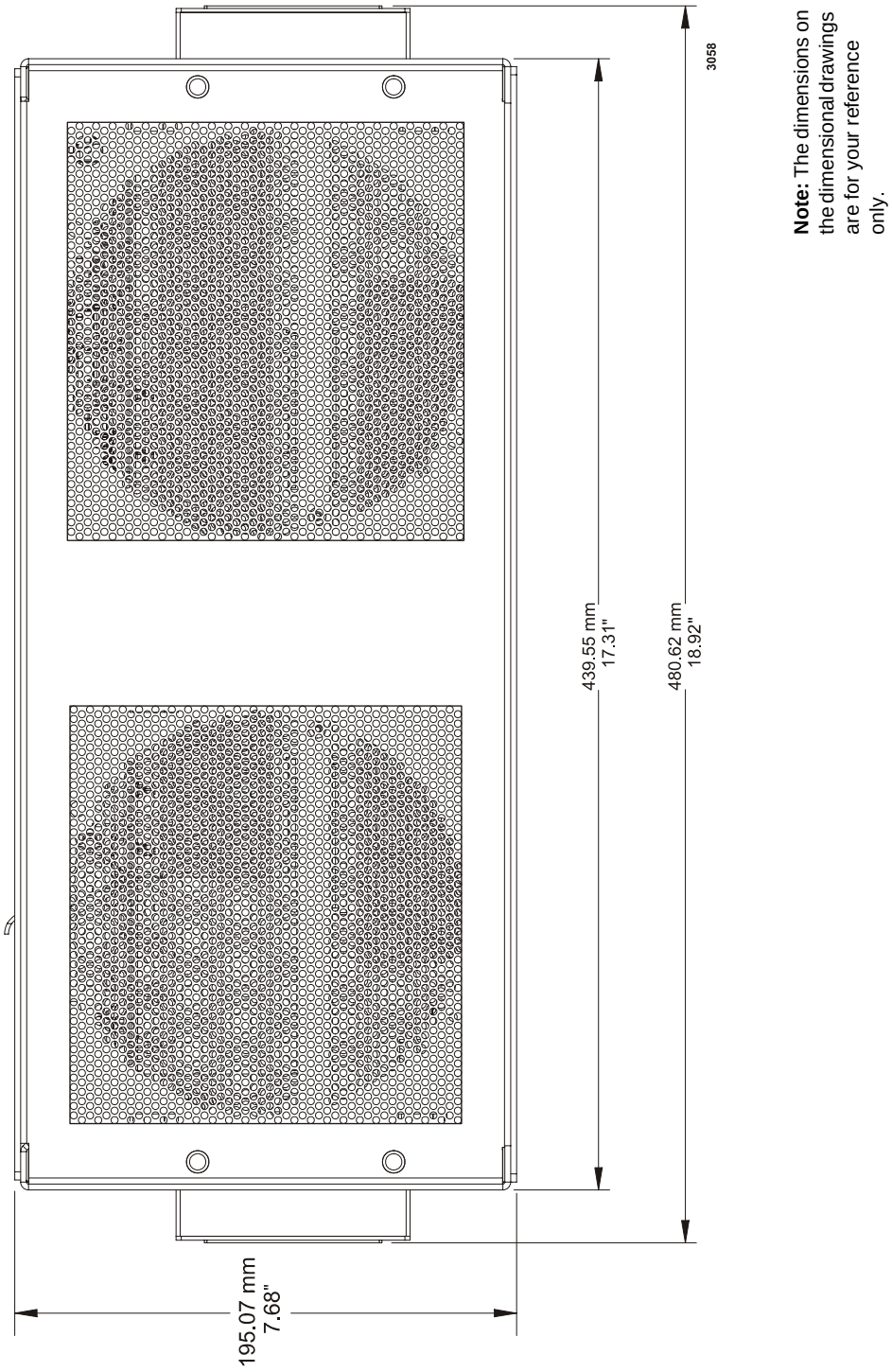
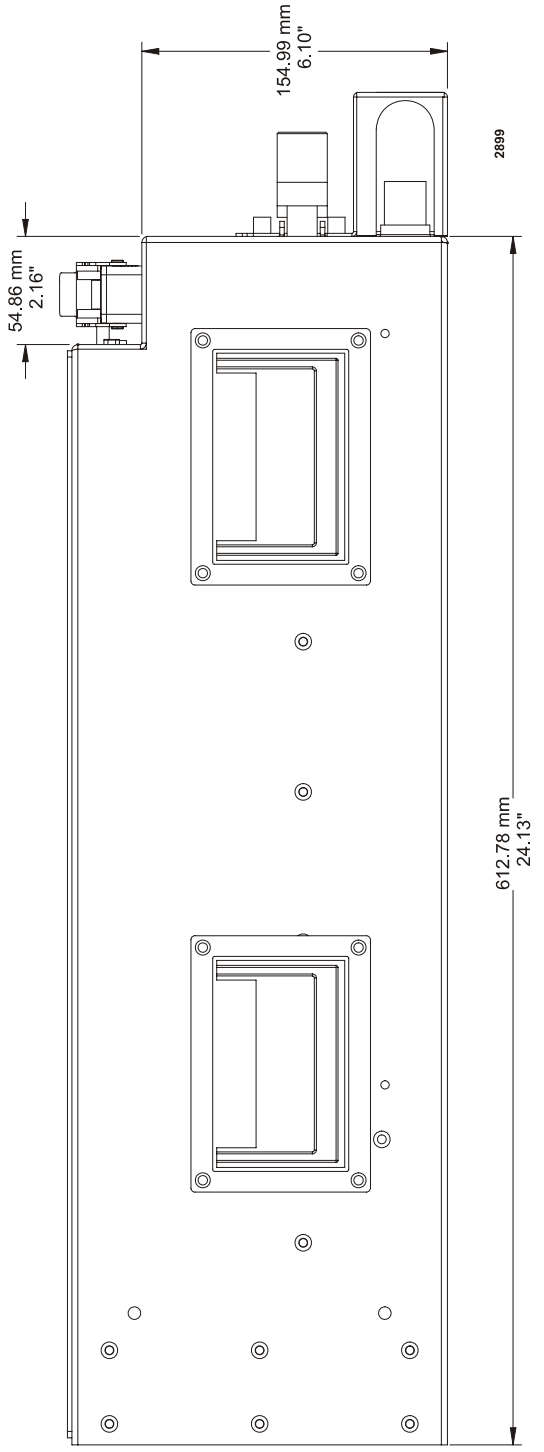


Figure 3-1. *Front view dimensions*



Note: The dimensions on the dimensional drawings are for your reference only.

Figure 3-2. *Side view dimensions*

ELECTRICAL SPECIFICATIONS

Table 3-2 lists the electrical specifications of the Ovation 2560 generator.

Table 3-2. *Electrical specifications*

Input Power Specifications	
Line Voltage	187 VAC to 229 VAC (nominal 208V +/-10%), 3 ϕ. Configurations supported: Delta, Wye, Corner grounded Delta. Secondary Protective Earth Ground to chassis stud required for Corner grounded Delta. Consult factory for other configurations.
Line Frequency	47 to 63 Hz variable (auto detects 50 Hz or 60 Hz)
Line Current	32 A per ϕ maximum at 60 Hz (at full-rated RF output power)
Over-current Protection	*Note:* Because the unit is NOT internally fuse-protected, you must supply an over-current protection device rated for 32 A.
Ground Leakage Current	Balanced three-phase systems: < 3.5 mA steady state operation; maximum of 5 mA during startup (e.g. normal wye or delta configuration) Unbalanced three-phase systems (e.g. corner-grounded delta): < 8 mA steady-state operation without secondary protective earth ground
Power Factor	Minimum 0.85 with full-rated output into 50 Ω, non-reactive load
RF Output Specifications	
Frequency	60 MHz ±5% (57 to 63 MHz)
Full-Rated Output Power	2500 W minimum into a 50 Ω nonreactive load

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

1.1:1 VSWR	2500 W minimum Delivered Power
1.5:1 VSWR	2500 W minimum Delivered Power
2.0:1 VSWR	2500 W minimum Delivered Power
3.0:1 VSWR	750 W minimum Delivered Power
Infinite VSWR	250 W minimum Forward Power
Output Power Range	25 W to 2500 W
Linearity	Into 50 Ω (as measured at an AE facility prior to shipment from the factory): • ±5 W (maximum 25 W to 99 W) • ±3 W (maximum 100 W to 300 W) • ±1% (maximum 301 W to 2500 W) Additional tolerance outside of 50 Ω: • 1.5:1 ≤ 0.5% or 1.5 W • 2.0:1 ≤ 1% or 3 W • 3.0:1 ≤ 2% or 6 W
Power Repeatability (same generator)	± 0.5% of setpoint or ± 3 W (whichever is greater), into a 50Ω load.
RF Enable Response Time	RF Rise Time = <10 ms (10 to 90%)
Response Time (up)	RF Rise Time = <10 ms (10 to 90%)
Reflected Power	Automatic foldback (load power limiting) occurs if the generator reflected power exceeds 500 W.
Harmonics	At full-rated output, all harmonics are < -40 dBc relative to the RF output signal when operated into a 50 Ω, nonreactive load.

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

Spurious Signals	Nonharmonic spurious and noise signals are < 40 dBc relative to the RF output signal when operated into a 50 Ω, non-reactive load.
Protection Features and Specifications	
Analog Interface Protection	Unit is protected from miswiring. Any pin, including ground, can come in contact with any other pin without causing permanent damage.
Over Temperature Protection	Unit will protect against loss of water-cooling or forced air.
Fault Reset	All faults, except interlock with RF_OFF, are latched. They can only be reset when RF enable is cycled from RF_ON to RF_OFF.

COOLING SPECIFICATIONS

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

CAUTION:
Be sure to purge all water from the generator before shipping. Failure to do so can result in damage to the generator during shipping.

Table 3-3 lists the cooling specifications of the Ovation 2560 generator.

Table 3-3. *Cooling specifications*

Air Cooling Requirements	
Inlet Ambient Temperature	+5 °C to + 40 °C (+41°F to + 104°F)
Inlet Flow Rate	600 CFM
Outlet Ambient Temperature	+15 °C (+27 °F) above inlet ambient

Table 3-3. *Cooling specifications (Continued)*

Outlet Flow Rate	600 CFM
Water Cooling Requirements	
Temperature	+5 °C to +35°C (+41°F to +95 °F) inlet temperature
Flow Rate	7.57 lpm (2 gpm) minimum
Inlet Pressure	100 psi (6.89 bar) maximum inlet pressure
Pressure Drop	<20 psi at rated flow
Contaminants	The following specifications are recommended for the water used to cool the Ovation 2560 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 lists the environmental specifications of the Ovation 2560 generator.

Table 3-4. *Climatic Specifications (per EN50178)*

	Temperature	Relative Humidity	Air Pressure
Operating	5 °C to +40 °C +41°F to +104 °F	5% to 85%[1] +1 g/m^3 to +25 g/m^3	78.8 kPa to 106 kPa 788 mbar to 1060 mbar Equivalent altitude: 2000 m to -500 m (6562 ft to -1640 ft)
Storage	-25 °C to +55 °C -13 °F to +131 °F	5% to 95% +1 g/m^3 to +29 g/m^3	78.8 kPa to 106 kPa 788 mbar to 1060 mbar Equivalent altitude: 2000 m to -500 m (6562 ft to -1640 ft)
Transportation	-25 °C to +70 °C -13 °F to +158 °F	95%[2] +60 g/m^3	65.6 kPa to 106 kPa 656 mbar to 1060 mbar Equivalent altitude: 3500 m to -500 m (11480 ft to -1640 ft)

[1] Non-condensing, no formation of ice

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

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

Table 3-5. *Environmental standard specifications*

Description	Specification
Overvoltage	Category II
Pollution degree	2

Communication Interfaces

The following sections provide information on configuring and using the different communication interfaces available on the Ovation 2560sf generator.

USER PORT

This section describes the **User** port connector and provides detailed information about the **User** port signals.

User Port Connector

The User port is a 25-pin, female, subminiature-D connector located on the rear panel. This port provides analog and digital signals for controlling and monitoring the unit.

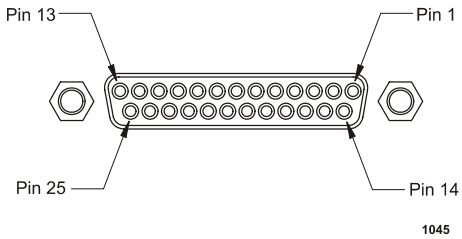


Figure 4-1. *User port connector*

Types of User Port Signals

The following section describes the analog and digital signal types that are used with the **User** port. "User Port Pin Descriptions" on page 4-2 provides detailed information about the **User** port pins.

ANALOG SIGNALS

Analog inputs have an input impedance of 10 kΩ. All analog inputs should be driven with a low impedance source, less than 100 Ω.

DIGITAL SIGNALS

All digital inputs are TTL compatible.

User Port Pin Descriptions

Table 4-1 provides the connector pin descriptions for the **User** port interface.

Table 4-1. *User port pin descriptions*

Signal Pin	Return Pin	Name	Signal Type	Description
1		*Return for Signal Pin 14*		Out of Set Point return
2	15	*REFLECTED POWER MONITOR*	analog output	This signal indicates a linear DC voltage that represents the reflected power output level. 0 to +10 V corresponds to 0 to 1000W (100 W/V).
3	16	*FORWARD POWER MONITOR*	analog output	This signal indicates a linear DC voltage that represents the forward power output level. 0 to +10 V corresponds to 0 to 3500 W (350 W/V).
4	17	*RF POWER ON COMMAND*	digital input	This signal enables/disables RF output of the generator. A voltage level of 4 V to 24 V between this pin and pin 17 turns RF power ON. If this pin is open or shorted to pin 17, RF power is turned OFF.
5	18	*SET POINT*	analog input	This signal defines the desired set point for the RF output of the generator. 0 to +10 V represents a 0 to 2500 W set point (250 W/V).
6		*Return for Signal Pin 19*		RF Interlock OK return
7		*Return for Signal Pin 20*		RF Enabled return
8		*UNASSIGNED*		
9		*Return for Signal Pin 22*		RF OK return
10		*Return for Signal Pin 23*		Interlock return
11		*Return for Signal Pin 24*		Water Solenoid Control return

Table 4-1. *User port pin descriptions*

Signal Pin	Return Pin	Name	Signal Type	Description
12	25	*LOAD POWER MONITOR*	analog output	This signal indicates a linear DC voltage that represents the load power level. 0 to +10 V corresponds to 0 to 2500 W (250 W/V).
13		*UNASSIGNED*		
14	1	*OUT OF SET POINT*	digital output	A low impedance path between these pins indicates that an internal power limit has been encountered. When RF power is enabled, a high impedance path between these pins indicates that the generator is at set point.
15		*Return for Signal Pin 2*		Reflected Power Monitor return
16		*Return for Signal Pin 3*		Power Monitor return
17		*Return for Signal Pin 4*		RF Power On Command return
18		*Return for Signal Pin 5*		Set Point return
19	6	*RF INTERLOCK OK*	digital output	When all generator interlocks are satisfied, a hardware contact closure creates a low impedance path between pins 19 and 6.
20	7	*RF ENABLED*	digital output	A low impedance path between pins 20 and 7 indicates that the RF power is present at the output of the generator. The interlock loop must be closed and the *RF POWER ON COMMAND* (Pin 4) signal must be active to enable RF power.
21		*UNASSIGNED*		

Table 4-1. *User port pin descriptions*

Signal Pin	Return Pin	Name	Signal Type	Description
22	9	*RF OK*	digital output	A low impedance path between pins 22 and 9 indicates that RF is OK to operate. A high impedance path indicates a fault condition exists.
23	10	*INTERLOCK*	digital input	Pins 23 and 10 are part of a series interlock string that must be closed to enable AC power in the generator. A contact resistance of 15 Ω or less across these pins closes the loop. Pin 23 is connected to +12 V through the generator through a current limiting circuit. Pin 23 should not be grounded externally.
24	11	*WATER SOLENOID CONTROL*	digital output	A low impedance path between pins 24 and 11 indicates that the external water solenoid should be opened to allow coolant flow to the generator. A high impedance path indicates that the solenoid should be closed to prevent condensation on the heat-sink inside the generator.
25		*Return for Signal Pin 12*		Load Power Monitor return

AE BUS HOST PORT (RS-232)

The following sections describe the serial AE Bus **Host** port connection, communications, and commands.

Host Port Connector

The Ovation 2560 generator provides a serial communications interface through the AE Bus **Host** port. This interface allows the Ovation 2560 generator to interface with a host computer. The port connector is a 9-pin, female, subminiature-D connector, located on the rear panel.

Note: For a complete list of available functions, see "AE Bus Commands" on page 4-14. To obtain sample AE Bus host software, please call AE's Global Services (for contact information see "AE Global Services" on page 6-10).

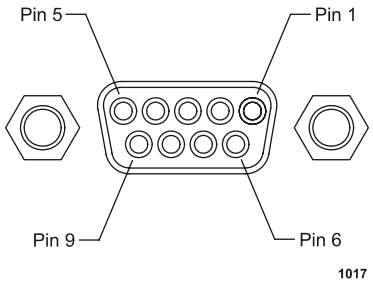


Figure 4-2. *RS-232 port connector*

Host Port Pin Descriptions

Table 4-2 describes the Host port pins.

Table 4-2. *Host port pin descriptions*

SIgnal Pin	Name	Description
1	*RESERVED*	Reserved for future use
2	*TXD*	RS-232 transmit data
3	*RXD*	RS-232 receive data
4	*RESERVED*	Reserved for future use
5	*COM*	Data Common
6 through 9	*RESERVED*	Reserved for future use

AE Bus Transmission Parameters

The communications capability of the serial AE Bus **Host** port is limited to the following parameters:

- RS-232 protocol
- 19,200 baud rate
- Ovation 2560 generator unit address of 1
- Odd parity
- One start bit, eight data bits, one stop bit
- Low-order bytes are transmitted before high-order bytes.

The time-out period for the Ovation 2560 generator is factory set at 0.75 seconds (that is, no more than 0.75 seconds can elapse between bytes, or the unit will reset and begin searching for a new message packet). Use command **40** to change this value (see "AE Bus Commands" on page 4-14).

The host computer must finish one transaction with the Ovation 2560 generator before it initiates another one, either with the same unit or any other unit.

Note: The Ovation 2560 generator sends data through pin 2 (*TXD.D*). This pin must be connected to the receive pin (*RXD.D*) on the host computer's serial connector. The receive pin is normally pin 2 for a standard, 9-pin serial port and normally pin 3 for a standard, 25-pin serial port.

External DIP Switch Settings

USING THE DIP SWITCH

You can use the DIP switch next to the serial port connector to set the AE Bus network address of the Ovation 2560 generator. You can also use the switch to set the serial port's baud rate and communication mode (see "Setting Baud Rates and Communication Mode" on page 4-8 for more information).

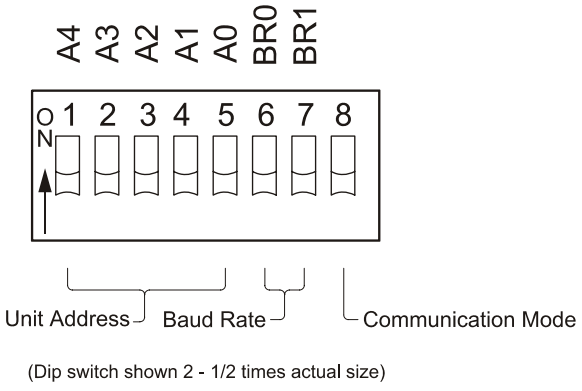


Figure 4-3. *External DIP switch*

Following is the function of the mini-switches (or miniature switches) on the DIP switch:

- The first five mini-switches (**A4** to **A0**) are used to specify the address of the Ovation 2560 generator (Table 4-3 on page 4-7). The host computer must include these switch settings in the message packet it sends to the unit.
- The next two mini-switches (**BR0** and **BR1**) specify the serial port's baud rate (Table 4-4 on page 4-8).
- The last mini-switch sets the communications mode (see Table 4-5 on page 4-9).

SETTING THE UNIT AE BUS ADDRESS

Table 4-3 outlines the switch settings for the 31 possible unit addresses. "On" refers to setting the switch towards the mini-switch number, and "off" refers to setting the switch away from the mini-switch number.

Table 4-3. *Possible address settings*

Address	A4	A3	A2	A1	A0
0	Don't assign this address to a unit; it is the network broadcast address--all units receive a message sent to this address by the host, but will not reply. If address 0 is selected, the unit defaults to address 1.				
1	on	on	on	on	off
2	on	on	on	off	on
3	on	on	on	off	off
4	on	on	off	on	on
5	on	on	off	on	off
6	on	on	off	off	on
7	on	on	off	off	off
8	on	off	on	on	on
9	on	off	on	on	off
10	on	off	on	off	on
11	on	off	on	off	off
12	on	off	off	on	on
13	on	off	off	on	off
14	on	off	off	off	on
15	on	off	off	off	off
16	off	on	on	on	on
17	off	on	on	on	off

Table 4-3. *Possible address settings (Continued)*

Address	A4	A3	A2	A1	A0
18	off	on	on	off	on
19	off	on	on	off	off
20	off	on	off	on	on
21	off	on	off	on	off
22	off	on	off	off	on
23	off	on	off	off	off
24	off	off	on	on	on
25	off	off	on	on	off
26	off	off	on	off	on
27	off	off	on	off	off
28	off	off	off	on	on
29	off	off	off	on	off
30	off	off	off	off	on
31	off	off	off	off	off

SETTING BAUD RATES AND COMMUNICATION MODE

Use the DIP switch to set the serial port's baud rate and communication mode. The following tables show the DIP switch settings for **BR0**, **BR1**, and Switch **8**.

- Switches **BR0** and **BR1** set the baud rates (see Table 4-4).
- Switch **8** sets the communication mode of the power supply (see Table 4-5).

Note: When setting the mini-switch, "on" refers to setting the switch towards the mini-switch number, and "off" refers to setting the switch away from the mini-switch number. See Figure 4-3 on page 4-6 for an illustration of the external DIP switch.

Table 4-4. *Baud rate settings*

Baud Rate	BR0	BR1
9600	on	on
19200	on	off
57600	off	on
115200	off	off

Table 4-5. *Setting switch 8*

Communication Mode	Switch Position
RS-232	on

AE Bus Protocol

The AE Bus protocol uses pure binary data (nothing is coded in ASCII) and is designed to facilitate direct communications between a host computer and the Ovation 2560 generator.

The AE Bus message packet combines a set quantity of bits and bytes in such a way that groups of information can be sent over communications lines at one time. Five types of information (fields) make up communications message packets (see Figure 4-4):

- Header (address and the length of Data field)
- Command Number (the commands are listed in "AE Bus Commands" on page 4-14)
- Optional Length byte
- Data
- Checksum

Figure 4-4 shows the organization of these fields in the AE Bus message packet. The subsequent paragraphs describe each field in detail.

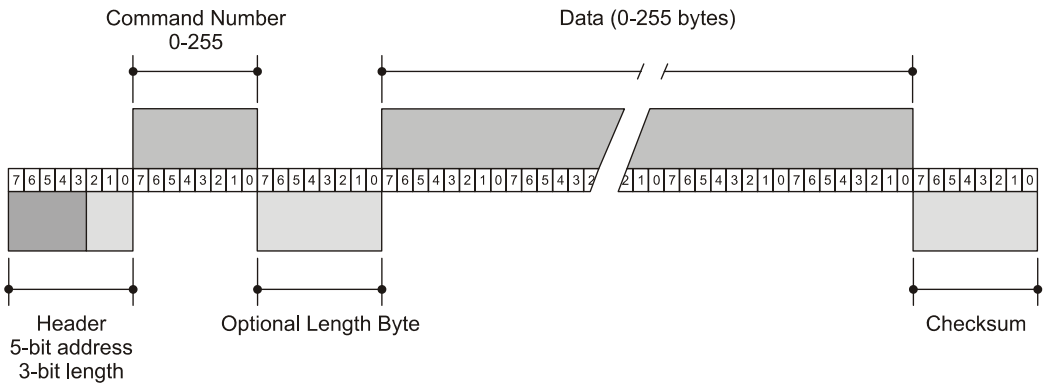


Figure 4-4. *Graphic representation of a message packet*

AE BUS HEADER BYTE

The first byte in each packet contains two pieces of information: five bits contain the packet address, and three bits contain the data byte count. If the message packet originates with the host computer, the address specifies the packet destination (to the Ovation 2560 generator, for example). If the packet is going to the host, the address specifies the packet origin (from the Ovation 2560 generator). The address section of the Header field is five bits long (bits 3-7), which allows a total of 32 distinct addresses. Address 0 (zero) is reserved for the network broadcast address; when this address is used in a host-originated packet, all units execute the packet (but do not respond to the host).

The remaining three bits (bits 0, 1, and 2) are the length bits. These bits tell the receiving unit how long the Data field is so that the unit can determine when it has received the entire message. If the Data field contains more than six bytes, the value of these three bits will be set to 7 (07h), and the Optional length byte field will contain a value indicating the number of data bytes in the Data field.

Note: The value of these bits refers only to the number of actual data bytes in the Data field. Do not include the checksum byte when calculating the value for these bits (see "AE Bus Checksum Byte" on page 4-11).

AE BUS COMMAND NUMBER BYTE

This one-byte field contains an 8-bit value from 0 to 255 (00h to ffh) representing the command number. If the message packet originates with the host computer, this value specifies the purpose of the message packet. If the message originates with the Ovation 2560 generator, the value specifies the command to which it is responding. See "AE Bus Commands" on page 4-14 for a complete list of commands.

AE BUS OPTIONAL LENGTH BYTE

This field supplements the Header field and exists only when the length bits (bits 0, 1, and 2) in the Header field contain a value of 7 (07h). If the number of data bytes in the Data field is six or less, then the three length bits in the Header field are sufficient to represent this amount 0 to 6 (00h to 06h). Since the Data field may contain up to 255 bytes of information, the Optional Length byte is required when the Data field is larger than six bytes.

When the Data field is larger than six bytes, the length bits in the header (bits 0, 1, and 2) will equal 7 (07h), and the Optional Length byte will contain a one-byte value, from 7 to 255 (07h to ffh), representing the number of data bytes in the Data field.

AE BUS DATA BYTES

The Data field may contain from 0 to 255 bytes of binary data. This field contains command-related data or a command status response (CSR). Since some commands do not require data, sometimes the Data field is not present.

If the value specified in the length bits (bits 0, 1, and 2) of the Header field is 0 to 6, the Ovation 2560 generator expects zero to six data bytes. However, if the value in the Header field is 7 (07h), the Ovation 2560 generator looks for the Optional Length byte after the Command field and reads this value to calculate the data byte count.

Unless otherwise specified for individual commands, AE Bus protocol is little endian, which means that all values greater than 1 byte are sent in little endian order. For example, a command with 7 data bytes that included one 8-bit value, one 16-bit value, and one 32-bit value, would be sent as shown in Table 4-6.

Table 4-6. *AE Bus byte structure*

Value to Send	Byte configuration
8-bit value = 15	Byte 1 = 0x0F
16-bit value = 23450	Bytes 2 and 3 = 0x9A 0x5B
32-bit value = 147679	Bytes 4 through 7 = 0xDF 0x40 0x02 0x00

AE BUS CHECKSUM BYTE

This one-byte field is the last byte in the packet. The value of this byte depends upon the number of bytes in each of the preceding fields. The transmitting unit determines this value by accumulating the *exclusive-or* (XOR) of all bytes of the packet up to, but not including, the checksum value. The receiving unit accumulates the XOR of all bytes of the packet, including the checksum. If the result is zero, the unit has received the packet intact.

The unit will act on the message *only* if the address is valid and the checksum is validated as having no parity errors.

Creating an Ideal Communications Transaction

Figure 4-5 illustrates the steps in an ideal communications transaction between a host computer and the Ovation 2560 generator.

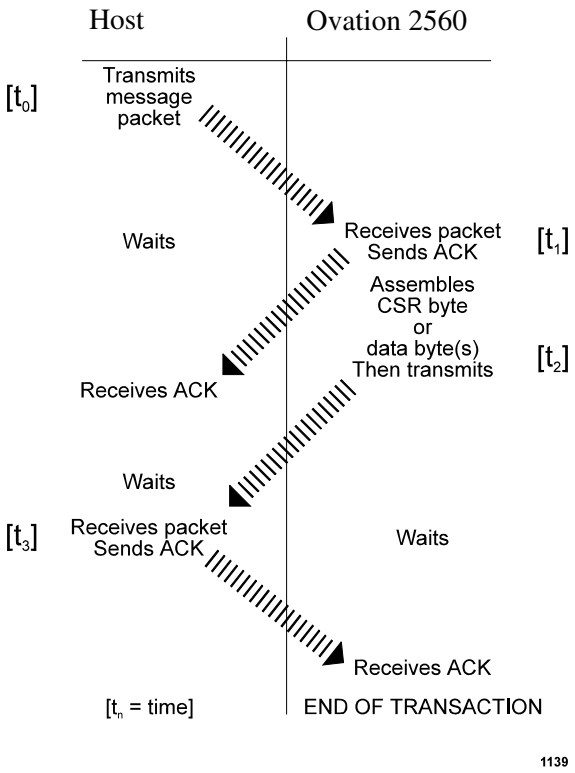


Figure 4-5. *AE Bus communications transaction*

T_0: HOST TRANSMITS MESSAGE PACKET

The host computer sends a message packet to the Ovation 2560 generator. The packet contains one of the following:

- A command that requests data or status information
- A command and data that change a parameter setting
- An executable command

T_1: UNIT VERIFIES HOST TRANSMISSION PACKET

Once the Ovation 2560 generator receives the host computer transmission message packet, the Ovation 2560 generator verifies that the message is intended for it and not for another unit on the network. At this time, the Ovation 2560 generator also analyzes the checksum to verify that the message was received correctly.

- If the address does not match, the Ovation 2560 generator does not respond to the host computer; the Ovation 2560 generator resets and resumes waiting for a message addressed to it. If the address matches but the *exclusive-or* (XOR) sum of the bytes in the packet (including the checksum) is not zero, the Ovation 2560 generator sends a negative acknowledgment (NAK), hexadecimal 15h, to the host computer.
- If the address matches and the message is intact, the Ovation 2560 generator sends an acknowledgment (ACK), hexadecimal 06h, to the host computer.

If the Ovation 2560 generator receives a request for data or status information, it gathers and sends the requested information. Otherwise, it evaluates the incoming command and sends a message packet that contains a one-byte data value (CSR code) to the host (see "AE Bus Commands" on page 4-14). CSR code 0 is sent when the command has been accepted.

If the host computer receives a NAK from the Ovation 2560 generator, the host computer either retransmits the packet or does whatever else it has been programmed to do in this situation. If the host computer receives an ACK, it waits for the requested data or status information, or it waits for the CSR code telling it whether or not the new parameter was accepted. If the host computer receives no response within a reasonable period, it takes whatever action it has been programmed to take.

T_2: UNIT TRANSMITS RESPONSE TO HOST

The Ovation 2560 generator prepares a response packet with the requested information or appropriate CSR code, which it then transmits to the host computer. The host computer then determines, by means of the checksum, if the response packet is complete. If the host computer detects an error in the transmission (the checksum is not validated), it can request the packet be sent again by transmitting a NAK.

T_3: HOST ACKNOWLEDGES UNIT RESPONSE

If the Ovation 2560 generator receives an ACK from the host computer, it returns to the normal waiting state. If the Ovation 2560 generator receives a NAK from the host computer, the Ovation 2560 generator retransmits the response packet. The Ovation 2560 generator continues to retransmit in response to NAK transmissions until the host computer stops the cycle. If the Ovation 2560 generator receives no response, it assumes an ACK and returns to the waiting state.

AE BUS COMMUNICATIONS TRANSACTION EXAMPLE

Figure 4-6 is illustrates the steps in an example communications transaction between a host computer and a Ovation 2560 generator.

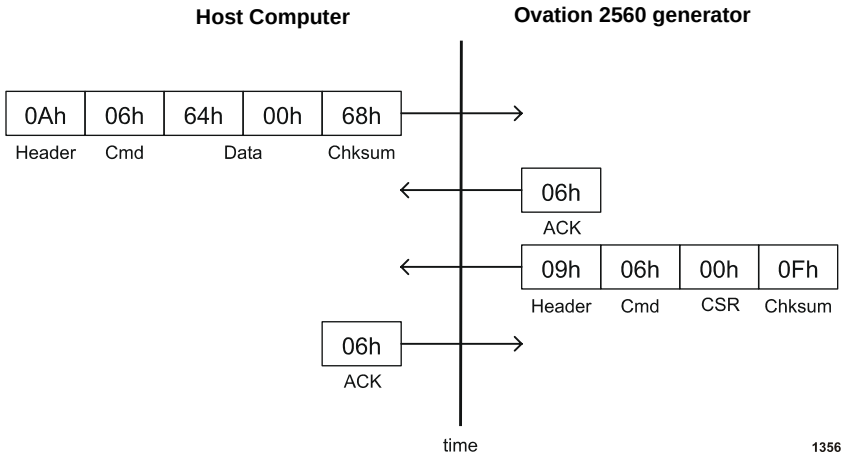


Figure 4-6. *Communications transaction example*

AE Bus Commands

The following sections describe the command status response (CSR) codes returned by the Ovation 2560 generator in response to a command, as well as the AE Bus commands for the Ovation 2560 generator.

AE BUS COMMAND STATUS RESPONSE (CSR) CODES

When the Ovation 2560 generator receives a command, it may respond with a command status response (CSR) code. The CSR is a single-byte number that indicates whether the unit accepted or rejected the command and, in the case of rejection, the reason the unit could not respond to the command. Use Table 4-7 to interpret the CSR codes.

Table 4-7. *AE Bus CSR codes*

Value	Meaning
0	Command accepted
1	Unit is in the wrong control mode
2	Output is on
4	Data is out of range
5	User port off signal is active

Table 4-7. *AE Bus CSR codes (Continued)*

Value	Meaning
7	One or more faults are active in the unit
8	Set point ramp is active
9	Data byte count is incorrect
12	Requested feature is not available on the unit.
17	Minimum off time active
28	Set point exceeds the user limit
30	EEPROM read/write error exists
41	One or more warnings are active in the unit
63	Flash mode is active
99	Command not implemented

COMMAND SET FOR THE RS-232, AE BUS HOST PORT

The Ovation 2560 generator AE Bus serial communication interface has two types of commands:

- Commands **1** through **127** request a change to the Ovation 2560 generator, such as turning output on or off or changing a setting in the unit. The unit responds to these commands by sending a command status response (CSR). This single-byte response indicates whether the unit has accepted or rejected the command and, in the case of rejection, the reason the unit could not respond to the command. For more information on CSR codes, see "AE Bus Command Status Response (CSR) Codes" on page 4-14.
- Command numbers **128** through **255** request information from the unit, such as output on/off status and unit settings. The unit responds to these commands by sending the data requested or a CSR code.

Unless otherwise specified for individual commands, AE Bus protocol is little endian, which means that all values greater than 1 byte are sent in little endian order. For an example of this structure, see "AE Bus Protocol" on page 4-9.

Table 4-8 provides descriptions for the Ovation 2560 generator AE Bus commands.

Table 4-8. *Host port commands for RS-232 with AE Bus*

Command	Description	Number of Host Data Bytes	Number of Response Data Bytes
1 turn output off	Shut the output off immediately. Accepted regardless of control mode. This command explicitly clears all latched faults.	0	1
2 turn output on	Turns the output on if there are no active or latched faults. Accepted only when host control mode is active.	0	1
4 set user power limit	Sets the user power limit. The power limit cannot be changed while the unit is on. Valid values are from 1% of the maximum power to the unit maximum power. Send 2 data bytes (16-bit value) indicating the power limit in watts. *Note:* Each time AC is cycled, the limit returns to the default factory set parameter. Read back this value with command **169**.	2	1
7 restore factory defaults	Restores all non-volatile RAM values to the factory preset values. Send 2 data bytes (16-bit value): • 0 = restore all default values.	2	1
8 set power set point	Specifies a power set point in Watts. Set point cannot be greater than the unit's maximum output power or the user power limit. Accepted only when host control mode is active. Send 2 data bytes (16-bit value) to set the power set point in watts. Read back this value with command **164**.	2	1

Table 4-8. *Host port commands for RS-232 with AE Bus (Continued)*

Command	Description	Number of Host Data Bytes	Number of Response Data Bytes
14 select active control mode	Sets the control mode. This mode cannot be changed while the output is on. Send 1 data byte (8-bit value): • 2 = Host • 4 = User Port (analog) Read back this value with command **155**.	1	1
20 set coarse tuning threshold	Set the tuning criteria level where the tuning algorithm switches from coarse tuning to fine tuning mode. This parameter cannot be changed while the output is on. This parameter is stored in non-volatile memory. Send 4 data bytes (32-bit value) to set the tuning criteria. Read back this value with command **179**.	4	1
31 set set point ramping parameters	Sets the set point ramping mode and ramp parameters. The ramp up and down parameters can be set independently. Send 6 data bytes (three 16-bit values): • Bytes 0 and 1 (16-bit value) = Ramp mode ▸ 0 = disabled ▸ 1 = W/s (watts/second) ▸ 2 = Timed (in ms) • Bytes 2 and 3 (16-bit value) = Ramp up parameter (in watts/second or ms) • Bytes 4 and 5 (16-bit value) = Ramp down parameter (in watts/second or ms) In W/s mode, the minimum ramp rate is 1 watt/sec. In the Timed mode, the minimum ramp time is 8 ms. You can set the set point ramp parameters while the output is on. The ramp parameters are not allowed to change during a set point ramp that is currently in progress. In either operating mode, the set point is updated at 4 ms intervals. Read back this value with command **151**.	6	1

Table 4-8. *Host port commands for RS-232 with AE Bus (Continued)*

Command	Description	Number of Host Data Bytes	Number of Response Data Bytes
38 set tuning timeout	Sets the amount of time in milliseconds (ms) that the generator is allowed to tune before the RF output is turned off and a fault is activated. This parameter cannot be changed while the output is on. This parameter is stored in non-volatile memory. Send 4 data bytes (32-bit value) to set the time in ms. Read back this value with command **138**.	4	1
40 host port timeout	Sets the amount of time that the generator waits between bytes from the host before resetting and waiting for a new packet. Send 2 data bytes (16-bit value) representing hundredths of seconds (send LSB first). The valid range of values is 2 to 500 (0.02 s to 5.0 s). Read back this value with command **140**.	2	1
44 set tuning minimum frequency	Sets tuning minimum frequency in KHz. The generator uses this parameter to automatically tune the generator. You cannot change this parameter when output is on. This parameter is stored in non-volatile memory. Send 4 data bytes (32-bit value). Read back this value with command **144**.	4	1
45 set tuning maximum frequency	Sets tuning maximum frequency in KHz. The generator uses this parameter to automatically tune the generator. You cannot change this parameter when output is on. This parameter is stored in non-volatile memory. Send 4 data bytes (32-bit value). Read back this value with command **145**.	4	1

Table 4-8. *Host port commands for RS-232 with AE Bus (Continued)*

Command	Description	Number of Host Data Bytes	Number of Response Data Bytes
46 set tuning start frequency	Sets tuning start frequency in KHz. The generator uses this parameter to begin to automatically tune the generator. You cannot change this parameter when output is on. This parameter is stored in non-volatile memory. Send 4 data bytes (32-bit value). Read back this value with command **146**.	4	1
48 set fixed or variable frequency mode	Sets the frequency control mode. You cannot change this mode while the output is on. Send 1 data byte (8-bit value): • 0 = Fixed frequency mode • 1 = Variable frequency mode. Read back this value with command **148**.	1	1
49 set minimum frequency tuning step	Sets minimum frequency step size in KHz. the generator uses this parameter to automatically tune the generator. You cannot change this parameter while the output is on. This parameter is stored in non-volatile memory. Send 4 data bytes (32-bit value). Read back this value with command **149**.	4	1
50 set initial fine tuning step	Sets initial fine tuning step in KHz. The generator uses this parameter to automatically tune the generator. You cannot change this parameter while the output is on. This parameter is stored in non-volatile memory. Send 4 data bytes (32-bit value). Read back this value with command **150**.	4	1

Table 4-8. *Host port commands for RS-232 with AE Bus (Continued)*

Command	Description	Number of Host Data Bytes	Number of Response Data Bytes
58 set retuning threshold	Sets the tuning criteria level at which the tuning algorithm determines the generator must be retuned. You cannot change this parameter while the output is on. This parameter is stored in non-volatile memory. Send 4 data bytes (32-bit value). Read back this value with command **158**.	4	1
60 set tune delay	Set the amount of time in milliseconds (ms) that the tuning algorithm waits before beginning to automatically tune the generator. You cannot change this parameter while the output is on. This parameter is stored in non-volatile memory. Send 2 data bytes (16-bit value) to set the amount of time in ms. Read back this value with command **160**.	2	1
61 set DDS fixed frequency	Set the generator output frequency when operating in fixed frequency mode. You can change the DDS frequency while the output is on when operating in the Fixed Frequency mode. Send 4 data bytes (32-bit value) to set the DDS frequency in kHz. Read back this value with command **161**.	4	1
119 explicit fault clear	Immediately shuts the output off. Accepted regardless of control mode. This command explicitly clears all latched faults. It does not clear any faults that are currently active.	0	1
128 report power supply type	Requests the power supply type. Returns a non-terminated ASCII string that represents the power supply type: “OVATION.”	0	7 ASCII characters
129 report power supply size	Requests the power supply size. Returns a non-terminated ASCII string that represents the maximum output power for the power supply (for example, “__2500”).	0	6 ASCII characters

Table 4-8. *Host port commands for RS-232 with AE Bus (Continued)*

Command	Description	Number of Host Data Bytes	Number of Response Data Bytes
130 report software part number	Requests the software part number. Returns a non-terminated ASCII string that represents the AE software part number (for example, "7432006"). *Note:* This can be used in conjunction with the revision number returned by command **198** to fully identify the software in the unit.	0	7 ASCII characters
138 report tuning timeout value	Requests the tuning timeout value set with command **38**. Returns 4 data bytes (32-bit value) reporting the time in ms.	0	4
140 report host timeout	Requests the current host port timeout value for the serial port set with command **40**. Returns 2 data bytes (16-bit value) reporting the host port timeout value (LSB first).	0	2
144 report minimum tuning frequency	Requests the minimum tuning frequency set with command **44**. Returns 4 data bytes (32-bit value) reporting the minimum frequency in kHz.	0	4
145 report maximum tuning frequency	Requests the maximum tuning frequency set with command **45**. Returns 4 data bytes (32-bit value) reporting the maximum frequency in kHz.	0	4
146 report tuning start frequency	Requests the tuning start frequency set with command **46**. Returns 4 data bytes (32-bit value) reporting the start frequency in kHz.	0	4

Table 4-8. *Host port commands for RS-232 with AE Bus (Continued)*

Command	Description	Number of Host Data Bytes	Number of Response Data Bytes
147 report generator actual frequency	Requests the actual output frequency when the output is turned on. Returns 4 data bytes (32-bit value) reporting the actual output frequency in kHz. If the output is off when you send this command, the command requests the following: • In Fixed Frequency mode, reports the DDS fixed frequency (as in command **161**). • In Variable Frequency mode, reports the tuning start frequency (as in command **146**). In either mode when the output is off, the unit reports the frequency that it will first output next time that the unit is turned on.	0	4
148 report fixed or variable frequency mode	Requests the frequency mode set with command **48**. Returns 1 data byte (8-bit value) reporting the frequency mode: • 0 = Fixed frequency mode • 1 = Variable frequency mode.	0	1
149 report minimum frequency tuning step	Requests the minimum frequency tuning step set with command **49**. Returns 4 data bytes (32-bit value) reporting the frequency in kHz.	0	4
150 report initial fine tuning step	Requests the initial fine tuning step set with command **50**. Returns 4 data bytes (32-bit value) reporting the frequency in kHz.	0	4

Table 4-8. *Host port commands for RS-232 with AE Bus (Continued)*

Command	Description	Number of Host Data Bytes	Number of Response Data Bytes
151 report set point ramping parameters	Requests the set point ramping mode and the ramping parameters set with command **31**. Returns 6 data bytes (three 16-bit values): • Bytes 0 and 1 (16-bit value) = Ramp mode ▸ 0 = disabled ▸ 1 = W/s ▸ 2 = Timed (in ms) • Bytes 2 and 3 (16-bit value) = ramp up (in watts/second or ms) • Bytes 4 and 5 (16-bit value) = ramp down (in watts/second or ms).	0	6
155 report active control method	Requests the active control mode set with command **14**. Returns 1 data byte (8-bit value): • 2 = Host • 4 = User port (analog).	0	1
158 report retuning threshold	Requests the retuning threshold set with command **58**. Returns 4 data bytes (32-bit value) reporting the tuning criteria.	0	4
160 report tune delay	Requests the amount of time in milliseconds (ms) set with command **60** for the tune delay. Returns 4 data bytes (32-bit value) reporting the amount of tune delay in ms.	0	4
161 report DDS fixed frequency	Requests the DDS fixed frequency set with command **61**. Returns 4 data bytes (32-bit value) reporting the DDS fixed frequency in kHz.	0	4

Table 4-8. *Host port commands for RS-232 with AE Bus (Continued)*

Command	Description	Number of Host Data Bytes	Number of Response Data Bytes
162 report process status	Requests report on process status. Returns 4 data bytes (four 8-bit values): • Byte 0 = first status byte (8-bit value) ▸ Bit 0 = tuning status (0 = not tuned, 1 = tuned) ▸ Bit 1 = set point ramp (1 = ramp in progress) ▸ Bit 2 = Reserved ▸ Bit 3 = Reserved ▸ Bit 4 = Reserved ▸ Bit 5 = RF output power (0 = off, 1 = on) ▸ Bit 6 = RF ON requested (0 = off, 1 = on) ▸ Bit 7 = setpoint tolerance (0 = in tolerance, 1 = out of tolerance) • Byte 1 = second status byte (8-bit value) ▸ Bit 0 = Reserved ▸ Bit 1 = Reserved ▸ Bit 2 = Reserved ▸ Bit 3 = Coldplate overtemperature fault (1 = fault) ▸ Bit 4 = Reserved ▸ Bit 5 = Reserved ▸ Bit 6 = Reserved ▸ Bit 7 = interlock open (0 = interlock closed, 1 = interlock open) • Byte 2 = third status byte (8-bit value) ▸ Bit 0 = Reserved ▸ Bit 1 = Reserved ▸ Bit 2 = Reserved ▸ Bit 3 = Reserved ▸ Bit 4 = Reserved ▸ Bit 5 = Reserved ▸ Bit 6 = Reserved ▸ Bit 7 = Reserved (continued on next page)	0	4

Table 4-8. *Host port commands for RS-232 with AE Bus (Continued)*

Command	Description	Number of Host Data Bytes	Number of Response Data Bytes
162 report process status (cont'd)	(continued from previous page) • Byte 3 = fourth status byte (8-bit value) ▸ Bit 0 = Reserved ▸ Bit 1 = Inverter not ready (1 = not ready) ▸ Bit 2 = Reserved ▸ Bit 3 = Reserved ▸ Bit 4 = Reserved ▸ Bit 5 = Fault present (0 = no faults, 1 = faults exist) ▸ Bit 6 = Warning present (0 = no warning, 1 = warnings exist) ▸ Bit 7 = Reserved. *Note:* When either of the fault present or warning present bits are set, one or more active or latched faults/ warnings currently exist in the unit. You can obtain a list of current faults or warnings through command **210** or **223** with the appropriate parameter.	0	4
164 report set point and regulation mode	Requests the output set point set with command **8** and the output regulation mode. Returns 3 data bytes (one 16-bit value; one 8-bit value): • Bytes 0 and 1 = set point value (LSB first) • Byte 2 = output regulation mode (7 = Delivered or Load).	0	3
165 report forward power	Requests the forward power in watts. Returns 2 data bytes (16-bit value) reporting the forward power in watts (LSB first).	0	2
166 report reflected power	Requests the reflected power in watts. Returns 2 data bytes (16-bit value) reporting the reflected power in watts (LSB first).	0	2

Table 4-8. *Host port commands for RS-232 with AE Bus (Continued)*

Command	Description	Number of Host Data Bytes	Number of Response Data Bytes
167 report delivered power	Requests the delivered power in watts. Returns 2 data bytes (16-bit value) reporting the delivered power in watts (LSB first).	0	2
169 report user power limit	Requests the user power limit in watts set with command **4**. Returns 2 data bytes (16-bit value) reporting the power limit in watts (LSB first).	0	2
179 report coarse tuning threshold	Requests the coarse tuning threshold set with command **20**. Returns 4 data bytes (32-bit value) reporting the tuning criteria.	0	4
198 report software revision level	Requests the software revision level. Returns a 3-element ASCII character string: • Byte 0 = ASCII revision level letter • Bytes 1 to 2 = ASCII revision level numeral.	0	3 ASCII characters

Table 4-8. *Host port commands for RS-232 with AE Bus (Continued)*

Command	Description	Number of Host Data Bytes	Number of Response Data Bytes
210 report extended faults, warnings and shutdowns	Requests extended faults, warnings and shutdown. Send no data byte or 1 data byte depending on the information you want to receive. If you send no data byte, the command returns 16 data bytes (eight 16-bit values) identifying the faults: • Bytes 0 to 1 = Active faults 0:15 • Bytes 2 to 3 = Active faults 16:31 • Bytes 4 to 5 = Active faults 32:47 • Bytes 6 to 7 = Active faults 48:63 • Bytes 8 to 9 = Latched faults 0:15 • Bytes 10 to 11 = Latched faults 16:31 • Bytes 12 to 13 = Latched faults 32:47 • Bytes 14 to 15 = Latched faults 48:63 **Possible Faults List** ▸ bit 00 = Coldplate overtemperature fault (1 = fault active) ▸ bits 01 through 07 = Unused ▸ bit 08 = PA current imbalance (1 = fault active) ▸ bits 09 through 14 = Unused ▸ bit 15 = EEPROM fault (1 = fault active) ▸ bits 16 through 18 = Unused ▸ bit 19 = Inverter not ready (1 = not ready) ▸ bits 20 through 36 = Unused ▸ bit 37 = Unable to tune (1 = fault active) ▸ bits 38 through 63 = Unused (continued on next page)	0 or 1	16

Table 4-8. *Host port commands for RS-232 with AE Bus (Continued)*

Command	Description	Number of Host Data Bytes	Number of Response Data Bytes
210 report extended faults, warnings and shutdowns (cont'd)	(continued from previous page) Send 1 data byte (8-bit value): • 1 = Report faults • 2 = Report warnings. Returns 16 data bytes (eight 16-bit values) that report a list of the first eight active or latched faults/warnings that currently exist in the unit. A code value of 0 indicates no fault or warning exists. • Bytes 0 to 1 = Fault or warning code 1 • Bytes 2 to 3 = Fault or warning code 2 • Bytes 4 to 5 = Fault or warning code 3 • Bytes 6 to 7 = Fault or warning code 4 • Bytes 8 to 9 = Fault or warning code 5 • Bytes 10 to 11 = Fault or warning code 6 • Bytes 12 to 13 = Fault or warning code 7 • Bytes 14 to 15 = Fault or warning code 8. See command **223** for a description of the fault/warning code list.	0 or 1	16

Table 4-8. *Host port commands for RS-232 with AE Bus (Continued)*

Command	Description	Number of Host Data Bytes	Number of Response Data Bytes
223 report fault or warning code list	Requests the fault or warning code list. Send 1 data byte (8-bit value): • 1 = Report faults • 2 = Report warnings. Returns CSR 0 when no fault or warning exists or a variable length of data bytes reporting a list of all active or latched faults that currently exist in the unit. Each fault is reported in two data bytes. *Note:* If you experience a fatal fault, you must reset the unit. • 20 = Hardware initialization fault (fatal) • 21 = RTOS initialization fault (fatal) • 22 = EEPROM initialization fault (fatal) • 23 = A-D converter initialization fault (fatal) • 24 = RTOS initialization fault (fatal) • 25 = Unexpected error fault (fatal) • 26 = RTOS runtime fault (fatal) • 30 = Interlock open fault (non-latching) • 31 = Coldplate overtemperature fault/ warning (latching) • 32 = Ambient air overtemperature fault/ warning (latching) • 33 = Water reversed warning • 34 = Fan 1 speed fault/warning (latching) • 35 = Fan 2 speed fault/warning (latching) • 39 = Out of set point warning • 40 = Coldplate temperature rate fault (latching) • 44 = F47 event fault (latching) • 45 = Missing phase fault (latching) • 100 = Inverter A link failure fault (non-latching) (continued on next page)	1	Variable

Table 4-8. *Host port commands for RS-232 with AE Bus (Continued)*

Command	Description	Number of Host Data Bytes	Number of Response Data Bytes
223 (continued from previous page)	(continued from previous page) • 101 = Inverter A not ready fault (non-latching) • 102 = Inverter A fault active fault (non-latching) • 103 = Inverter A PA current fault (non-latching) • 104 = Inverter A initialized fault (non-latching) • 105 = Inverter A set point ramp active fault (non-latching) • 106 = Inverter A DSP stopped fault (non-latching) • 107 = Inverter A DSP test jumper fault (non-latching) • 110 = Inverter B link failure (non-latching) • 111 = Inverter B not ready (non-latching) • 112 = Inverter B fault active (non-latching) • 113 = Inverter B PA current (non-latching) • 114 = Inverter B not initialized (non-latching) • 115 = Inverter B set point ramp active (non-latching) • 116 = Inverter B DSP stopped (non-latching) • 117 = Inverter B DSP test jumper fault (non-latching) • 120 = Inverter PA current imbalance (non-latching) • 200 = Unable to tune (latching) • 1001 = Message queue overflow (fatal)	1	Variable
225 report impedance	Requests the real and reactive impedance in hundredths of ohms. Returns 8 data bytes (two 32-bit values): • Bytes 0 through 3 = signed long value of the real impedance (LSB first) • Bytes 4 to 7 = signed long value of the imaginary impedance (LSB first).	0	8

Table 4-8. *Host port commands for RS-232 with AE Bus (Continued)*

Command	Description	Number of Host Data Bytes	Number of Response Data Bytes
228 report cold plate tempera-ture	Requests the cold plate temperature (in degrees ºC). Returns 2 data bytes (16-bit value) representing the signed integer value for the temperature (LSB first).	0	2
231 report unit serial number	Requests the unit serial number. Returns 4 data bytes (32-bit value) representing the unit serial number (LSB first).	0	4

Chapter 5

Installation, Setup, and Operation

PREPARING TO INSTALL THE UNIT

The following sections provide information that you need to understand before installing the Ovation 2560 generator.

Spacing Requirements

Mount the unit so that there is at least 1″ (2.5 cm) clearance on the sides and front of the Ovation 2560 generator, and 2″ (5 cm) from the rear. Any blockages could cause overheating to occur.

Note: See "Dimensional Drawings" on page 3-2 for the unit dimensions.

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 and lockout/tagout all sources of input power before working on this unit or anything connected to it.

⚠ CAUTION:
This equipment is intended for use with a single source of three-phase power with all phases vectored at 120° angles ±5%. If the equipment is used with an uninterruptable power supply (UPS), or other type of power conditioner, the user is responsible to guarantee the safety and EMC performance of the entire system.

Unpacking the Unit

Unpack and inspect the unit carefully, looking for obvious physical damage. If no damage is apparent, proceed with the unit installation and setup. If you do see signs of shipping damage, contact Advanced Energy Industries, Inc., and the carrier immediately. Save the shipping container for submitting necessary claims to the carrier.

INSTALLING THE UNIT

The following sections explain how to install the Ovation 2560 generator unit.

Mounting the Generator

Refer to the dimensions of the unit to properly mount your Ovation 2560 generator (see "Physical Specifications" on page 3-1 for more information).

> **ATTENTION:**
>
> **The location of the Ovation 2560 generator must accommodate the spacing and airflow requirements. For more information, see "Spacing Requirements" on page 5-1.**

CENTER OF GRAVITY AND MOUNTING HOLES

Figure 5-1 through Figure 5-5 show the center of gravity and the mounting holes for the Ovation 2560 generator.

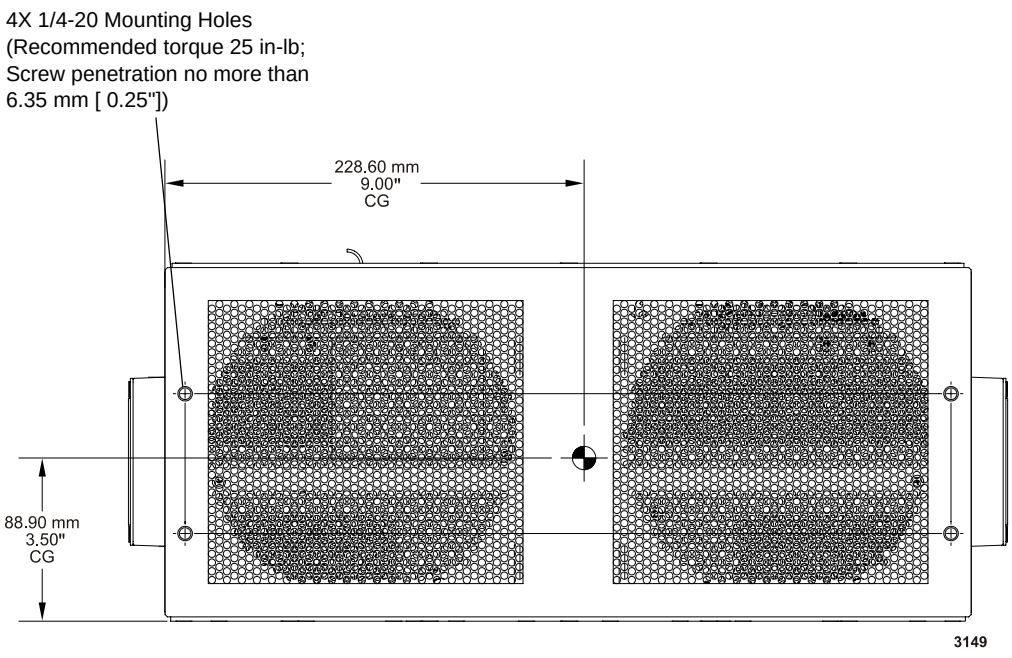


Figure 5-1. *Front panel view*

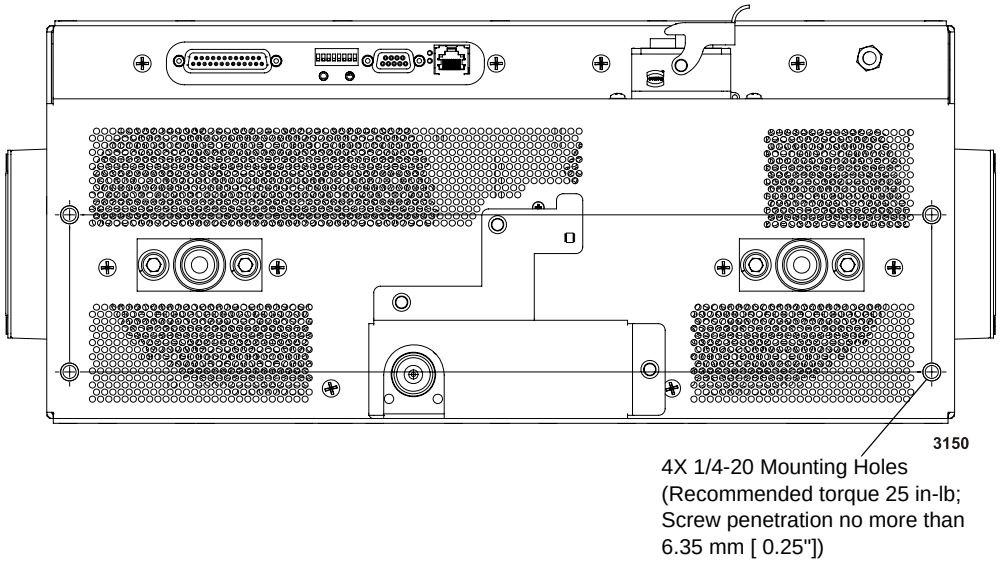


Figure 5-2. *Rear panel view*

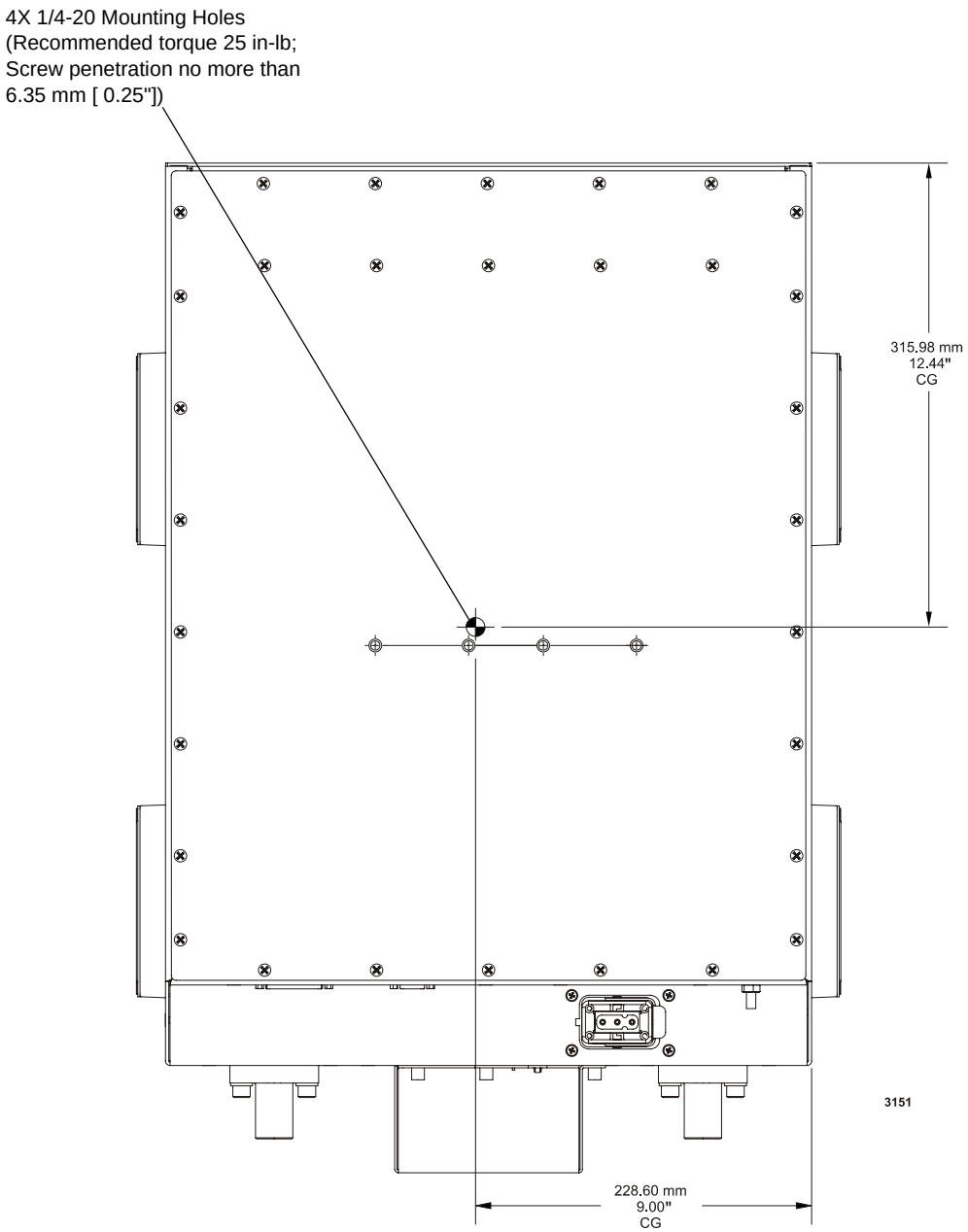


Figure 5-3. *Top panel view*

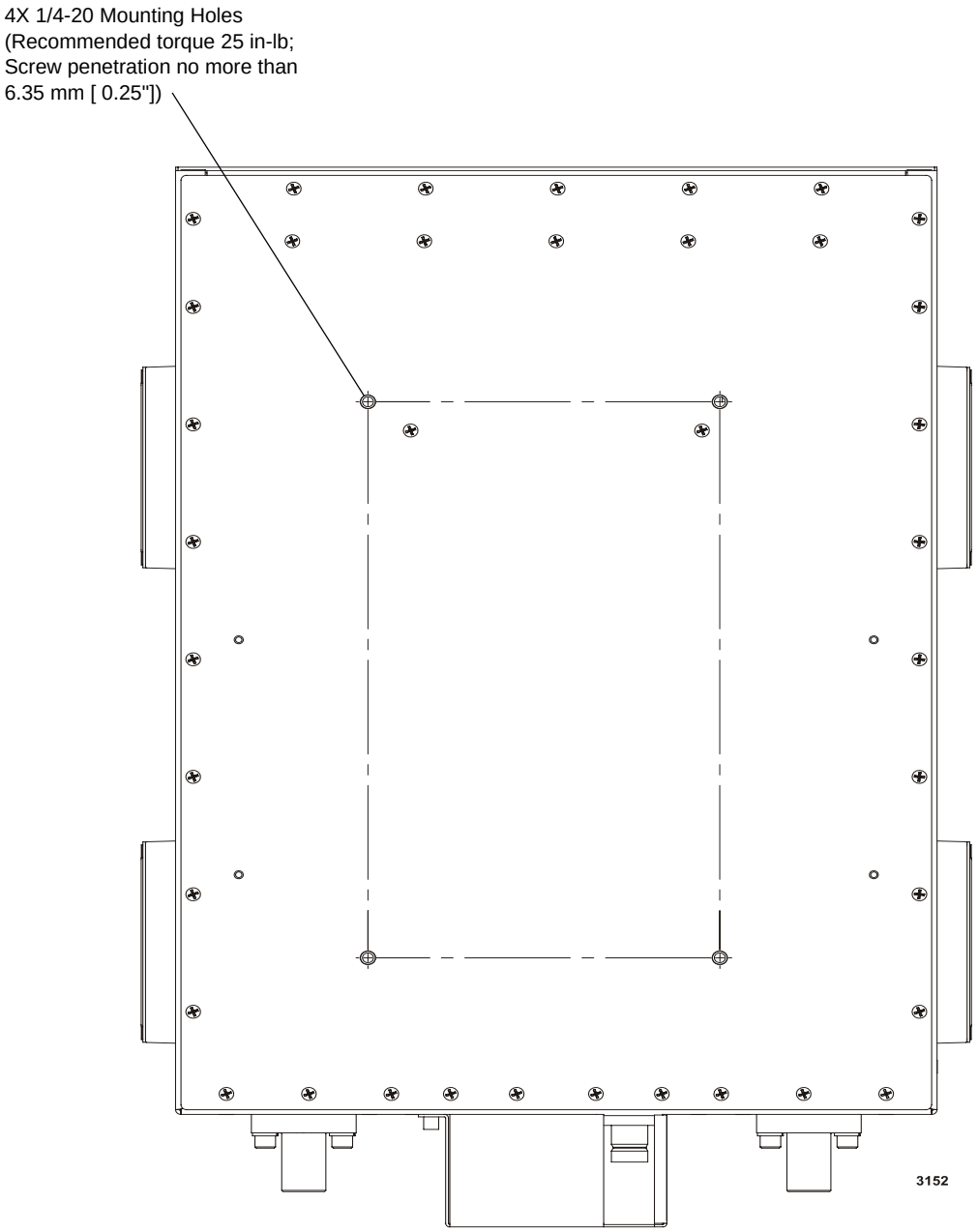


Figure 5-4. *Bottom panel view*

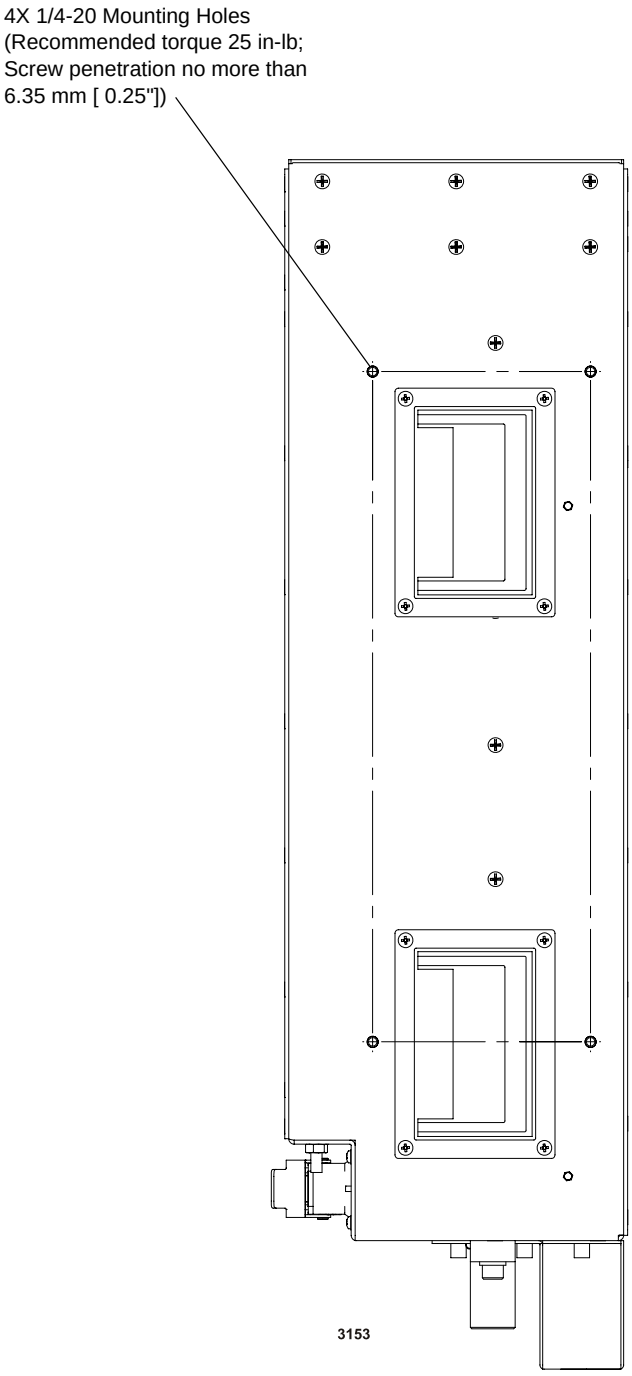


Figure 5-5. *Left panel view*

Lifting and Moving the Unit

> **CAUTION:**
> **Personnel should never stand beneath a suspended load for any reason.**

Do not attempt to lift and move the generator manually. To lift and move the generator, attach mechanical assist and lifting aids to the carrying handles located on the side panels (see "Dimensional Drawings" on page 3-2 for more information).

Note: The weight of the Ovation 2560 generator is approximately 38.6 kg (85 lbs) maximum.

Grounding

> **WARNING:**
> **Do not attempt to turn on power until the Ovation 2560 generator is grounded.**

The unit provides a grounding stud on the utilities panel for grounding. A suitable chassis ground connection made to this connection prevents or minimizes radio frequency interference.

Corner-grounded delta power connections require secondary Protective Earth grounding. Connect the secondary Protective Earth ground stud to the system ground terminal.

> **WARNING:**
> **Before making any other connection, you must connect the secondary Protective Earth ground stud to the system ground terminal. This connection is a mandatory connection.**

See "Grounding Stud Locations" on page 5-8 for the location of the grounding stud.

GROUNDING STUD LOCATIONS

Figure 5-6 locates the Secondary Protective Earth Ground stud as viewed from the top of the unit.

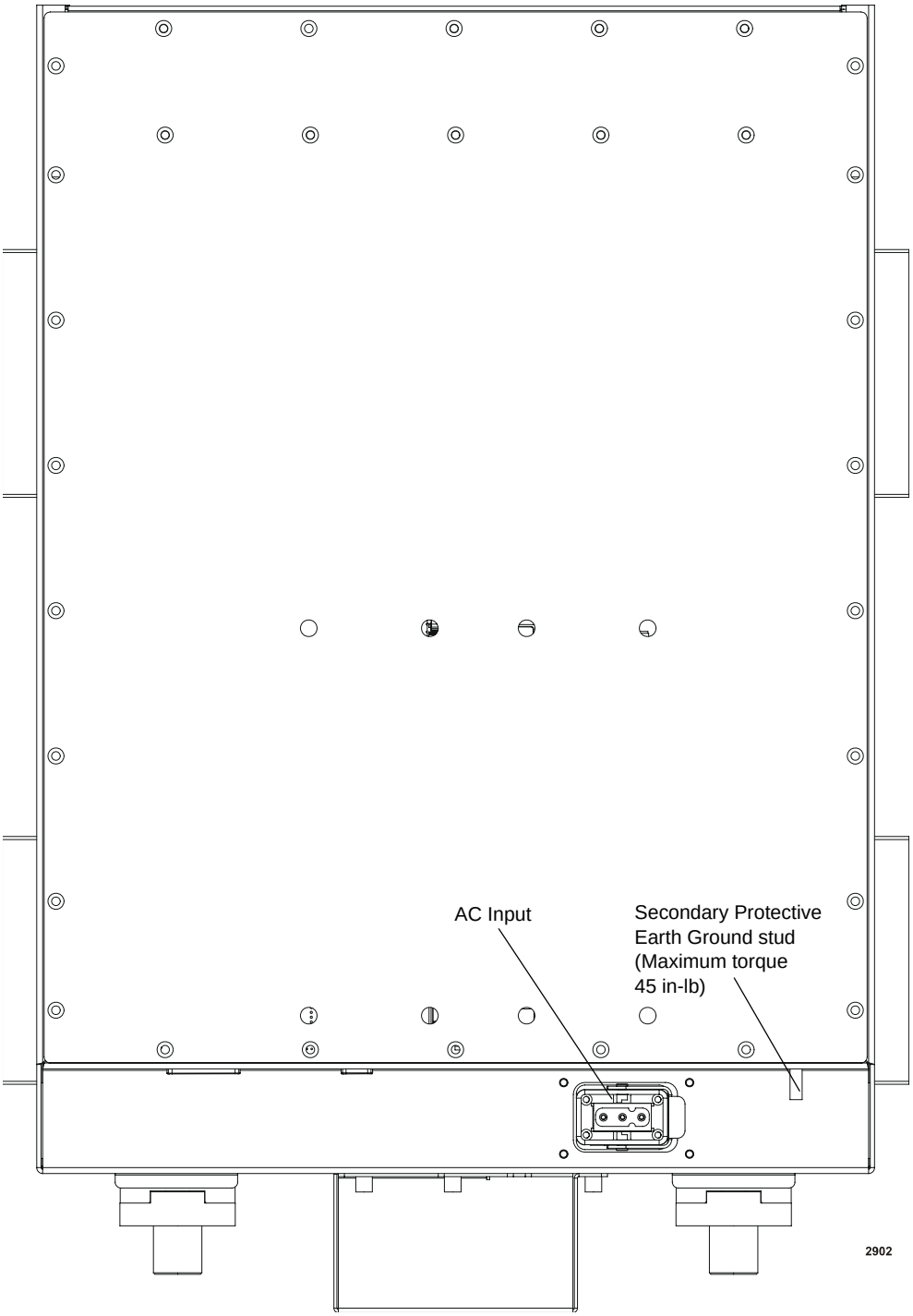


Figure 5-6. *Top panel view of grounding stud location*

Figure 5-7 locates the Secondary Protective Earth Ground stud as viewed from the rear of the unit.

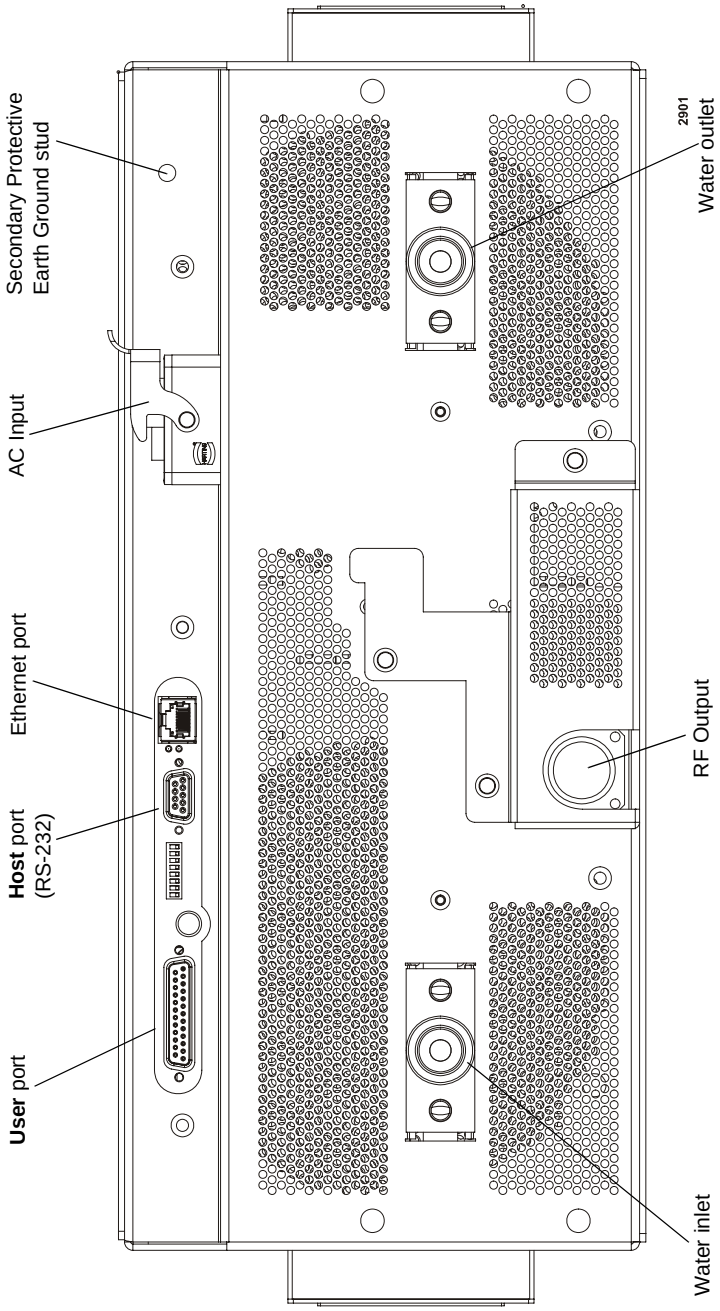


Figure 5-7. *Rear panel view of grounding stud location*

Connecting the Cooling Water

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

The Ovation 2560 generator is water cooled. Do not operate the unit until water is connected and the cooling requirements are met.

To Connect the Cooling Water:

1. Connect the input coolant line to the **Water In** connector on the rear of the Ovation 2560 generator. Torque the connection to 15 ft lbs.
2. Connect the output coolant line to the **Water Out** connector on the rear of the Ovation 2560 generator. Torque the connection to 15 ft lbs.

   Note: Use Teflon tape on the water fittings to prevent leakage. Ensure that the tape does not obstruct the water flow.

CAUTION:
Do not overtighten fittings. Damage to the heatsink of the generator could result. Torque the fittings to 15 ft lbs.

Connecting Output Power

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

WARNING:
Once input connections are complete, lethal voltages can be present at the output connector. Make sure the AC input power is disconnected before attempting to connect the RF output cable. Be sure this connector is terminated and follow normal safety precautions when the system is operating.

To Connect the Output Power:

1. Remove the RF shroud from the rear of the generator by removing its three mounting screws.
2. Pass the RF cable through the opening in the RF shroud.

   Note: Use an MS^2-480 or equivalent power handling RF cable. Failure to use the proper RF cable can cause the RF cable to overheat or fail.

3. Install and tighten the RF connector end of the cable to the RF output of the generator.
4. Replace the RF shroud and its mounting screws.
5. Connect the other end of the RF cable to the load.

Connecting AC Input Power

WARNING:
Connect the cooling water and ensure that the generator does not leak before you connect the input power.

The Ovation 2560 generator requires three-phase, 187 to 229 VAC line power with a maximum of 32 A per phase. The phase rotation is not critical. The connection is provided by a Harting 40 A modular connector. The input cable needs to be four-conductor 10 AWG or larger. The AC power should be protected with a circuit breaker rated for 32 A

Connecting I/O and Auxiliary Connectors

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

Connect and secure all interface connectors as well as any auxiliary connectors. See Chapter 4, “Communication Interfaces” for more information.

OPERATING THE UNIT

The Ovation 2560 generator comes from the factory set for the **User** port defined in Chapter 4, “Communication Interfaces” and is not programmable by the user. All other options are factory set as well.

The generator is designed to receive a power setpoint through the analog interface. When RF is enabled the generator attempts to deliver the requested power to the RF output. If the output impedance presented to the generator from the chamber is not 50 Ω, the generator may not be able to deliver the requested power.

The forward and reflected power as well as the status of the RF enable is reported to the **User** port.

Troubleshooting and Customer Support

BEFORE CALLING GLOBAL SERVICES

The following pages contain two types of helpful troubleshooting sections:

- A general checklist of potential problem areas (see "Checks With Power Off" on page 6-2 and "Checks With Power On" on page 6-2)
- A list of error codes and suggested responses (see "Error Codes" on page 6-2)

Please consult these section(s) if you believe you are experiencing trouble with your Ovation 2560 generator power supply. If the problem continues or if you cannot find an adequate solution in these pages, please call AE and ask to speak with a Global Services representative.

Before calling AE Customer Support, perform the following steps or procedures.

DANGER:

RISK OF DEATH OR BODILY INJURY. Disconnect and lockout/tagout all sources of input power before working on this unit or anything connected to it.

WARNING:

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.

Checks With Power Off

To begin troubleshooting the unit, perform the following steps with unit power off:

1. Ensure the AC 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 Power On

To troubleshoot the unit, perform the following steps with unit power on:

1. Ensure the proper power is being supplied to the unit's input and remote power connections. See "Electrical Specifications" on page 3-5 for more information on the power requirements.

Error Codes

If, after checking the unit with power off and then checking the unit with power on, you have not yet identified the problem, and if your unit reports an error code on the host computer, use the following table to troubleshoot your unit further. The table lists error codes, fault descriptions, possible problems that cause the fault, and suggested actions to resolve the problem.

FAULT TYPES

The units can report one or more types of fault or warning:

- **Fatal Fault** – This type of fault can occur at initialization or after running. You can try to clear it by AC power cycling the unit. If the fault persists, contact AE Global Services.
- **Non-Latching Faults** – Faults that are self clearing. If the fault condition clears, the fault self clears; However, if the cause of the fault has not cleared, the fault will not clear. If output was ON when the fault occurred, output will turn OFF. The unit does not require an OFF command before turning output ON. As soon as the fault condition clears, you can turn output ON.

- **Latching Faults** - When these faults occur, they remain latched until the unit receives an OFF command. If the cause of the fault has not cleared, the fault will not clear.
- **Non-Latching Warnings** – Warnings will self clear when the condition that caused the warning clears. If a warning occurs while output is ON, output will remain ON. If a warning occurs while output is OFF, you cannot turn output ON until the warning clears.

ERROR CODE TABLE

Table 6-1 lists faults and warnings for the unit.

Table 6-1. *Error codes, descriptions, and suggested actions*

Error Code	Problem Indicated	Suggested Action
20 Hardware Initialization Fault	Internal, Fatal Fault	Cycle AC power to the unit. If the fault persists, contact AE Global Services.
21 RTOS Initialization Fault	Internal, Fatal Fault	Cycle AC power to the unit. If the fault persists, contact AE Global Services.
22 EEPROM Initialization Fault	Internal, Fatal Fault	Cycle AC power to the unit. If the fault persists, contact AE Global Services.
23 A-D Converter Initialization Fault	Internal, Fatal Fault	Cycle AC power to the unit. If the fault persists, contact AE Global Services.
24 RTOS Initialization Fault	Internal, Fatal Fault	Cycle AC power to the unit. If the fault persists, contact AE Global Services.
25 Unexpected Error Fault	Internal, Fatal Fault	Cycle AC power to the unit. If the fault persists, contact AE Global Services.
26 RTOS Runtime Fault	Internal, Fatal Fault	Cycle AC power to the unit. If the fault persists, contact AE Global Services.

Table 6-1. *Error codes, descriptions, and suggested actions (Continued)*

Error Code	Problem Indicated	Suggested Action
30 **Interlock Open Fault**	Non-Latching Fault An interlock is open.	Verify interlock at two locations: • Ensure that the RF output cover switch moves without interference. • Verify that the impedance between 25-pin analog port pins 10 and 23 is less than 15 Ω.
31 **Coldplate Overtemp Warning**	Non-Latching Warning Cold plate temperature is moving higher than specification. Coolant may be out of specification. Water may be flowing in the wrong direction.	Verify coolant specifications for flow-rate and maximum temperature are met (see "Cooling Specifications" on page 3-7 for specifications). Verify water is flowing in the correct direction. If the fault persists, contact AE Global Services.
31 **Coldplate Overtemp Fault**	Latching Fault Possible obstruction in the water line Possible that water is flowing in the wrong direction	Verify coolant specifications for flow-rate and maximum temperature are met (see "Cooling Specifications" on page 3-7 for specifications). Verify water flow direction is correct. If the fault persists, contact AE Global Services.
32 **Ambient Air Overtemp Warning**	Non-Latching Warning Air temperature is moving higher than specification. Possible obstruction of the air inlet panel.	Verify ambient temperature at air inlet (opposite the utilities end). Verify there is no obstruction within 1" of the air inlet panel. If you find an obstruction, clear it. If the fault persists, contact AE Global Services.

Table 6-1. *Error codes, descriptions, and suggested actions (Continued)*

Error Code	Problem Indicated	Suggested Action
32 **Ambient Air Overtemp Fault**	Latching Fault Possible obstruction at or near air inlet panel	Verify ambient temperature at air inlet (opposite the utilities end). Verify there is no obstruction within 1" of the air inlet panel. If the ambient temperature is within operating range and the air inlet panel is clear, contact AE Global Services.
33 **Water Reversed Warning**	Non-Latching Warning "Outlet" water temperature is lower than "inlet" water temperature with respect to the labels on the unit.	Verify water is flowing in the correct direction. If the fault persists, contact AE Global Services.
34 **Fan 1 Speed Warning**	Non-Latching Warning Possible obstruction at the air inlet. If this condition exists for > 10 seconds, it will convert to Fault 34 (Fan 1 Speed Fault).	Verify there is no obstruction at the air inlet. If you find an obstruction, clear it. If the fault persists, contact AE Global Services.
34 **Fan 1 Speed Fault**	Latching Fault Possible obstruction at or near air inlet panel	Verify that the air inlet panel is clear. If the air inlet panel is clear and the fault continues, contact AE Global Services.
35 **Fan 2 Speed Warning**	Non-Latching Warning Possible obstruction at the air inlet. If this condition exists for > 10 seconds, it will convert to Fault 35 (Fan 2 Speed Fault).	Verify there is no obstruction at the air inlet. If you find an obstruction, clear it. If the fault persists, contact AE Global Services.
35 **Fan 2 Speed Fault**	Latching Fault Possible obstruction at or near air inlet panel	Verify that the air intlet panel is clear. If the air inlet panel is clear and the fault continues, contact AE Global Services.

Table 6-1. *Error codes, descriptions, and suggested actions (Continued)*

Error Code	Problem Indicated	Suggested Action
39 **Out Of Set Point Warning**	Non-Latching Warning This warning can occur anytime a non-favorable (high VSWR) load is presented to the generator output such that the unit cannot produce the requested delivered power. The threshold for this warning is +/- 1% or 3W, whichever is greater.	Ensure that you have set the correct regulation mode. Check the RF output cable connections and integrity. Verify that the match position is correct. Ensure that your set point is neither above nor below power limits for the generator. If the problem persists, Contact AE Global Services.
40 **Coldplate Temp Rate Fault**	Latching Fault Coolant flow rate and temperature may be out of specification. Water may be flowing in the wrong direction.	Verify coolant specifications for flow-rate and maximum temperature are met (see “Cooling Specifications” on page 3-7 for specifications). Verify water is flowing in the correct direction. If the fault persists, contact AE Global Services.
44 **F47 Event Fault**	Latching Fault An AC line voltage sag has been detected on one or more phases. One or more phases has sagged to <50% of nominal for more than 1 second.	Safely check three-phase and ground AC connections. Monitor and, if necessary, remedy AC power quality issues. Possible causes of AC voltage sags are under-rated power supply transformers, power plant events, local disturbances caused by nearby equipment, and so forth.

Table 6-1. *Error codes, descriptions, and suggested actions (Continued)*

Error Code	Problem Indicated	Suggested Action
45 Missing Phase Fault	Latching Fault Upon AC power-up, one or more phases was measured at <10% of nominal (<12 VAC) with respect to ground for more than 300 ms.	Safely check three-phase and ground AC connections. Each AC phase should measure 120 VAC ± 10% with respect to ground.
100 Inverter A Link Failure Fault	Internal, Non-Latching Fault	Contact AE Global Services.
101 Inverter A Not Ready Fault	Internal, Non-Latching Fault	Contact AE Global Services.
102 Inverter A Fault Active Fault	Internal, Non-Latching Fault	Contact AE Global Services.
103 Inverter A PA Current Fault	Internal, Non-Latching Fault	Contact AE Global Services.
104 Inverter A Not Initialized Fault	Internal, Non-Latching Fault	Contact AE Global Services.
105 Inverter A Setpoint Ramp Active Fault	Internal, Non-Latching Fault	Contact AE Global Services.
106 Inverter A DSP Stopped Fault	Internal, Non-Latching Fault	Contact AE Global Services.
107 Inverter A DSP Test Jumper Fault	Internal, Non-Latching Fault	Contact AE Global Services.
110 Inverter B Link Failure Fault	Internal, Non-Latching Fault	Contact AE Global Services.
111 Inverter B Not Ready Fault	Internal, Non-Latching Fault	Contact AE Global Services.

Table 6-1. *Error codes, descriptions, and suggested actions (Continued)*

Error Code	Problem Indicated	Suggested Action
112 Inverter B Fault Active Fault	Internal, Non-Latching Fault	Contact AE Global Services.
113 Inverter B PA Current Fault	Internal, Non-Latching Fault	Contact AE Global Services.
114 Inverter B Not Initialized Fault	Internal, Non-Latching Fault	Contact AE Global Services.
115 Inverter B Setpoint Ramp Active Fault	Internal, Non-Latching Fault	Contact AE Global Services.
116 Inverter B DSP Stopped Fault	Internal, Non-Latching Fault	Contact AE Global Services.
117 Inverter B DSP Test Jumper Fault	Internal, Non-Latching Fault	Contact AE Global Services.
120 Inverter PA Current Imbalance Fault	Internal, Non-Latching Fault	Contact AE Global Services.

Table 6-1. *Error codes, descriptions, and suggested actions (Continued)*

Error Code	Problem Indicated	Suggested Action
200 **Unable To Tune Fault**	Latching Fault This fault asserts when the auto-tuning algorithm is not successful based on the following criteria: • The lowest VSWR load within the frequency range must be < 3:1. • A load <3:1 VSWR must be present within 3 seconds of the RF ON command. Assertion of this fault is typically an indicator of a problem external to the generator; for example: The plasma did not ignite. The match position is not correct.	Check the RF output cable connections and integrity. Verify that the match position is correct. Ensure that process parameters are within limits. If the fault persists, contact AE Global Services.
1001 **Message Queue Overflow**	Fatal Fault	Cycle AC power to the unit. If the fault persists, contact AE Global Services.

AE WORLD WIDE WEB SITE

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

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

AE GLOBAL SERVICES

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

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

Table 6-2. *Global Services locations*

Office	Contact
AE, World Headquarters 1625 Sharp Point Drive Fort Collins, CO 80525 USA *Note:* For returns and repairs, please call Global Services to get the correct shipping address.	Phone (24 hrs/day, 7 days/week): 800.446.9167 or 970.221.0108 Fax (M–F, 7:00 am – 5:30 pm MST): 970.407.5981 Email: technical.support@aei.com (We will respond to email by the next business day.) *Note:* For customers outside the US, please contact your local AE office.
AE, GmbH Raiffeisenstrasse 32 D-70794 Filderstadt (Bonlanden) Germany	Phone: 49.711.779270 Fax: 49.711.7778700
AE, Japan KK 2971-8 Ishikawa-cho Hachioji-shi Tokyo 192-0032 Japan	Phone: 81.0426.45.8125 Fax: 81.0426.44.0779
AE, Korea Ltd. #701 Sicox Tower 513-4, Sangdaewon-dong, Chungwon-gu Sungnam-si, Kyunggi-do Korea, 462-120	Phone: +82.31.777.9191 Fax: +82.31.777.9195
AE, United Kingdom Unit 5, Minton Place, Victoria Road Bicester, Oxon OX26 6QB UK	Phone: 44.1869.320022 Fax: 44.1869.325004

Table 6-2. *Global Services locations (Continued)*

Office	Contact
AE, Taiwan, Ltd. 10F, No. 110, Chung Shan Rd., Sec. 3 235 Chungho City, Taipei Hsien Taiwan, R.O.C.	Phone: 886.2.82215599 Fax: 886.2.82215050
AE China 469 Huaxia Dong Road Zhangjiang Town Shanghai, China 201203	Phone: 86.21.58579011 Fax: 86.21.58579003

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 Services and discuss the problem with a representative. 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 Services to determine if the unit must actually be returned for the problem to be corrected. Such technical consultation is always available at no charge.

If you must return the unit, be sure to disconnect and lockout/tagout electrical power and facility water before servicing and purge all water before shipping the unit.

DANGER:

RISK OF DEATH OR BODILY INJURY. Disconnect and lockout/tagout all sources of input power before working on this unit or anything connected to it.

CAUTION:

Be sure to purge all water from the generator before shipping. Failure to do so can result in damage to the unit during shipping.

For more detailed information about the product warranty and return policy, see the following section, “Warranty”.

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 (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. 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 by AE Global Services

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 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.

Units that are returned without authorization from AE Global Services and that are found to be functional will not be covered under the warranty. 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. The AE Warranty Statement may be superseded by a service agreement entered into between AE and the buyer.

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