Paramount® HF 1013, 1250, 1513, 2013, and 3013 Generators

User Manual

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PRODUCT USAGE STATEMENT

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.

Advanced Energy Industries, Inc., (AE) provides information on its products and associated hazards, but it assumes no responsibility for the after-sale operation of the equipment or the safety practices of the owner or user. NEVER DEFEAT INTERLOCKS OR GROUNDS.

TRADEMARKS

CUSTOMER FEEDBACK

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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Table of Contents

Chapter 1. Safety and Product Compliance Guidelines

Chapter 2. Product Overview

Chapter 3. Specifications

Chapter 4. Communication Controls

Chapter 5. Installation, Setup, and Operation

Chapter 6. Troubleshooting and Global Services

List of Tables

List of Figures

Safety and Product Compliance Guidelines

IMPORTANT SAFETY INFORMATION

To ensure safe installation and operation of the Advanced Energy Paramount unit, read and understand this manual before attempting to install and operate this unit. At a minimum, read and follow the safety guidelines, instructions, and practices.

USING THIS MANUAL

The Paramount product line offers a variety of features that differ from unit to unit. This manual covers most of these features, not all of which are available in any individual unit.

You can easily distinguish some of these features by looking at the unit. In other cases, if you cannot tell what features your unit has, you can access the product identification number (PIN) that the unit returns when it receives command 221. The 31 characters (0 through 30) in this PIN provide information about the configuration of the unit. You can use the characters in the PIN to identify the features available in your unit, and to identify the information in this manual that applies to your unit. You can also retrieve the PIN using Virtual Front Panel (VFP).

This manual provides Configuration Notes similar to the following example. You can find these notes at the beginning of manual sections that provide configuration-specific information.

ATTENTION:

CONFIGURATION NOTE (Example)

To determine which User port a unit has, you can access the product identification number (PIN) that the unit returns when it receives command 221. The 31 characters (0 through 30) in this PIN provide information about the configuration of the unit. You can also retrieve the PIN using Virtual Front Panel (VFP). Character 8 indicates the User port installed in the unit.

Example PIN: 2 2 3 2 1 0 0 1 2 2 2 1 1 0 1 1 2 7 1 1 1 0 0 0 0 0 0 0 0 0 0

Possible values for character 8 are:

- 2 = Apex® compatible User port
- 9 = Apex G compatible User port
- 3 = RFG compatible User port
- 8 = Custom 1 User port

The following table lists the features identified by each PIN character.

Table 1-1. Paramount PIN characters and features

Character	Feature
0	Output power
1	Output frequency
2	Frequency tuning
3	Integrated serial ports
4	Integrated Ethernet ports
5	Expansion I/O port 1
6	Expansion I/O port 2
7	Front panel
8	Analog user card
9	Measurement system
10	Logic board
11	CPU module
12	DC inverter
13	Output circulator
14	Pulsing
15	CEX
16	Default control mode
17	Default regulation mode

Table 1-1. Paramount PIN characters and features (Continued)

Character	Feature
18	F47 recovery mode
19	Arc Management System™ technology
20	HALO mode
21	Special I/O port 1
22	Match interface
23	Intermodulation distortion (IMD) filter
24 through 30	Reserved

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 property damage. 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:

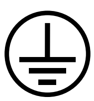
- Do not attempt to install or operate this equipment without proper training.
- Ensure that this unit is properly grounded.
- Ensure that all cables are properly connected.
- Verify that input voltage and current capacity are within specifications before turning on the power supplies.
- Use proper electrostatic discharge (ESD) precautions.

INTERPRETING PRODUCT LABELS

The following labels may appear on your unit:

CE label

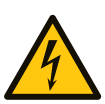
Complies with applicable European directives.



Protective conductor terminal

This terminal must be connected first and be of proper type and size for the circuit with the highest voltage and current carrying capacity. Note that other connections may have higher requirements than that of the MAINS connection.

Heavy object—can cause muscle strain or back injury



Hazardous voltage

Voltage > 30 V_{rms}, 42.4 V peak, or 60 VDC

Nonionizing radiation

Radio Frequency emissions may be harmful.

High leakage current

	Certified by CSA to North American Safety Standards for both Canada and the United States
	Refer to manual for more information
	SEMI® S2 compliant
	SEMI F47 compliant
	Environmentally Friendly Use Period of 25 years per China RoHS—recycle responsibly at end of life

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 may be certified according to the list below.

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

- NRTL – Safety certified by CSA International, a Nationally Recognized Testing Laboratory
- CE Marking – Self-declaration, assessed by AE Corporate Compliance
- EMC measurements – Verified by AE Corporate Compliance
- SEMI guidelines – Verified by AE Corporate Compliance

Safety and EMC Directives and Standards

For information concerning compliance to applicable EU requirements, refer to the EU Declaration of Conformity for this unit. The Declaration of Conformity may also include a supplementary section covering compliance to non-EU regulatory requirements and/or industry standards or guidelines.

INSTALLATION REQUIREMENTS

Install this unit according to the following requirements.

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.

DANGER:

Personnel must receive proper training before installing or troubleshooting 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.

CAUTION:

This equipment is intended for use with a single source of three-phase power with all phases vectored at 120º angles ± 5º. 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.

Conditions of Use

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

- For corner-grounded delta configuration installation, excessive leakage occurs. Secondary Protective Earth (ground) must be connected.
- Install and operate this unit in an overvoltage category according to environmental specifications.
- Install and operate this unit in a pollution degree environment according to environmental specifications.
- Use only clean, well-conditioned water with low conductivity. See the cooling specifications.
- To prevent against condensation, install and operate this device with an external water solenoid valve so that water flow is interrupted when the device is not operating.
- If this unit does not have a circuit breaker, you must install and operate it with a circuit breaker switch on the AC input. The circuit breaker switch must be

easily accessible and near the unit. The circuit breaker must be marked as the disconnecting device for the equipment.

- You must install and operate this device with a disconnect switch that conforms to the applicable requirements. The switch must be easily accessible and near the device.
- Use only a shielded cable for the input power connections.
- Use only a shielded cable for the output process power connections.
- Use only a shielded cable for communications and/or control connections.
- A pressure relief valve must be connected to the unit (inlet or outlet), and be of approved type acceptable to the authorities where the unit is sold.
- The connected pressure relief valve specifications must include 2x rated pressure.
- To meet all of the requirements for the CE mark, use a non-laptop computer when connected to the unit via the EtherCAT® communication port.

Environmental Compliance

- **EU REACH – European Union Regulation (EC) No. 1907/2006**

  Registration, Evaluation, Authorization and Restriction of Chemicals

  Advanced Energy manufactures articles subject to Article 33 of REACH and, upon request, will provide information regarding Substances of Very High Concern (SVHC) currently identified by the European Chemical Agency (ECHA) that are contained in this product, at concentrations greater than 0.1% by weight.

- **China RoHS - People's Republic of China (PRC) Ministry of Industry and Information Technology (MIIT) Order #32 (China RoHS 2)**

  Management Methods for the Restriction of the Use of Hazardous Substances Electrical and Electronic Products

  This product contains hazardous substances listed in PRC Standard GB/T 26572, above the maximum concentration limits stipulated. In compliance to PRC Standard SJ/T 11364, AE provides a disclosure of hazardous substance content and this product is marked with an Environmentally Friendly Use Period (EFUP) of 25 years.

INTERLOCKS AND LIMITING CONDITIONS

⚠ **WARNING:**

Advanced Energy 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 1-2. Hardware interlocks and limiting conditions

Mechanism	Detection Method	Equipment Condition When Interlock is Open
Interlock relay disables DC power to RF section of generator. ☞ **Important** The auxiliary power supply is not disabled, allowing communications and indication of an open interlock.	An external or internal Interlock Switch is open.	• Green **Interlock** LED is not lit on the front panel. This means that the interlock is not satisfied. • The **User** port interface Interlock Loop is not satisfied. • When the interlock is open, RF output is disabled and there is 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.

RF Output Interlock

Your unit might be equipped with one of the following RF output interlock features. Review the photos and drawings carefully to determine which interlock, if any, your unit is equipped with. Follow appropriate procedures for engaging and satisfying your unit's particular interlock.

RF OUTPUT CONNECTOR INTERLOCK SHROUD

The RF interlock shroud fits around the RF connector at the rear panel of the unit. The shroud prevents the user from disconnecting the RF connector. A magnetic switch on the shroud enables an interlock switch on the generator back panel, satisfying the interlock circuit. If you remove the shroud, the interlock switch opens, shutting down RF output.

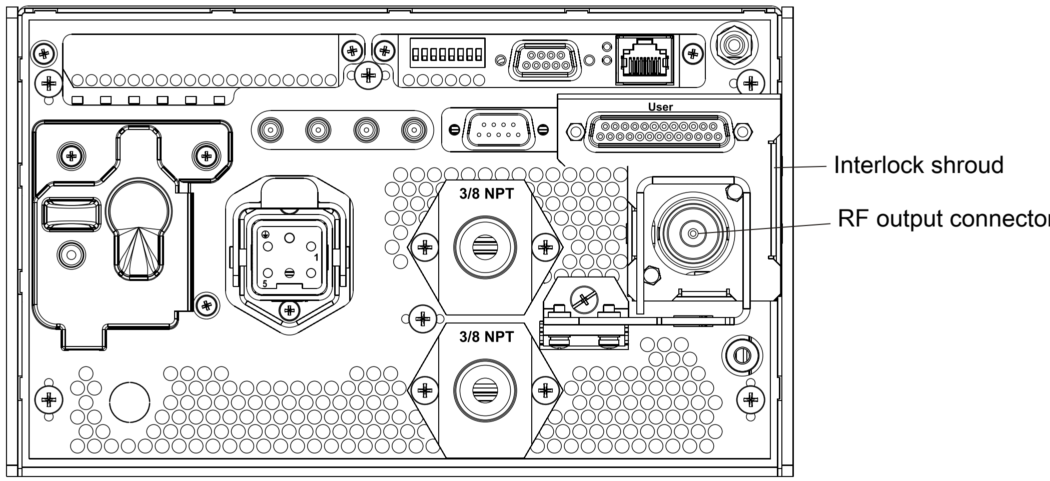


Figure 1-1. RF interlock shroud

The wiring diagram of the interlock and limit circuit shows the relay in the unit.

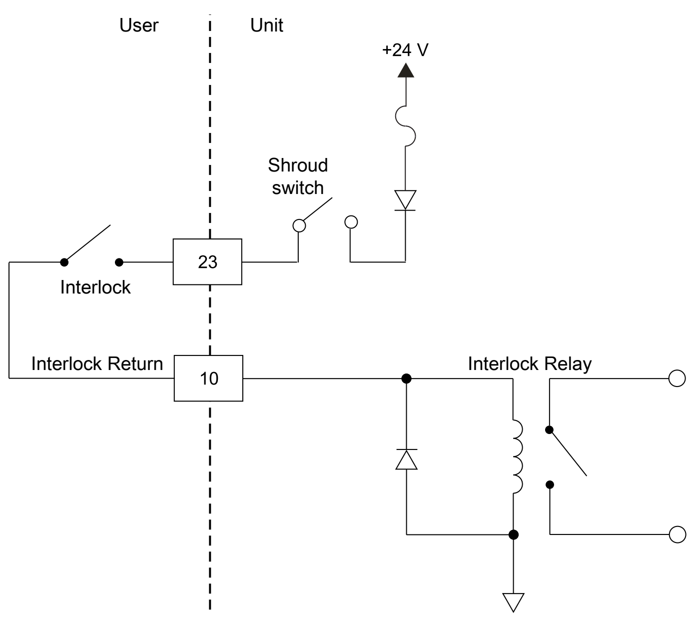


Figure 1-2. Interlock and limit circuit

RF OUTPUT AND ANALOG CONTROL CARD DRY INTERLOCK

The dry interlock feature consists of an external box connected in series with the analog control card located on the rear utilities end. An engagement switch in the box will sense the presence of the RF output power cable. If the RF output HN cable connector is present, pins 1 and 14 on the custom user port are closed. If the cable is not in place or fully engaged, pins 1 and 14 remain open. This interlock allows the user to ensure that the RF cable has been fully engaged prior to energizing AC power to the unit. On the unit side, the interlock relay circuit is satisfied following AC power on which is needed to generate various housekeeping supplies including the +24 V line that drives the interlock loop within the generator.

☞ **Important**

If interlock is opened and error code **101**, inverter not ready, has been activated, you can clear this fault by engaging interlock. Once interlock is engaged, you must wait 700 ms before sending an RF on command. If you do not wait for at least 700 ms, you might receive another inverter not ready error code (**101**) when you send an RF on command.

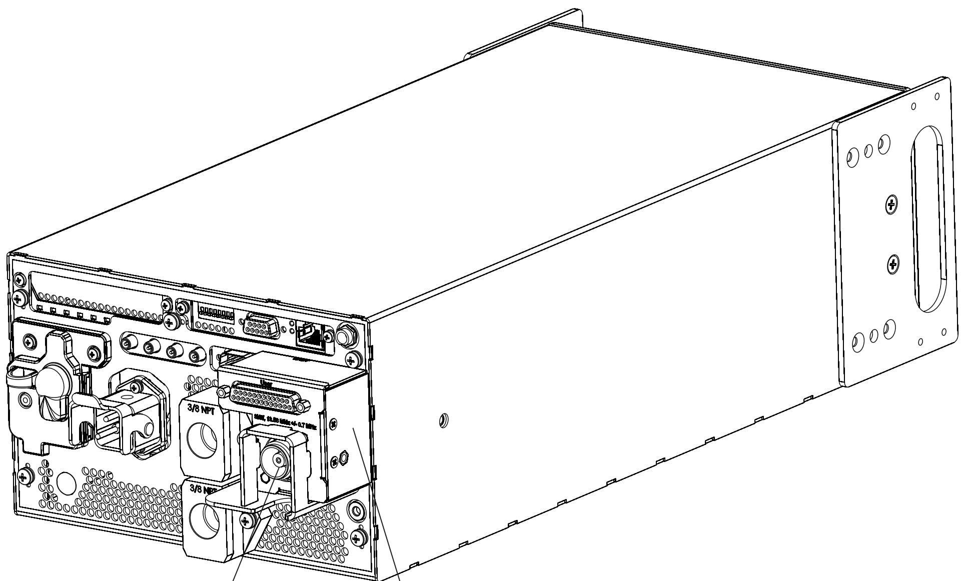


Figure 1-3. Isometric view of external interlock box

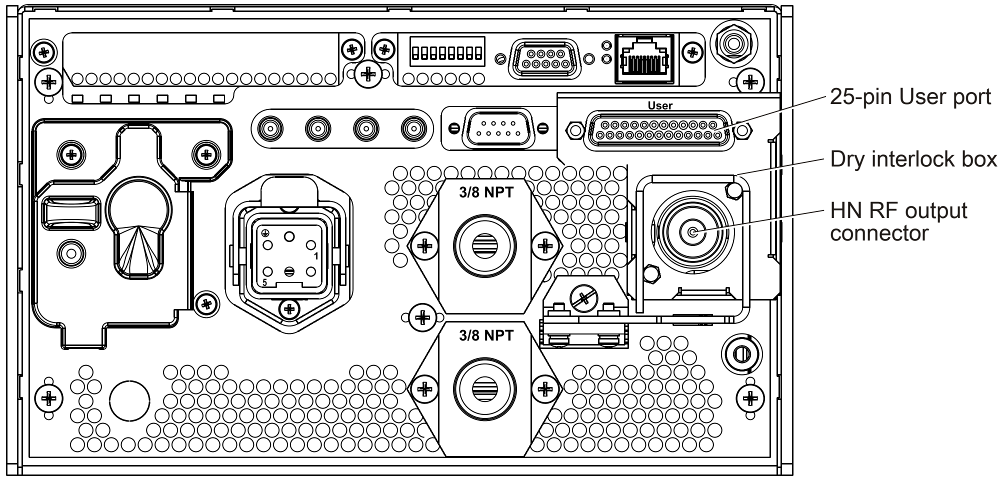
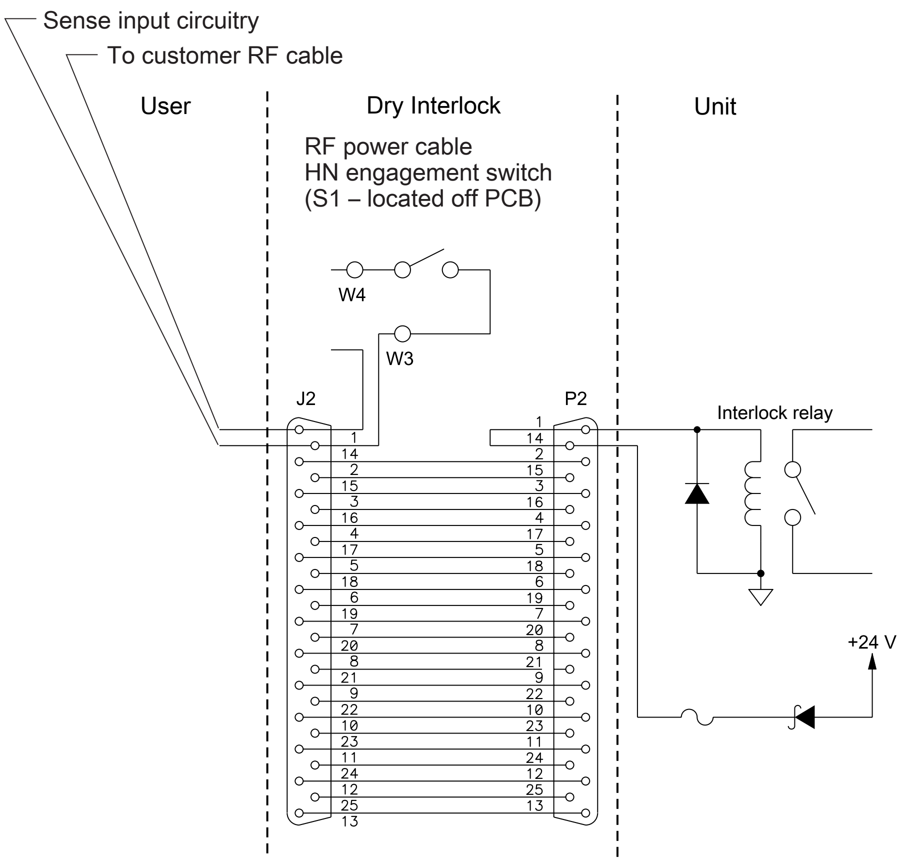


Figure 1-4. Rear view of unit with analog control card/RF output dry interlock



*When RF cable HN connector is present on gererator side (S1 - open), pins 1 and 14 are closed.

**When RF cable HN connector is not present (S1 - open), pins 1 and 14 are open.

Figure 1-5. Dry interlock circuit

Product Overview

PRODUCT DESCRIPTION

General Description

The Advanced Energy Paramount platform is capable of providing up to 3000 W into loads up to 1.6:1 VSWR. Some units operate at a fixed frequency of 13.56 MHz; other units operate at a variable frequency of 13.56 MHz ± 5% (12.882 MHz to 14.238 MHz). The generator provides high accuracy load or forward power regulation and incorporates internal protection limits permitting safe and reliable operation into all load conditions. The generator is designed for use with 200 VAC to 208 VAC ± 10%, 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.

Frequency Tuning Feature

The Paramount frequency tuning feature incorporates Direct Digital Synthesis (DDS) technology for control of the operating frequency when the generator load is mismatched. This field-proven, robust technology has been incorporated in AE products since 1996. The unit can be programmed to adjust frequency 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 nonvolatile 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 Paramount generator using the following interfaces (depending on the unit configuration):

- A 25-pin analog/digital (**User**) port
- A serial RS-232 communications port
- A serial RS-232/RS-485 communications port
- An Ethernet port
- A DeviceNet™ port
- An EtherCAT port

The serial and Ethernet communications ports provide access to all operating parameters and control functions in the Paramount generator. The **User** port provides limited access to operating parameters and control functions.

THEORY OF OPERATION

Operation Overview

The fundamental purpose of the generator is to take the nominal 200 VAC to 208 VAC ± 10%, 3 φ, 50 Hz ± 3 Hz or 60 Hz ± 3 Hz power from the line cord and convert it to RF energy at 13.56 MHz ± 5% (12.882 MHz to 14.238 MHz). The generator consists of several systems: AC input, DC, RF, and logic.

AC Input

The AC input section consists of an optional switch, fuses on each phase of the AC input, and a line filter.

DC

A DC module provides power for the RF module and auxiliary voltages for the control section.

RF

An RF module amplifies a logic level signal received from the logic section to the required output power.

Logic

The logic module contains a microprocessor module, a measurement and control module, and user interfaces.

The control system compares the RF output sample to the power set point, and makes adjustments until the output and set point are equal. The control system also performs other monitoring and controls operation within the generator. For example, to manage frequency tuning, a proprietary algorithm minimizes generator load mismatches.

Specifications

PHYSICAL SPECIFICATIONS

Table 3-1. Physical specifications

Description	Specification
Size	13.3 cm (H) x 21.6 cm (W) x 44.3 cm (D) 5.25″ (H) x 8.5″ (W) x 17.5″ (D) ☞ **Important** These measurements do not include connectors, covers, cable connections, or rack mounting extensions.
Weight	< 16 kg (35 lb)
Chassis (EMI) ground	Tapped hole in chassis (M4)
Color and finish	Black side panels Gray front panel
Mounting	Rack mount Option: Half-rack mount brackets with handles on front or rear of the unit Frame mount: M4 threads
Air Cooling	
Inlet	Located on front panel—no objects within 5 cm (2″) of air inlets
Outlet	Located on the rear panel—no objects within 5 cm (2″) of air outlets
Connectors/Cable Specifications	
RF output connector	HN female connector (standard) Connector shroud with magnetic switch
AC input power	HARTING Han® Q module, max 16 A connector (standard) • Male insert, quantity x 1: part number: 09 12 005 3001 • Housing, quantity x 1: part number: 09 20 003 0301 • HARTING connector pin, quantity x 4: part number: 09 33 000 6102 Switch plus fuses (non-resettable over-current trip)

Table 3-1. Physical specifications (Continued)

Description	Specification
	Lockout/tagout (LOTO) included
Serial ports	Rear panel: RS-232/RS-485 (AE Bus Host port), 9-pin subminiature-D female, labeled **Serial** Front panel: RS-232 only, 9-pin subminiature-D female, labeled **Service**
Ethernet port (rear panel)	RJ-45, labeled **Enet**
Analog port (**User**; rear panel)	25-pin female subminiature-D, labeled **User**
Arc detect in/out (rear panel)	SMA, female, shared with **Sync In**/**Sync Out**
Sync in/out (rear panel)	SMA, female, shared with arc detect in/out; labeled **Sync In**/ **Sync Out**
CEX in/out (rear panel) Your unit could have one of the following: • Phase locking on internal oscillator • Phase locking on output	SMA, female, labeled **CEX IN**/**CEX OUT**
Match control (rear panel)	9-pin subminiature-D male
EtherCAT (rear panel)	Two RJ-45 ports, labeled **In** and **Out**
DeviceNet (rear panel)	Round, 5-pin, male
Coolant connectors (water in and water out)	3/8″ NPT female, brass, or 1/2″ SST male/female quick release • Plug: SMC KKA6P-03M-X47 • Socket: KKA6S-03M-X47
Water control connector (rear panel)	Switchcraft® L712A
LEDs (all LEDs located on both front and rear panels)	See Table 3-2

Table 3-2. LED states during normal operation

LED (label on front panel)	LED (label on back panel)	Description
AC On	**AC**	Green: Lit as long as unit receives AC power.

Table 3-2. LED states during normal operation (Continued)

LED (label on front panel)	LED (label on back panel)	Description
RF On	**RF**	Green: Lit when unit has received RF on command and unit has no active faults, regardless of whether unit is actually delivering power. Turns off when unit receives RF off command or a fault occurs.
Interlock	**Intlk**	Green: Lit as long as interlock is satisfied. Turns off, subject to a 100 ms to 200 ms delay, when interlock opens.
Power Limit	**Lmt**	Yellow: Lit when RF is on and the following conditions exist: • Measured unit output deviates from set point by > 3 W and 1% • Set point < low power limit (factory set) and > 3 W
Over Temp	**Tmp**	Yellow: Lit when temperature in the unit exceeds limits. • If this fault occurs when RF is off, the fault clears and the LED will become unlit when the temperature falls below the limit. • If this fault occurs when RF is on, the LED remains lit until the temperature falls below the limit and the unit receives an RF off command.
Alarm	**Alm**	Yellow: Lit when any fault is active or latched.

ELECTRICAL SPECIFICATIONS

Specification Table

This table describes the input power, output power, and other electrical specifications for the Paramount generator. In some cases, the specifications for all units are the same, but in other cases, unit specifications vary depending on installed features. The following configuration note can help you in determining the various features that your unit has.

ATTENTION:

CONFIGURATION NOTE

The generators described in the specification table are 1013 (1000 W output power),1250 (1250 W output power), 1513 (1500 W output power), 2013 (2000 W output power), and 3013 (3000 W output power) units. They can also be high accuracy, low output (HALO) units. Where these product differences affect specifications, those differences are specifically noted in the table.

To determine the output power of a generator or whether a generator has the HALO feature, you can access the product identification number (PIN) that the unit returns when it receives command 221. The 31 characters (0 through 30) in this PIN provide information about the configuration of the unit. You can also retrieve the PIN using Virtual Front Panel (VFP). Character 0 indicates the output power of the unit. Character 20 indicates whether the unit has HALO.

Example PIN: 2 2 3 2 1 0 0 1 2 2 2 1 1 0 1 1 2 7 1 1 1 0 0 0 0 0 0 0 0 0 0

Possible values for character 0 are:

- C = 1013 unit
- C = 1250 unit
- 6 = 1513 unit
- 7 = 2013 unit
- 2 = 3013 unit

Possible values for character 20 are:

- 0 = No HALO
- 1 = HALO installed

Table 3-3. Electrical specifications

Description	Specification
Input Power	
Line voltage	200 VAC to 208 VAC ± 10%, 3 phase Compatible with wye, delta, and corner-grounded delta configurations
AC line sag response	Auto-restart to previous state if RF is off < 1 s
Input power	1013 unit: < 2.1 kVA 1250 unit: < 2.1 kVA 1513 unit: < 2.5 kVA 2013 unit: < 3.2 kVA 3013 unit: < 4.4 kVA
Line frequency	50 Hz ± 3 Hz or 60 Hz ± 3 Hz

Table 3-3. Electrical specifications (Continued)

Description	Specification
Operating line current	1013 unit: < 6.0 A or 6.2 A per φ at nominal line for 208 VAC or 200 VAC, respectively 1250 unit: < 6.0 A or 6.2 A per φ at nominal line for 208 VAC or 200 VAC, respectively 1513 unit: < 6.8 A or 7.1 A per φ at nominal line for 208 VAC or 200 VAC, respectively 2013 unit: < 8.7 A or 9.1 A per φ at nominal line for 208 VAC or 200 VAC, respectively 3013 unit: < 12.7 A to 13.2 A per φ at nominal line voltage for 208 VAC or 200 VAC
Inrush line current	< 24 A per φ
Phase-current imbalance	< 1 A_{RMS}
Overcurrent protection	Three 20 A fuses
Power factor	Minimum 0.95 with full-rated output into 50 Ω, nonreactive load
Efficiency	1013 unit: > 60% at 1000 W into 50 Ω 1250 unit: > 60% at 1250 W into 50 Ω 1513 unit: > 64% at 1500 W into 50 Ω 2013 unit: > 66% at 2000 W into 50 Ω 3013 unit: > 68% at 3000 W into 50 Ω
Line imbalance	10% continuous operation
RF Output Power	
Center frequency	13.56 MHz
Frequency range	Fixed frequency option: Fixed at center frequency Variable frequency option: 12.882 MHz to 14.238 MHz
Frequency stability	± 0.005% (5°C to 40°C / 41°F to 104°F)
Load impedance	50 Ω nominal (50 - j0)
Full-rated output power	1013 unit: 1000 W 1250 unit: 1250 W 1513 unit: 1500 W 2013 unit: 2000 W 3013 unit: 3000 W
Output power range	The output power range varies according to the full-scale output power of the unit and whether or not the unit is a HALO (high accuracy, low output) generator. To determine the configuration of a unit, see the configuration note that precedes this table.

Table 3-3. Electrical specifications (Continued)

<table>
<tr><th>Description</th><th>Specification</th></tr>
<tr><td></td><td>
<table>
<tr><th>Unit</th><th>Range Into 50 Ω</th></tr>
<tr><td colspan="2">Standard units</td></tr>
<tr><td>1013</td><td>10 W to 1000 W</td></tr>
<tr><td>1250</td><td>12.5 W to 1250 W</td></tr>
<tr><td>1513</td><td>15 W to 1500 W</td></tr>
<tr><td>2013</td><td>20 W to 2000 W</td></tr>
<tr><td>3013</td><td>30 W to 3000 W</td></tr>
<tr><td colspan="2">HALO units</td></tr>
<tr><td>1013</td><td>5 W to 1000 W</td></tr>
<tr><td>1250</td><td>5 W to 1250 W</td></tr>
<tr><td>1513</td><td>5 W to 1500 W</td></tr>
<tr><td>2013</td><td>5 W to 2000 W</td></tr>
<tr><td>3013</td><td>5 W to 3000 W</td></tr>
</table>
</td></tr>
<tr><td>Reflected power limit</td><td>1013 unit: Selectable, 250 W maximum
1250 unit: Selectable, 600 W maximum
1513 unit: Selectable, 400 W maximum
2013 unit: Selectable, 600 W maximum
3013 unit: Selectable, 600 W maximum</td></tr>
<tr><td>Maximum forward power</td><td>1013 unit: 1250 W
1250 unit: 1850 W
1513 unit: 1900 W
2013 unit: 2600 W
3013 unit: 3600 W</td></tr>
<tr><td>Load power into:</td><td>
<table>
<tr><th>Unit</th><th>VSWR</th><th>Load Power (Forward Power)</th></tr>
<tr><td rowspan="4">1013</td><td>1:1</td><td>1000 W (1000 W forward power)</td></tr>
<tr><td>1.6:1</td><td>1000 W (1000 W forward power)</td></tr>
<tr><td>2:1</td><td>1000 W (1000 W forward power)</td></tr>
<tr><td>3:1</td><td>700 W (933 W forward power)</td></tr>
<tr><td rowspan="4">1250</td><td>1:1</td><td>1250 W (1250 W forward power)</td></tr>
<tr><td>1.6:1</td><td>1250 W (1250 W forward power)</td></tr>
<tr><td>2:1</td><td>1111 W (1250 W forward power)</td></tr>
<tr><td>3:1</td><td>935 W (1250 W forward power)</td></tr>
</table>
</td></tr>
</table>

Table 3-3. Electrical specifications (Continued)

<table>
<tr><th>Description</th><th>Specification</th></tr>
<tr><td></td><td>
<table>
<tr><th>Unit</th><th>VSWR</th><th>Load Power (Forward Power)</th></tr>
<tr><td rowspan="4">1513</td><td>1:1</td><td rowspan="2">1500 W (1500 W forward power)</td></tr>
<tr><td>1.6:1</td></tr>
<tr><td>2:1</td><td>1350 W (1500 W forward power)</td></tr>
<tr><td>3:1</td><td>1000 W (1333 W forward power)</td></tr>
<tr><td rowspan="4">2013</td><td>1:1</td><td rowspan="2">2000 W (2000 W forward power)</td></tr>
<tr><td>1.6:1</td></tr>
<tr><td>2:1</td><td>1300 W (1465 W forward power)</td></tr>
<tr><td>3:1</td><td>1000 W (1333 W forward power)</td></tr>
<tr><td rowspan="4">3013</td><td>1:1</td><td rowspan="2">3000 W (3000 W forward power)</td></tr>
<tr><td>1.6:1</td></tr>
<tr><td>2:1</td><td>2400 W (2700 W forward power)</td></tr>
<tr><td>3:1</td><td>1600 W (2133 W forward power)</td></tr>
</table>
</td></tr>
<tr><td colspan="2">Setpoint</td></tr>
<tr><td>Minimum step (resolution)</td><td>
<table>
<tr><th></th><th>Digital I/O</th><th>Analog I/O</th></tr>
<tr><td colspan="3">Standard units</td></tr>
<tr><td>1013, 1250, 1513, 2013, 3013</td><td>1 W</td><td>1 W</td></tr>
<tr><td colspan="3">HALO units</td></tr>
<tr><td>1013, 1250, 1513, 2013, 3013</td><td>0.1 W</td><td>1 W</td></tr>
</table>
</td></tr>
<tr><td>Zero setpoint</td><td>Any unit with setpoint ≤ 3 W; RF output is off and there is no out-of-setpoint warning.

Standard units with setpoint > 3 W but less than shown in the following list, RF output is off and the out-of-setpoint warning is active:
• 1013 unit is < 5 W
• 1250 unit is < 5 W
• 1513 unit is < 15 W
• 2013 unit is < 20 W</td></tr>
</table>

Table 3-3. Electrical specifications (Continued)

Description	Specification
	• 3013 unit is < 30 W HALO units with setpoint > 3 W but less than shown in the following list, RF output is off and the out-of-setpoint warning is active: • 1013 unit is < 5 W • 1250 unit is < 5 W • 1513 unit is < 5 W • 2013 unit is < 5 W • 3013 unit is < 5 W
Zero watt output power	< 0.5 W
Serial response time	< 10 ms from the end of command to 90% of setpoint
Analog response time (bandwidth)	< 2 ms from change in analog setpoint to 90% of change in power (typical)
Output Power Measurement: Accuracy and Repeatability	
Accuracy: Load power accuracy into 50 Ω (<1.1:1 VSWR)	± 1% of setpoint or ± 0.5 W, whichever is greater
Accuracy: Load power accuracy into all loads up to 3:1 VSWR	± 2% of setpoint or ± 1 W, whichever is greater
Power repeatability	± 0.5% over warranty period for same generator
Unit to unit power measurement variation	< ± 1% of setpoint, 50 Ω non-reactive loads
Output power regulation into 50 Ω	For digital I/O: • Regulates to within accuracy specification For analog I/O: • ± 3 W or ± 1% of setpoint, whichever is greater
Output power regulation into 3:1 VSWR	For digital I/O: • Regulates to within accuracy specification For analog I/O: • ± 7.5 W or ± 3% of setpoint, whichever is greater
Stability drift over time	± 0.5% during continuous hours of operation over one hour

Table 3-3. Electrical specifications (Continued)

Description	Specification
Stability as a function of AC line	< 0.1% for a 10% AC line voltage
Dynamic Response	
RF rise time	< 2 ms
RF fall time	< 2 ms
Settling time	< 2 ms
Turn-on time	< 10 ms from command to start of transition
Turn-off time	< 10 ms from command to start of transition
Reaction time	< 10 ms from command to start of transition
Overshoot	< 10% of setpoint (into 50 Ω)
Output Filtering (at full rated output into a 50 Ω load)	
Harmonics	< -50 dBc (typical) into a broadband resistive 50 Ω load at 3000 W
Spurious signals	< -50 dBc
Total AM	< 2%
Warm-up period (All power specs)	≤ 2 minutes from AC on
CEX Phase locking on output (not compatible with pulsing option)	
Capture range CEX bandwidth	13.56 MHz ± 5%
Locked CEX bandwidth	± 0.5 kHz
CEX in	2 dBm to 10 dBm, 13.56 MHz ± 5%, 50 Ω nominal input impedance (≤ 1.5:1 VSWR); tolerant to 2.5 V_{PP} input (V_{PP} means peak to peak voltage or twice the amplitude), AC coupled
CEX out	Square wave, 13.56 MHz ± 5%, 50 Ω nominal source impedance (≤ 1.5:1 VSWR); minimum 1.5 V_{PP} when loaded by 50 Ω, nominal 5 V_{PP} when unloaded, AC coupled
Phase delay control	0° to 360° (programmable)
CEX Phase locking on internal oscillator	
Capture range CEX bandwidth	13.56 MHz ± 5%
Locked CEX bandwidth	± 0.5 kHz
CEX in	2 dBm to 10 dBm, 13.56 MHz ± 5%, 50 Ω nominal input impedance (≤ 1.5:1 VSWR); tolerant to 2.5 V_{PP} input (V_{PP} means peak to peak voltage or twice the amplitude), AC coupled

Table 3-3. Electrical specifications (Continued)

Description	Specification
CEX out	Square wave, 13.56 MHz ± 5%, 50 Ω nominal source impedance (≤ 1.5:1 VSWR); minimum 1.5 V_{PP} when loaded by 50 Ω, nominal 5 V_{PP} when unloaded, AC coupled
Phase delay control	0° to 360° (programmable)
Pulsing	
Single-level Pulsing (SLP)	Provided (On/Off)
Pulsed output amplitude	Peak “on” pulse amplitude is controllable over the full output power range through the setpoint. The output goes to 0 during the off period.
RF output frequency stability	± 0.01%
Pulse frequency	10 Hz to 100 kHz in 1 Hz increments
Pulse frequency deviation	< 2%
Pulse frequency stability	< 5%
Duty cycle	10% to 90% in 1% increments, subject to on/off time restrictions
On time	5 µs to 90 ms
Off time	5 µs to 90 ms
Overshoot	≤ 2% of setpoint into 50 Ω
Pulse rise time	< 2.5 µs
Pulse fall time	< 2.5 µs
Pulse delay (from pulse sync input)	0 to 10 µs less than the pulse repetition period for pulsing frequencies 1 kHz and lower 0 to 5 µs less than the pulse repetition period for pulsing frequencies above 1 kHz
Pulse sync input	Low to high transition turns RF on, 50 Ω nominal input impedance (≤ 1.5:1 VSWR), threshold voltage nominally 0.95 V, tolerant to 0 V to 2.5 V input
Pulse sync output	High level when RF is on, 50 Ω nominal source impedance (≤ 1.5:1 VSWR), 0 V to minimum 1.5 V when loaded by 50 Ω, nominal 0 V to 5 V when unloaded
Pulsed output timing accuracy	0.5 µs edge uncertainty
Arc Management	
Arc response time	3 µs
Arc shutdown time	< 2 µs
Arc suppression time (first attempt n=1)	5 µs to 511 µs ± 2 µs (0 = disabled)

Table 3-3. Electrical specifications (Continued)

Description	Specification
Turn on time	2 µs
Arc suppression time (attempt 2 to n)	Arc suppression time * 2^{n-1} (where n = attempt number) until maximum off time reaches 65.5 ms
Proportional parameter	Hard coded to double on every attempt
Arc suppression attempts	0 to 250 attempts (0 = infinite attempts)
Arc initial RF on delay (time from RF on to arc management enabled)	0 ms to 10 s ± 10 ms
Arc setpoint delay (time from > 10 W setpoint change to arc management enabled)	0 ms to 245 ms ± 10 ms

COOLING SPECIFICATIONS

The Paramount generator uses both water and forced air cooling.

Table 3-4. Cooling specifications

Description	Specification
Air Cooling	
Location and clearance	Forced air intake on front panel Exhaust on rear panel Minimum clearance required for both front and rear panels: • > 50.8 mm (2.0″)
Input air temperature range	5°C to 40°C (41°F to 104°F)
Air flow	< 9 m^3/minute
Air heat removal	< 400 W at full rated power
Water Cooling	
Temperature	
Maximum water temperature at minimum flow rate and maximum ambient air temperature (+ 40°C/ +104 °F)	+35°C (+95°F)

Table 3-4. Cooling specifications (Continued)

Description	Specification
Minimum temperature at water inlet	+5°C (+41°F)
Flow rate (minimum)	7.6 lpm (2 gpm)
Pressure	
Minimum pressure differential (supply to drain) required to achieve specified minimum flow rates, at 7.6 lpm (2 gpm)	• 0.6 Bar • 8 psi • 60 kPa
Maximum pressure rating	• 6.9 Bar • 100 psi • 690 kPa
Contaminants	Cooling water quality recommended: • pH between 6.0 and 9.0 • 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 ≤ 640,000/ specific resistivity (Ω-cm) • All surfaces in contact with water must be copper, brass, bronze, or superior materials (aluminum with or without coatings is expressly forbidden).

ENVIRONMENTAL SPECIFICATIONS

Table 3-5 and Table 3-6 describe the environmental specifications for the Paramount generator.

Table 3-5. Environmental standard specifications

Description	Specification
Overvoltage category	II
Pollution degree	2

Table 3-6. Climatic specifications

	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′ to -1640′)
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′ to -1640′)
Transportation	-25°C to +70°C -13°F to +158°F	95% [2] 60 g/m^3 [3]	65.6 kPa to 106 kPa 656 mbar to 1060 mbar Equivalent altitude: +3500 m to -500 m (+11480′ to -1640′)

[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 (-13°F to +86°F)

[3] Maximum absolute humidity when the unit temperature directly decreases from +70°C to +15°C (+158°F to +59°F)

Communication Controls

LED STATES DURING NORMAL OPERATION

The Paramount generator has six LEDs on the front panel and six LEDs on the back panel. The six LEDs on the back panel function exactly the same as the six LEDs on the front panel: Only the labels differ. You can check the LEDs at either location to troubleshoot the unit.

If your generator is operating normally, LED states should match those in Table 4-1. If your generator LED states do not match the states in this table, you need to troubleshoot the unit.

Table 4-1. LED states during normal operation

LED (label on front panel)	LED (label on back panel)	Description
AC On	**AC**	Green: Lit as long as unit receives AC power.
RF On	**RF**	Green: Lit when unit has received RF on command and unit has no active faults, regardless of whether unit is actually delivering power. Turns off when unit receives RF off command or a fault occurs.
Interlock	**Intlk**	Green: Lit as long as interlock is satisfied. Turns off, subject to a 100 ms to 200 ms delay, when interlock opens.
Power Limit	**Lmt**	Yellow: Lit when RF is on and the following conditions exist: • Measured unit output deviates from set point by > 3 W and 1% • Set point < low power limit (factory set) and > 3 W
Over Temp	**Tmp**	Yellow: Lit when temperature in the unit exceeds limits. • If this fault occurs when RF is off, the fault clears and the LED will become unlit when the temperature falls below the limit. • If this fault occurs when RF is on, the LED remains lit until the temperature falls below the limit and the unit receives an RF off command.

Table 4-1. LED states during normal operation (Continued)

LED (label on front panel)	LED (label on back panel)	Description
Alarm	**Alm**	Yellow: Lit when any fault is active or latched.

25-PIN USER PORTS

Your unit has one of several types of **User** ports:

- Compatible with Apex **User** port
- Compatible with an Apex G **User** port
- Compatible with an RFG **User** port
- Custom 1 **User** port

To determine which **User** port your Paramount generator has, use the following configuration note.

ATTENTION:

CONFIGURATION NOTE

To determine which User port a unit has, you can access the product identification number (PIN) that the unit returns when it receives command 221. The 31 characters (0 through 30) in this PIN provide information about the configuration of the unit. You can also retrieve the PIN using Virtual Front Panel (VFP). Character 8 indicates the User port installed in the unit.

Example PIN: 2 2 3 2 1 0 0 1 2 2 2 1 1 0 1 1 2 7 1 1 1 0 0 0 0 0 0 0 0 0 0

Possible values for character 8 are:

- 2 = Apex compatible User port
- 9 = Apex G compatible User port
- 3 = RFG compatible User port
- 8 = Custom 1 User port

25-Pin User Port Connector

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

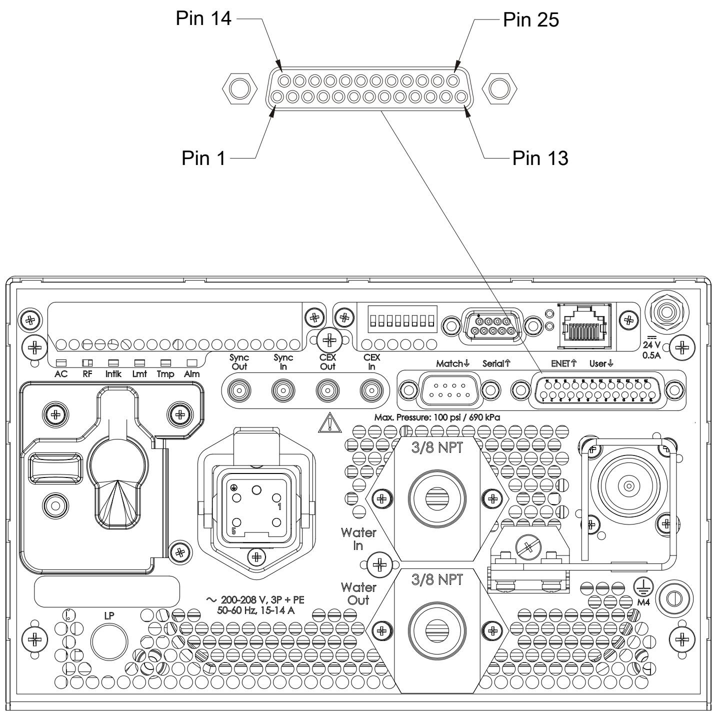


Figure 4-1. User port connector, 25 pin

Unless otherwise specified, all analog signals are 0 V to 10 V, opto-coupled (open-collector signals with return lines nonreferenced to ground). All digital signals range from 0 V to 24 V, with the high range typically 4 V to 24 V, and the low range typically 0 V to 1 V. Digital signals are also opto-coupled.

Ground/return lines are floating and need to be connected as close to the system as possible. Grounding the **User** port at the generator reduces noise interference. To avoid ground loop problems, you should typically ground only one end of the **User** port cable.

Satisfying **User** Port Minimal Requirements

Regardless of whether you are controlling and monitoring the generator through the **User** port or through another port, *RF PWR ON* and interlock must be satisfied. Check the applicable user port section for pin assignments.

☞ **Important**

If you are controlling your generator through a port other than the **User** port, make sure that the control mode is set appropriately (to host mode to control through the host port, for example). The control mode can be set through an AE host command.

If you are not using the **User** port to control or monitor the unit, you can use a "dummy" or "cheater" plug to satisfy these signals, thereby ignoring the **User** port. To make a dummy plug, as seen in the following example for Apex or RFG user port operation, solder three jumpers on a mating connector:

Table 4-2. Jumpers on a dummy plug to satisfy minimal signal requirements

Jumper Between Pins	Description
4 and 13	Satisfies *RF PWR ON* signal
10 and 23	Satisfies *INTERLOCK LOOP* signal
17 and 21	Connects *RF ON RETURN* and *GROUND*

Some configurations allow for the unit to turn on even if the **User** port ON signal is not satisfied.

If desired, you can add an emergency off switch in series with the *RF PWR ON* signal (pin 4) and/or tie your system interlocks in series with the generator *INTERLOCK LOOP* signal (pins 10 and 23).

User Port Cabling Requirements

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

Apex Compatible 25-Pin User Port

Some Paramount generators have an Apex compatible 25-pin **User** port. Other units have other 25-pin **User** ports. To determine if your unit has the Apex compatible 25-pin **User** port, use the following configuration note.

ATTENTION:

CONFIGURATION NOTE

To determine which User port a unit has, you can access the product identification number (PIN) that the unit returns when it receives command 221. The 31 characters (0 through 30) in this PIN provide information about the configuration of the unit. You can also retrieve the PIN using Virtual Front Panel (VFP). Character 8 indicates the User port installed in the unit.

Example PIN: 2 2 3 2 1 0 0 1 2 2 2 1 1 0 1 1 2 7 1 1 1 0 0 0 0 0 0 0 0 0 0

Possible values for character 8 are:

- 2 = Apex compatible User port
- 9 = Apex G compatible User port
- 3 = RFG compatible User port
- 8 = Custom 1 User port

PIN DESCRIPTIONS FOR APEX COMPATIBLE USER PORT

*Table 4-3. 25-pin Apex **User** port pin descriptions*

Signal Pin	Related Pin	Name	Signal Type	Description
1	14	*SETPOINT STATUS RETURN*	Digital output	See pin 14.
2	15	*RFL PWR MONITOR*	Analog output	This signal provides a linearly scaled read back of reflected power. 0 V to 10 V = 0 to maximum rated power output. Pin 15 must be grounded.
3	16	*FWD/LOAD PWR MONITOR*	Analog output	This signal provides a linearly scaled read back of forward power when the generator is operated in forward power regulation mode or the load power when operated in the load power regulation mode. 0 V to 10 V = 0 to maximum rated power output. Pin 16 must be grounded.
4	17	*RF PWR ON*	Digital input	Applying a positive voltage from 4 VDC to 24 VDC enables RF output. When voltage is less than 1 VDC, RF output is disabled.

Table 4-3. 25-pin Apex ***User*** *port pin descriptions (Continued)*

Signal Pin	Related Pin	Name	Signal Type	Description
				☞ **Important** The interlocks must be satisfied and the setpoint must be within the output power range before unit will deliver power.
5	18	*SETPOINT*	Analog input	This pin linearly controls the RF output of the generator. 0 V to 10 V = 0 to maximum rated power output. ☞ **Important** Setpoint must be greater than the low power limit before the unit will deliver power.
6	19	*DC BIAS/ POWER REGULATION*	Digital input	This pin is used in conjunction with pin 7 to allow the generator to regulate its power based on an external feedback signal. Applying a positive voltage from 4 VDC to 24 VDC to this pin (reference to ground pin 19) causes the generator to regulate on the input voltage signal on pin 7 (*DC BIAS INPUT*). When voltage is less than 1 VDC, or if there is no connection to this pin, the generator regulates power.
7	20	*DC BIAS INPUT*	Analog input	This pin is used in conjunction with the signal on pin 6 to allow the generator to regulate its power based on an external feedback signal. This user-defined 0 V to 10 V signal provides an input which you can use for closing the power control loop around external components in the RF path. The unit usually uses Pin 7 for bias regulation with this input signal being a scaled representation of the DC bias measured at a match network.
8	21	*FWD/LOAD PWR REGULATION*	Digital input	Applying a positive voltage between 4 VDC and 24 VDC to this pin causes the generator to regulate on load power. When voltage is less than 1 VDC, or if there is no connection to this pin, the

*Table 4-3. 25-pin Apex **User** port pin descriptions   (Continued)*

Signal Pin	Related Pin	Name	Signal Type	Description
				generator defaults to forward power regulation.
9	22	*OVERTEMP RETURN*	Digital output	See pin 22.
10	23	*INTERLOCK LOOP*		External voltage interlock loop, internal voltage supplied. This pin, when connected externally to pin 23, closes the interlock and allows the RF output to be enabled. The external circuit should be capable of switching 100 mA at 24 VDC.
11	24	*DC BUS OK RETURN*	Digital output	See pin 24.
12	25	*CEX LOCK*	Digital output	When the generator is successfully phase-locked to an external oscillator, a low (opto-coupler output) impedance is created between this pin and return pin 25 (6 mA maximum).
13	21	*+15 VDC*		This pin, referenced to ground, provides a +15 VDC ± 1 V auxiliary supply for external use. 100 mA maximum.
14	1	*SETPOINT STATUS*	Digital output	When the generator is out of setpoint, a low (opto-coupler output) impedance is created between this pin and pin 1 (6 mA maximum).
15	2	*RFL POWER MONITOR RETURN*	Analog output	See pin 2.
16	3	*FWD/LOAD PWR MONITOR RETURN*	Analog output	See pin 3.
17	4	*RF PWR ON RETURN*	Digital input	See pin 4.
18	5	*SETPOINT RETURN*	Analog input	See pin 5.
19		*DC GROUND*	Analog output	This pin represents DC ground connection common to chassis ground.
20	7	*DC BIAS INPUT RETURN*	Analog input	See pin 7.

*Table 4-3. 25-pin Apex **User** port pin descriptions (Continued)*

Signal Pin	Related Pin	Name	Signal Type	Description
21		*CHASSIS GROUND*	Chassis ground	Chassis ground connection common to DC ground.
22	9	*OVERTEMP*	Digital output	When an internal overtemperature shutdown condition is detected, a low (opto-coupler output) impedance is created between this pin and pin 9 (6 mA maximum).
23	10	*INTERLOCK LOOP RETURN*		See pin 10.
24	11	*DC BUS OK*	Digital output	When the interlocks are satisfied, AC input voltage is within specification, and no generator faults exist, a low (opto-coupler output) impedance is created between this pin and pin 11 (6 mA maximum).
25	12	*CEX LOCK RETURN*	Digital output	See pin 12.

WIRING DIAGRAMS FOR APEX COMPATIBLE USER PORT

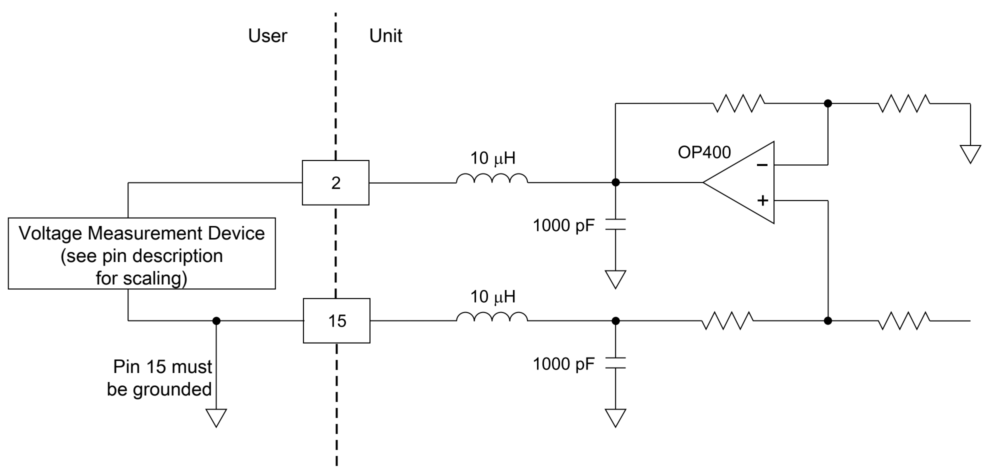


Figure 4-2. REFL PWR MONITOR (pins 2 and 15)

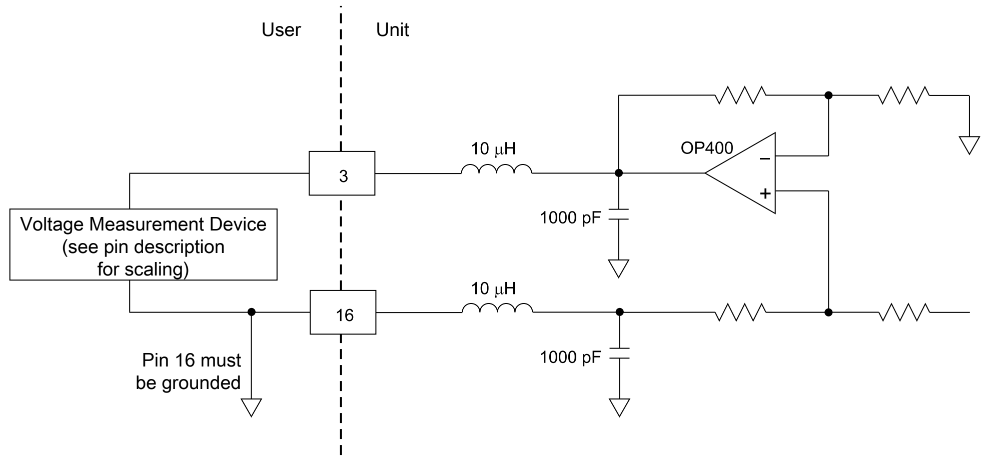


Figure 4-3. FWD/LOAD PWR MONITOR (pins 3 and 16)

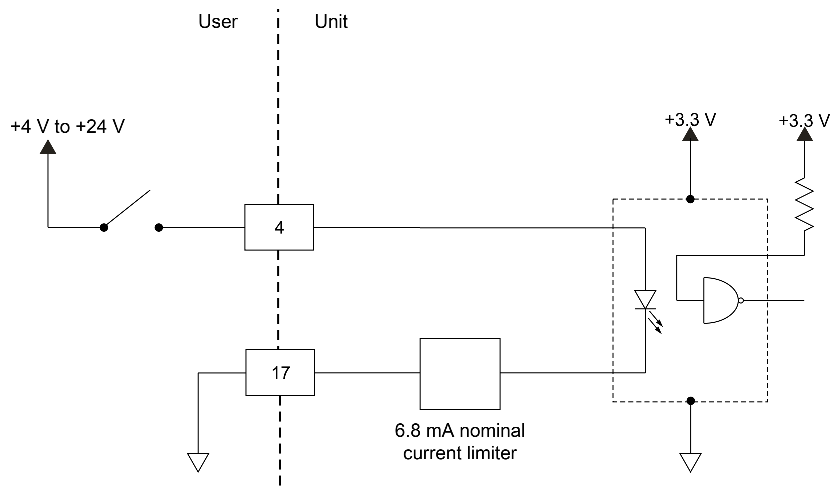


Figure 4-4. RF PWR ON (pins 4 and 17)

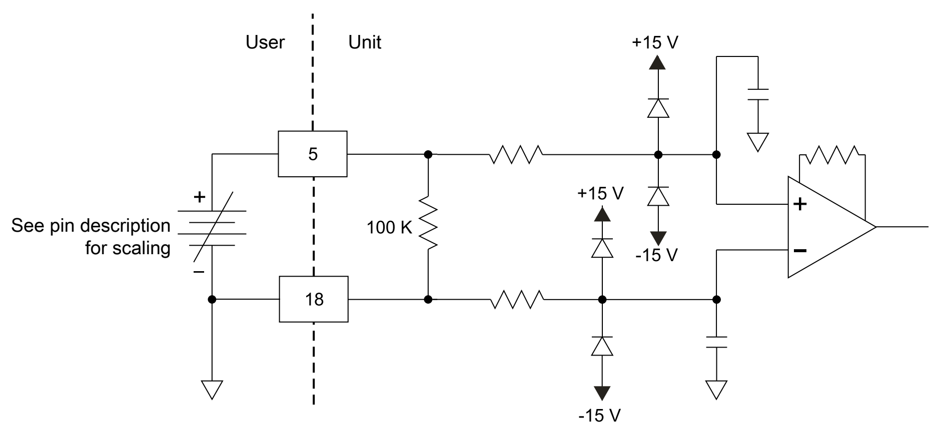


Figure 4-5. SETPOINT (pins 5 and 18)

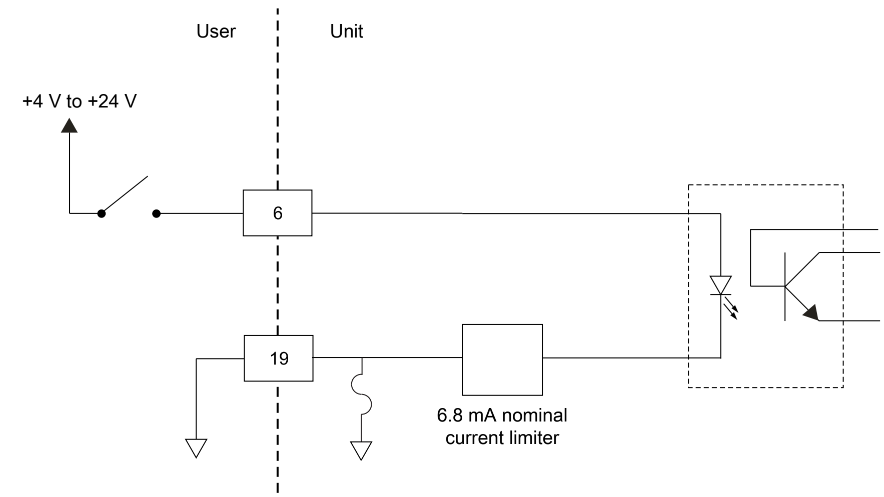


Figure 4-6. DC BIAS/POWER REGULATION (pins 6 and 19)

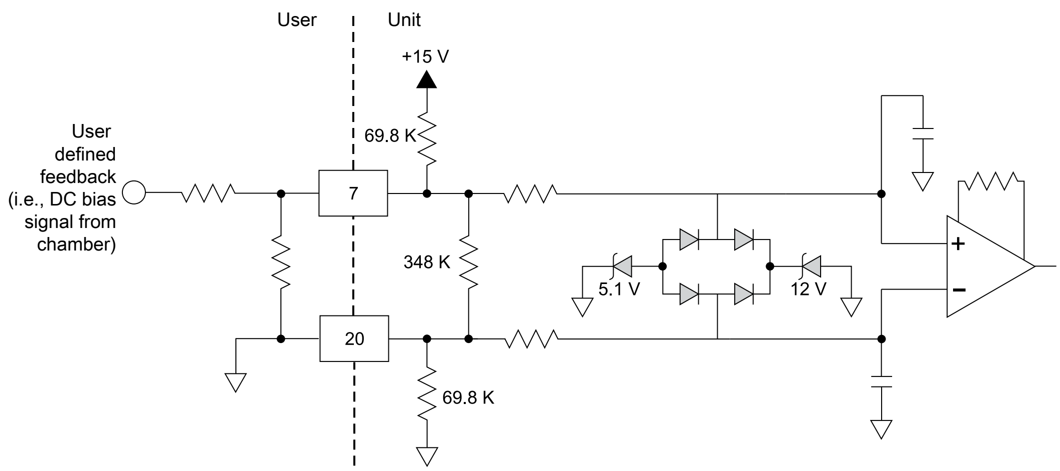


Figure 4-7. DC BIAS INPUT (pins 7 and 20)

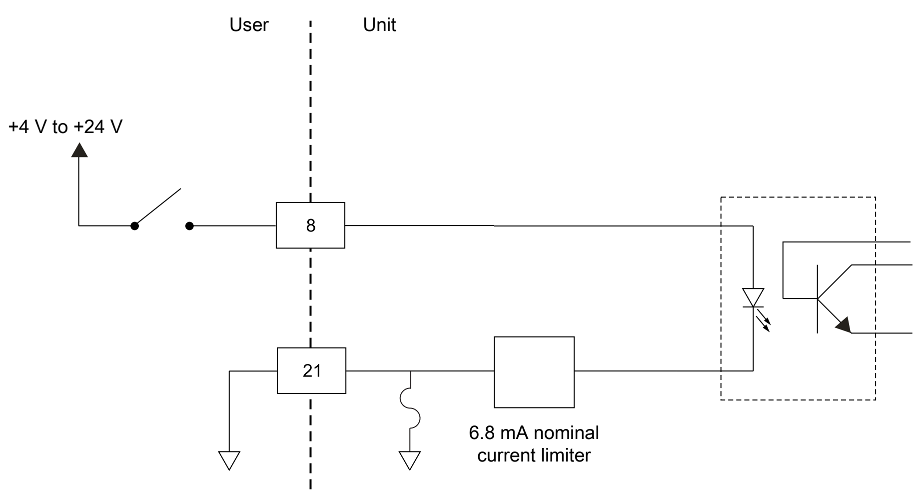


Figure 4-8. FWD/LOAD PWR REGULATION (pins 8 and 21)

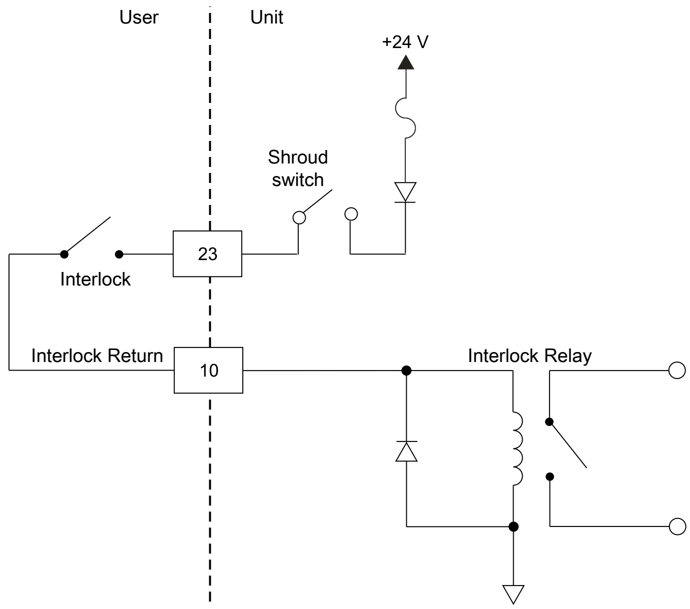


Figure 4-9.   INTERLOCK LOOP (pins 23 and 10)

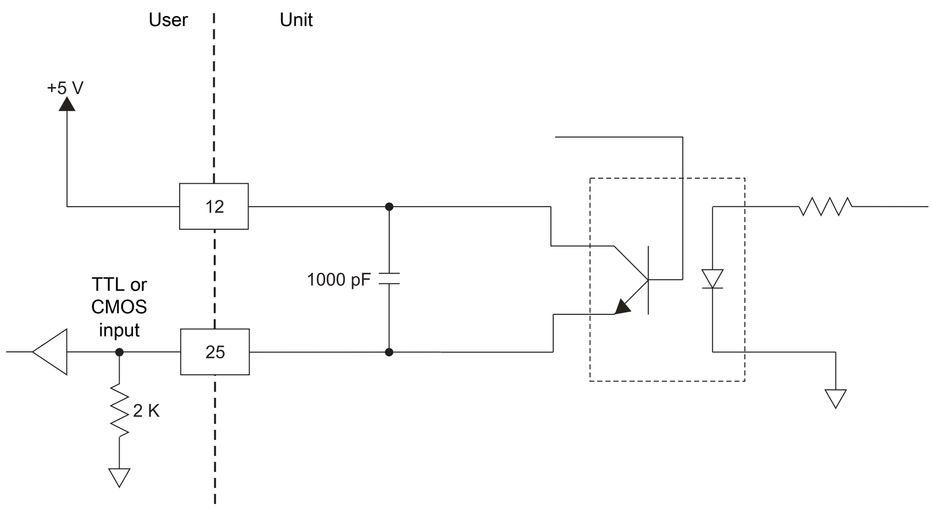


Figure 4-10.   CEX LOCK (pins 12 and 25)

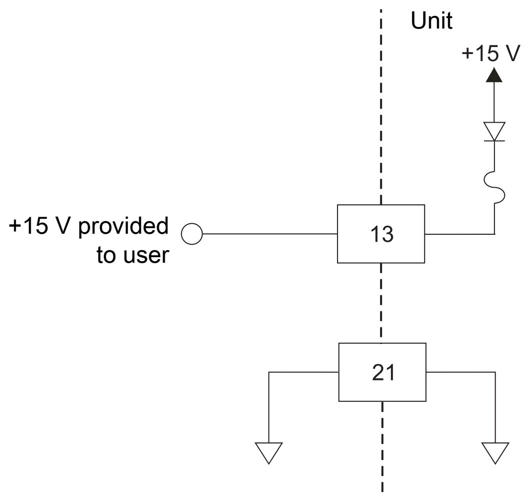


Figure 4-11. +15 VDC (pins 13 and 21)

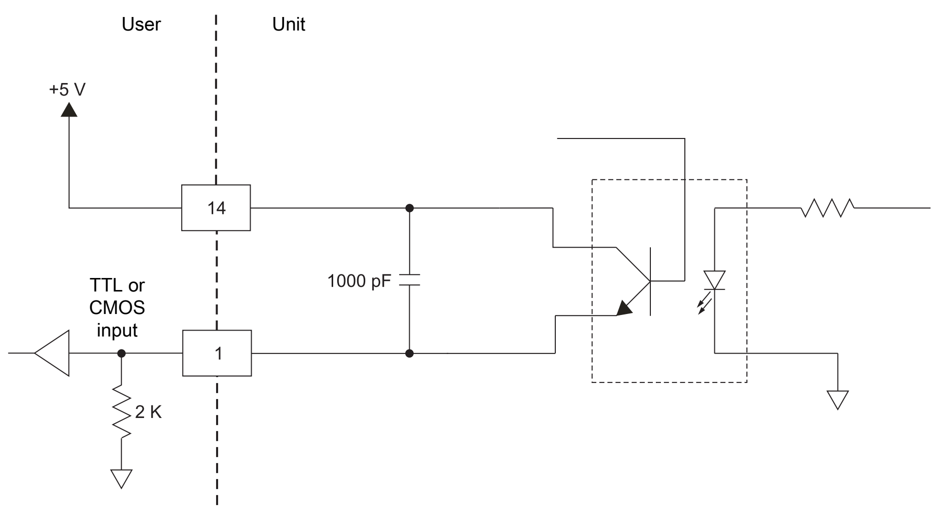


Figure 4-12. SETPOINT STATUS (pins 14 and 1)

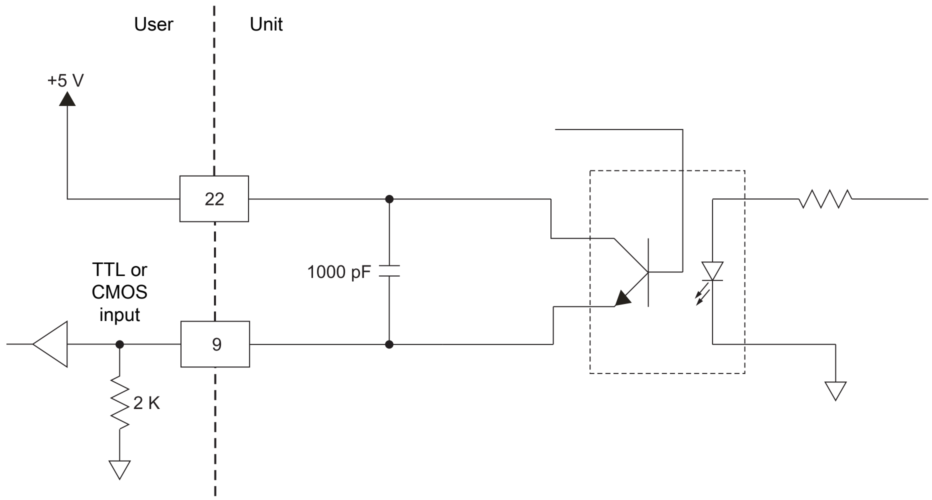


Figure 4-13. OVERTEMP (pins 22 and 9)

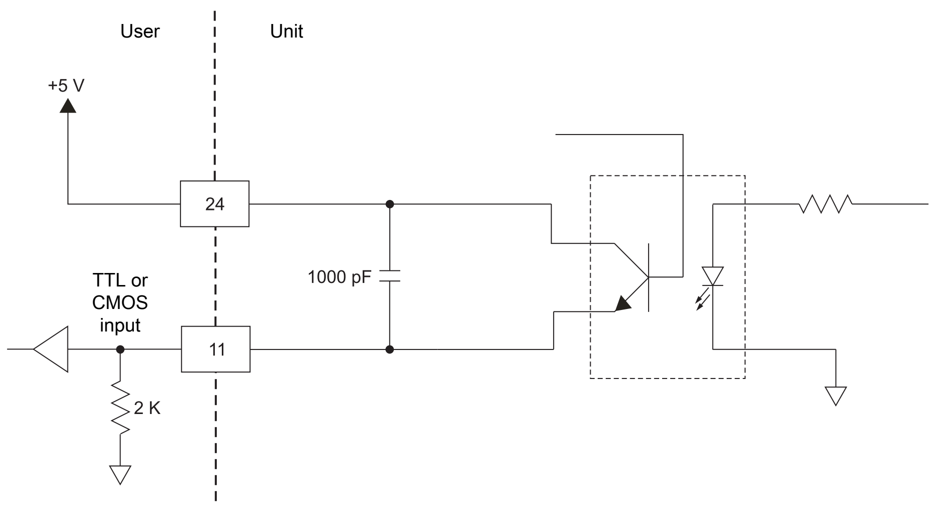


Figure 4-14. DC BUS OK (pins 24 and 11)

Apex G Compatible 25-Pin **User** Port

Some Paramount generator units have an Apex G compatible 25-pin **User** port. Other units have other 25-pin **User** ports. To determine if your unit has the Apex G compatible 25-pin **User** port, use the following configuration note.

ATTENTION:

CONFIGURATION NOTE

To determine which User port a unit has, you can access the product identification number (PIN) that the unit returns when it receives command 221. The 31 characters (0 through 30) in this PIN provide information about the configuration of the unit. You can also retrieve the PIN using Virtual Front Panel (VFP). Character 8 indicates the User port installed in the unit.

Example PIN: 2 2 3 2 1 0 0 1 2 2 2 1 1 0 1 1 2 7 1 1 1 0 0 0 0 0 0 0 0 0 0

Possible values for character 8 are:

- 2 = Apex compatible User port
- 9 = Apex G compatible User port
- 3 = RFG compatible User port
- 8 = Custom 1 User port

PIN DESCRIPTIONS FOR APEX G COMPATIBLE USER PORT

Table 4-4. 25-pin Apex G ***User*** *port pin descriptions*

Signal Pin	Related Pin	Name	Signal Type	Description
1	14	*SETPOINT STATUS RETURN*	Digital output	See pin 14.
2	15	*RFL PWR MONITOR*	Analog output	This signal provides a linearly scaled read back of reflected power. 0 V to 10 V = 0 to maximum rated power output. Pin 15 must be grounded.
3	16	*FWD/LOAD PWR MONITOR*	Analog output	This signal provides a linearly scaled read back of forward power when the generator is operated in forward power regulation mode or the load power when operated in the load power regulation mode. 0 V to 10 V = 0 to maximum rated power output. Pin 16 must be grounded.
4	17	*RF PWR ON*	Digital input	Applying a positive voltage from 4 VDC to 24 VDC enables RF output. When voltage is less than 1 VDC, RF output is disabled.

*Table 4-4. 25-pin Apex G **User** port pin descriptions (Continued)*

Signal Pin	Related Pin	Name	Signal Type	Description
				☞ **Important** The interlocks must be satisfied and the setpoint must be within the output power range before unit will deliver power.
5	18	*SETPOINT*	Analog input	This pin linearly controls the RF output of the generator. 0 V to 10 V = 0 to maximum rated power output. ☞ **Important** Setpoint must be greater than the low power limit before the unit will deliver power.
6	19	*DC BIAS/ POWER REGULATION*	Digital input	This pin is used in conjunction with pin 7 to allow the generator to regulate its power based on an external feedback signal. Applying a positive voltage from 4 VDC to 24 VDC to this pin (reference to ground pin 19) causes the generator to regulate on the input voltage signal on pin 7 (*DC BIAS INPUT*). When voltage is less than 1 VDC, or if there is no connection to this pin, the generator regulates power.
7	20	*DC BIAS INPUT*	Analog input	This pin is used in conjunction with the signal on pin 6 to allow the generator to regulate its power based on an external feedback signal. This user-defined 0 V to 10 V signal provides an input which you can use for closing the power control loop around external components in the RF path. The unit usually uses Pin 7 for bias regulation with this input signal being a scaled representation of the DC bias measured at a match network.
8	21	*FWD/LOAD PWR REGULATION*	Digital input	Applying a positive voltage between 4 VDC and 24 VDC to this pin causes the generator to regulate on load power. When voltage is less than 1 VDC, or if there is no connection to this pin, the

Table 4-4. 25-pin Apex G ***User*** *port pin descriptions (Continued)*

Signal Pin	Related Pin	Name	Signal Type	Description
				generator defaults to forward power regulation.
9	22	*OVERTEMP RETURN*	Digital output	See pin 22.
10	23	*INTERLOCK LOOP*		External voltage interlock loop, internal voltage supplied. This pin, when connected externally to pin 23, closes the interlock and allows the RF output to be enabled. The external circuit should be capable of switching 100 mA at 24 VDC.
11	24	*DC BUS OK RETURN*	Digital output	See pin 24.
12	25	*RF ON STATUS*	Digital output	When RF is on, a low impedance path is generated between pin 12 (opto-coupler output) and pin 25 (opto-coupler return). 6 mA maximum.
13	21	*+15 VDC*		This pin, referenced to ground, provides a +15 VDC ± 1 V auxiliary supply for external use. 100 mA maximum.
14	1	*SETPOINT STATUS*	Digital output	When the generator is out of setpoint, a low (opto-coupler output) impedance is created between this pin and pin 1 (6 mA maximum).
15	2	*RFL POWER MONITOR RETURN*	Analog output	See pin 2.
16	3	*FWD/LOAD PWR MONITOR RETURN*	Analog output	See pin 3.
17	4	*RF PWR ON RETURN*	Digital input	See pin 4.
18	5	*SETPOINT RETURN*	Analog input	See pin 5.
19		*DC GROUND*	Analog output	This pin represents DC ground connection common to chassis ground.
20	7	*DC BIAS INPUT RETURN*	Analog input	See pin 7.
21		*CHASSIS GROUND*	Chassis ground	Chassis ground connection common to DC ground.

*Table 4-4. 25-pin Apex G **User** port pin descriptions (Continued)*

Signal Pin	Related Pin	Name	Signal Type	Description
22	9	*OVERTEMP*	Digital output	When an internal overtemperature shutdown condition is detected, a low (opto-coupler output) impedance is created between this pin and pin 9 (6 mA maximum).
23	10	*INTERLOCK LOOP RETURN*		See pin 10.
24	11	*DC BUS OK*	Digital output	When the interlocks are satisfied, AC input voltage is within specification, and no generator faults exist, a low (opto-coupler output) impedance is created between this pin and pin 11 (6 mA maximum).
25	12	*RF ON STATUS RETURN*	Digital output	See pin 12.

WIRING DIAGRAMS FOR APEX G COMPATIBLE USER PORT

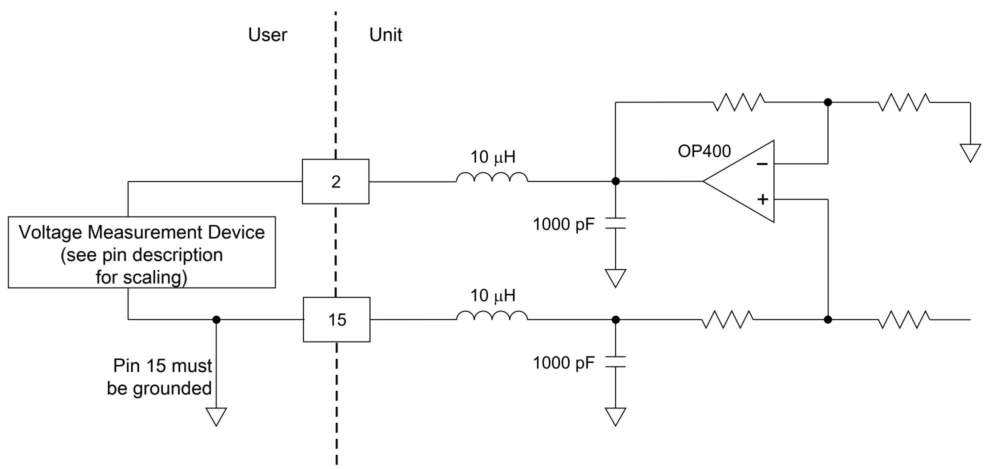


Figure 4-15. REFL PWR MONITOR (pins 2 and 15)

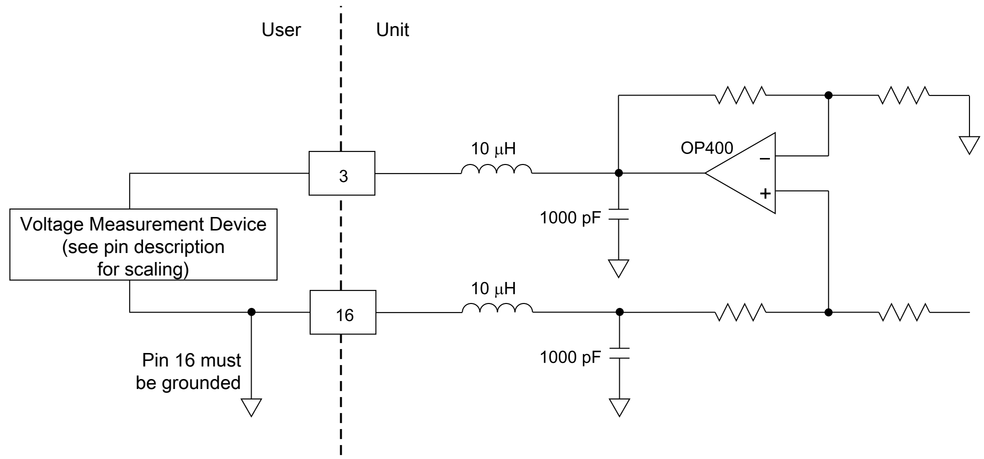


Figure 4-16. FWD/LOAD PWR MONITOR (pins 3 and 16)

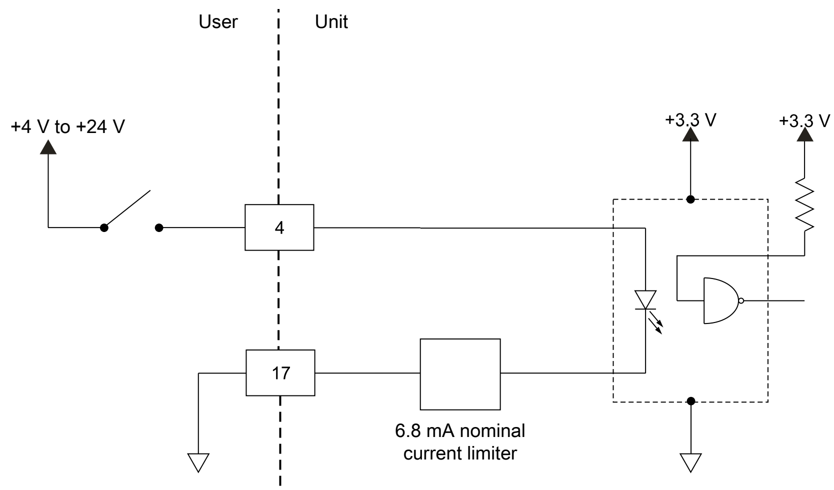


Figure 4-17. RF PWR ON (pins 4 and 17)

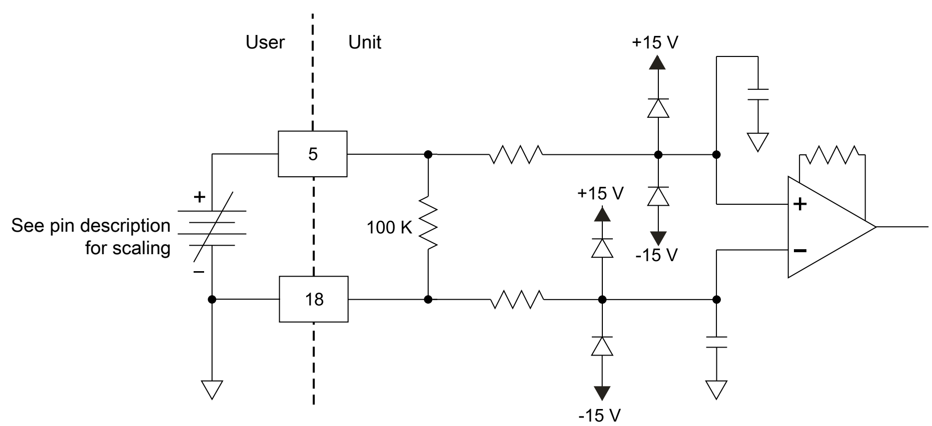


Figure 4-18. SETPOINT (pins 5 and 18)

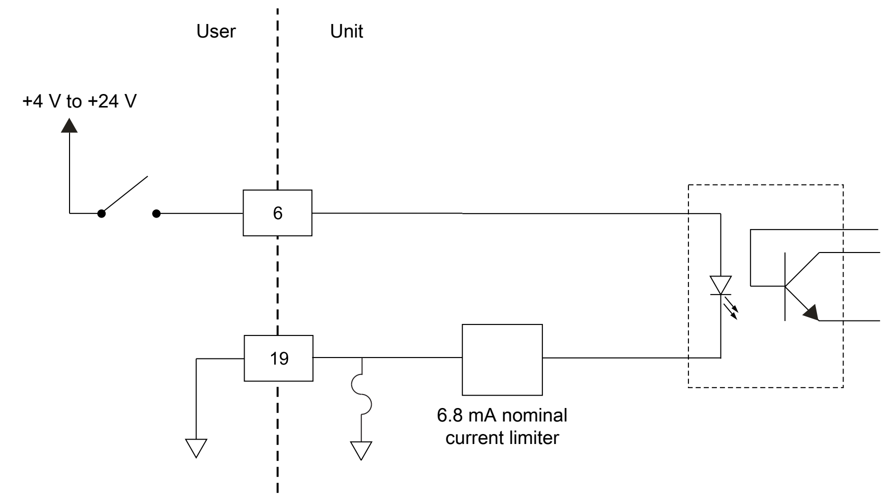


Figure 4-19. DC BIAS/POWER REGULATION (pins 6 and 19)

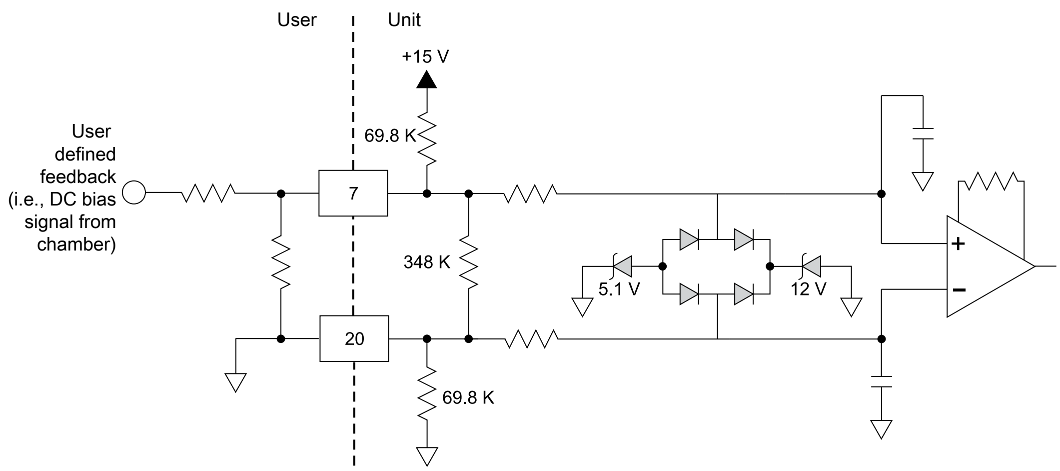


Figure 4-20. DC BIAS INPUT (pins 7 and 20)

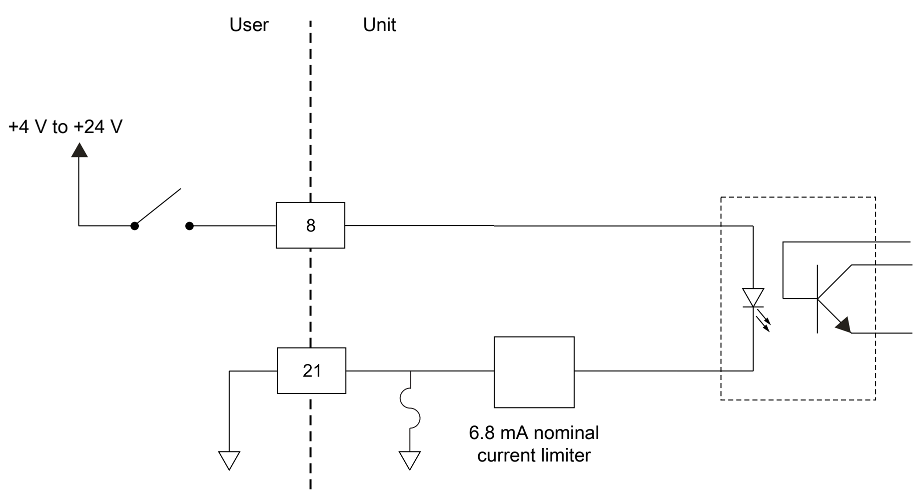


Figure 4-21. FWD/LOAD PWR REGULATION (pins 8 and 21)

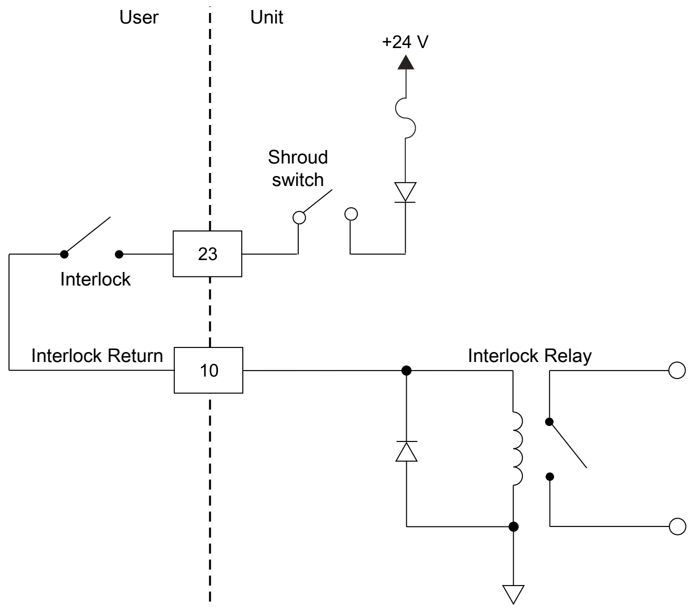


Figure 4-22. INTERLOCK LOOP (pins 23 and 10)

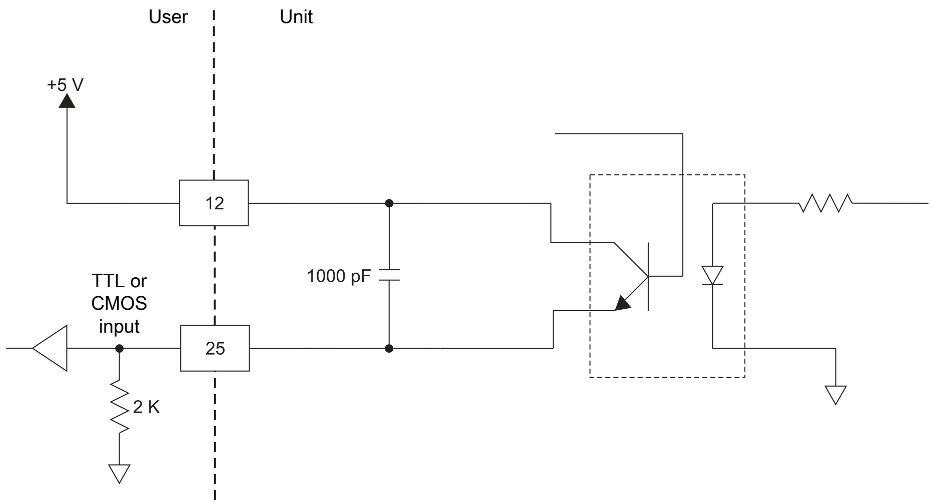


Figure 4-23. RF ON STATUS (pins 12 and 25)

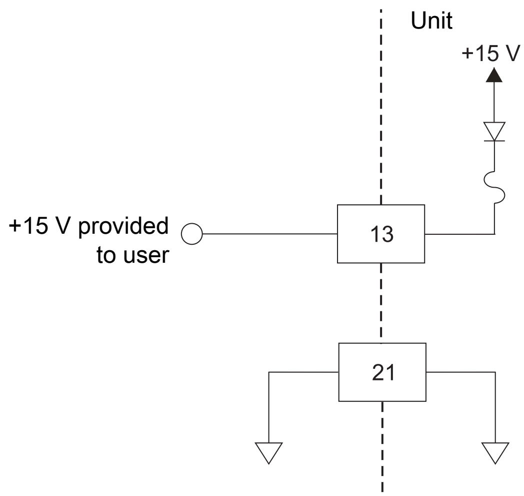


Figure 4-24. *+15 VDC (pins 13 and 21)*

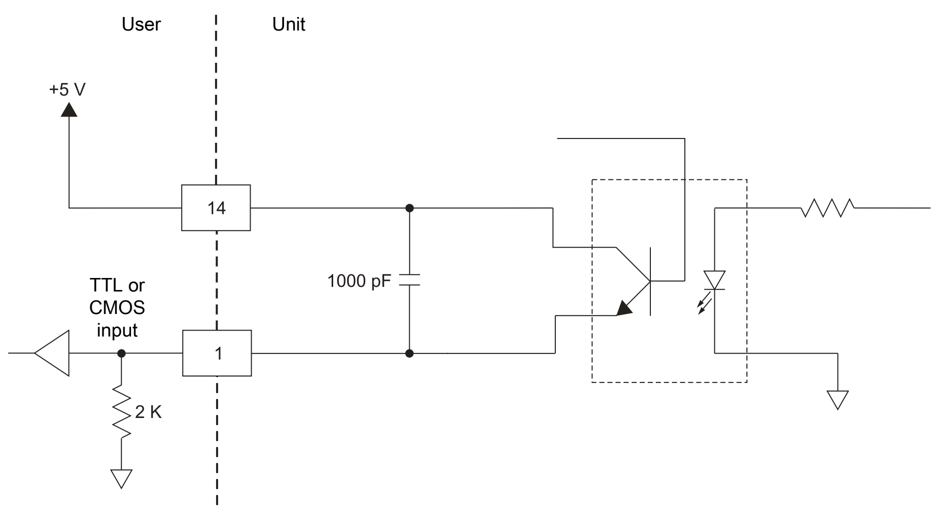


Figure 4-25. *SETPOINT STATUS (pins 14 and 1)*

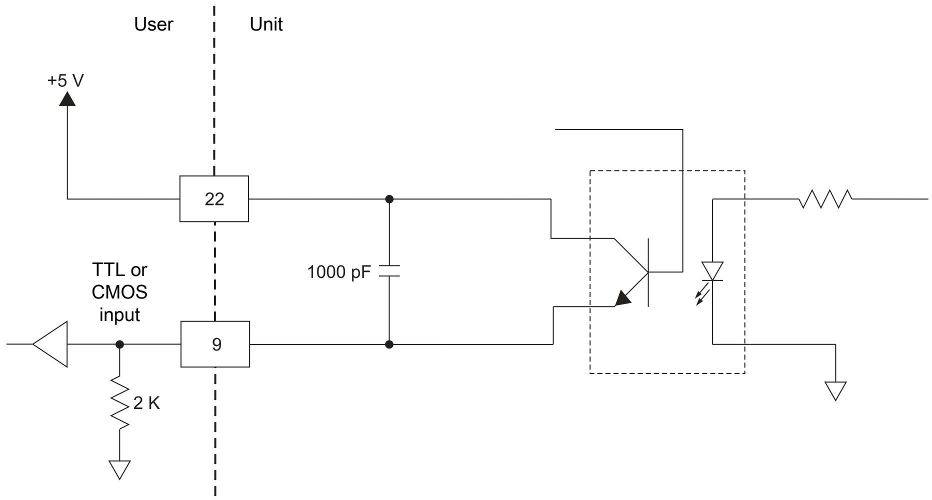


Figure 4-26. *OVERTEMP (pins 22 and 9)*

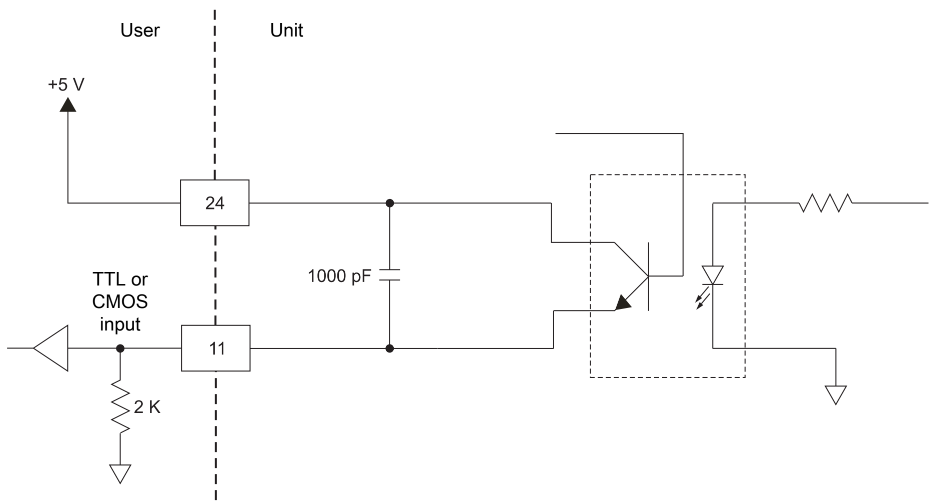


Figure 4-27. *DC BUS OK (pins 24 and 11)*

RFG Compatible 25-Pin **User** Port

Some Paramount generator units have an RFG compatible 25-pin **User** port. Other units have other 25-pin **User** ports. To determine if your unit has the RFG compatible 25-pin **User** port, use the following configuration note.

ATTENTION:

CONFIGURATION NOTE

To determine which User port a unit has, you can access the product identification number (PIN) that the unit returns when it receives command 221. The 31 characters (0 through 30) in this PIN provide information about the configuration of the unit. You can also retrieve the PIN using Virtual Front Panel (VFP). Character 8 indicates the User port installed in the unit.

Example PIN: 2 2 3 2 1 0 0 1 2 2 2 1 1 0 1 1 2 7 1 1 1 0 0 0 0 0 0 0 0 0 0

Possible values for character 8 are:

- 2 = Apex compatible User port
- 9 = Apex G compatible User port
- 3 = RFG compatible User port
- 8 = Custom 1 User port

PIN DESCRIPTIONS FOR RFG COMPATIBLE USER PORT

*Table 4-5. 25-pin RFG **User** port pin descriptions*

Signal Pin	Related Pin	Name	Signal Type	Description
1	14	*SETPOINT STATUS RETURN*	Digital output	See pin 14.
2	15	*RFL PWR MONITOR*	Analog output	This signal provides a linearly scaled read back of reflected power. 0 V to 10 V = 0 to maximum rated power output. For some units, this signal provides a linearly scaled read back of compensated reflected power at 0 V to 10 V = 0 W to 100 W. Pin 15 must be grounded.
3	16	*FWD/LOAD PWR MONITOR*	Analog output	This signal provides a linearly scaled read back of forward power when the generator is operated in forward power regulation mode, or of load power when operated in load power regulation mode. 0 V to 10 V = 0 to maximum rated power output. For some units, this signal provides a linearly scaled read back of compensated

*Table 4-5. 25-pin RFG **User** port pin descriptions (Continued)*

Signal Pin	Related Pin	Name	Signal Type	Description
				forward power when the generator is operated in forward power regulation mode or of compensated load power when operated in load power regulation mode. For these units, this signal is scaled at 0 V to 10 V = 0 W to 100 W. Pin 16 must be grounded.
4	17	*RF PWR ON*	Digital input	Applying a positive voltage from 4 VDC to 24 VDC enables RF output. When voltage is less than 1 VDC, RF output is disabled. ☞ **Important** The interlocks must be satisfied and the setpoint must be within the output power range before unit will deliver power.
5	18	*SET POINT*	Analog input	This pin linearly controls the RF output of the generator. 0 V to 10 V = 0 to maximum rated power output. For some units, this pin is scaled at 0 V to 10 V = 0 W to 100 W. ☞ **Important** Set point must be greater than the low power limit before the unit will deliver power.
6	21	*+ 24 VDC*		This pin, referenced to ground, provides a + 24 VDC ±1 V auxiliary supply for external use. 100 mA maximum.
7	20	*RF ON STATUS RETURN*	Digital output	See pin 20.
8	17	*FWD/LOAD PWR REGULATION*	Digital input	Applying a positive voltage between 4 VDC and 24 VDC to this pin causes the generator to regulate on load power. When voltage is less than 1 VDC, or if there is no connection to this pin, the generator defaults to forward power regulation.
9	22	*OVERTEMP RETURN*	Digital output	See pin 22.

*Table 4-5. 25-pin RFG **User** port pin descriptions (Continued)*

Signal Pin	Related Pin	Name	Signal Type	Description
10	23	*INTERLOCK LOOP*		External voltage interlock loop, internal voltage supplied. This pin, when connected externally to pin 23, closes the interlock and allows the RF output to be enabled. The external circuit should be capable of switching 100 mA at 24 VDC.
11	24	*DC BUS OK RETURN*	Digital output	See pin 24.
12	25	*CEX LOCK*	Digital output	When the generator is successfully phase-locked to an external oscillator, a low (opto-coupler output) impedance is created between this pin and return pin 25 (6 mA maximum).
13	21	*+15 VDC*		This pin, referenced to ground, provides a +15 VDC ± 1 V auxiliary supply for external use. 100 mA maximum.
14	1	*SETPOINT STATUS*	Digital output	When the generator is out of setpoint, a low (opto-coupler output) impedance is created between this pin and pin 1 (6 mA maximum).
15	2	*RFL POWER MONITOR RETURN*	Analog output	See pin 2.
16	3	*FWD/LOAD PWR MONITOR RETURN*	Analog output	See pin 3.
17	4, 8	*RF PWR ON* and *PWR REGULATION RETURN*	Digital input	See pin 4 or pin 8.
18	5	*SETPOINT RETURN*	Analog input	See pin 5.
19		*DC GROUND*	Analog output	This pin represents DC ground connection common to chassis ground.
20	7	*RF ON STATUS*	Digital output	When RF is on, a low impedance path is generated between pin 20 (opto-coupler output) and pin 7 (opto-coupler return). 6 mA maximum.
21		*CHASSIS GROUND*	Chassis ground	Chassis ground connection common to DC ground.

*Table 4-5. 25-pin RFG **User** port pin descriptions (Continued)*

Signal Pin	Related Pin	Name	Signal Type	Description
22	9	*OVERTEMP*	Digital output	When an internal overtemperature shutdown condition is detected, a low (opto-coupler output) impedance is created between this pin and pin 9 (6 mA maximum).
23	10	*INTERLOCK LOOP RETURN*		See pin 10.
24	11	*DC BUS OK*	Digital output	When the interlocks are satisfied, AC input voltage is within specification, and no generator faults exist, a low (opto-coupler output) impedance is created between this pin and pin 11 (6 mA maximum).
25	12	*CEX LOCK RETURN*	Digital output	See pin 12.

WIRING DIAGRAMS FOR RFG COMPATIBLE USER PORT

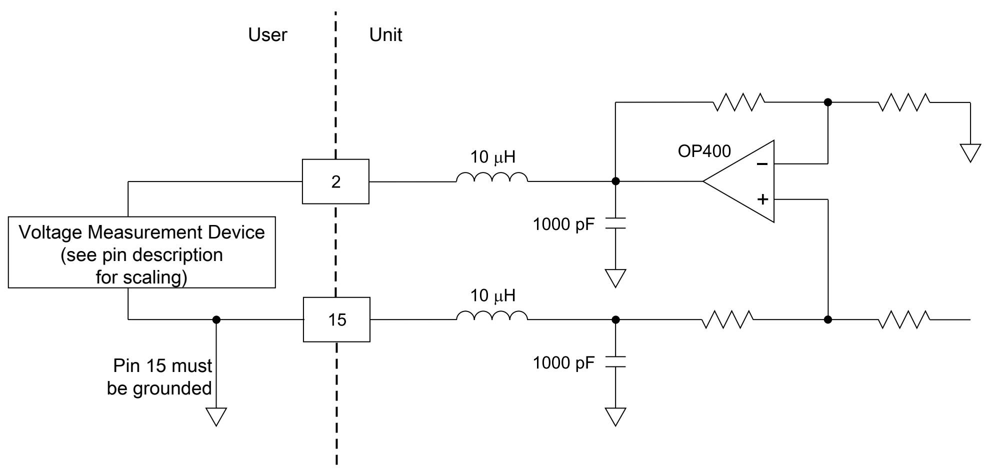


Figure 4-28. REFL PWR MONITOR (pins 2 and 15)

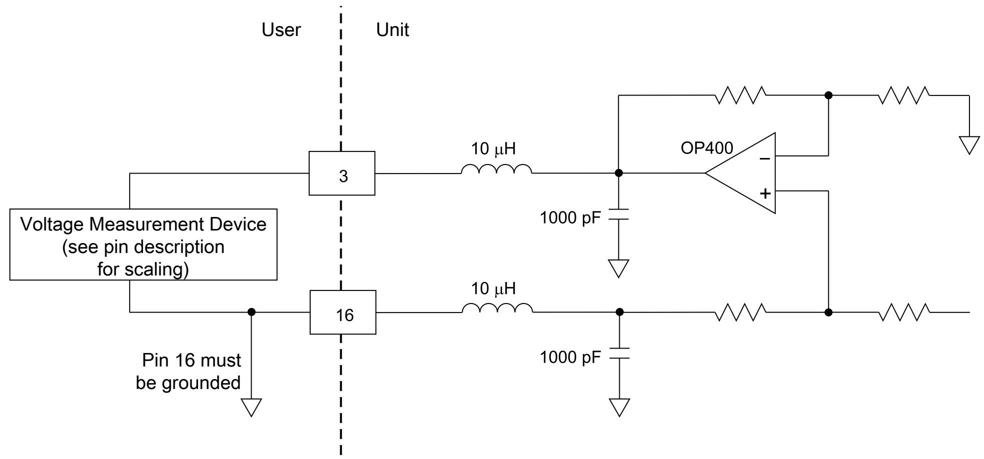


Figure 4-29. *FWD/LOAD PWR MONITOR (pins 3 and 16)*

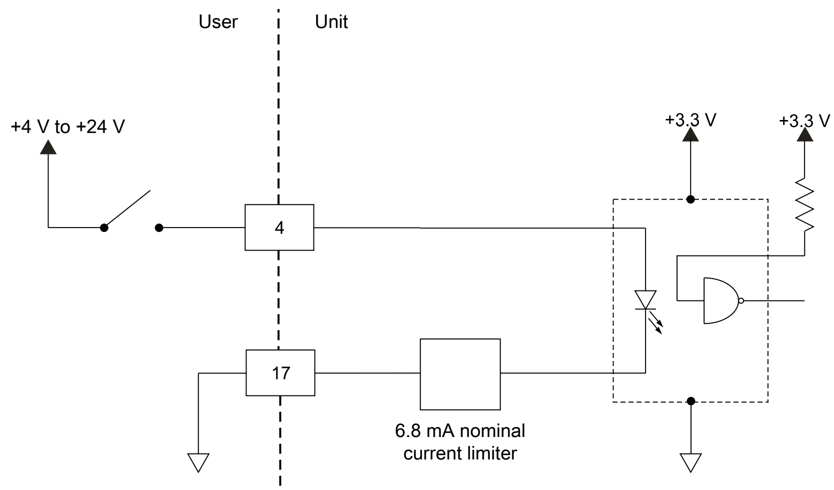


Figure 4-30. *RF PWR ON (pins 4 and 17)*

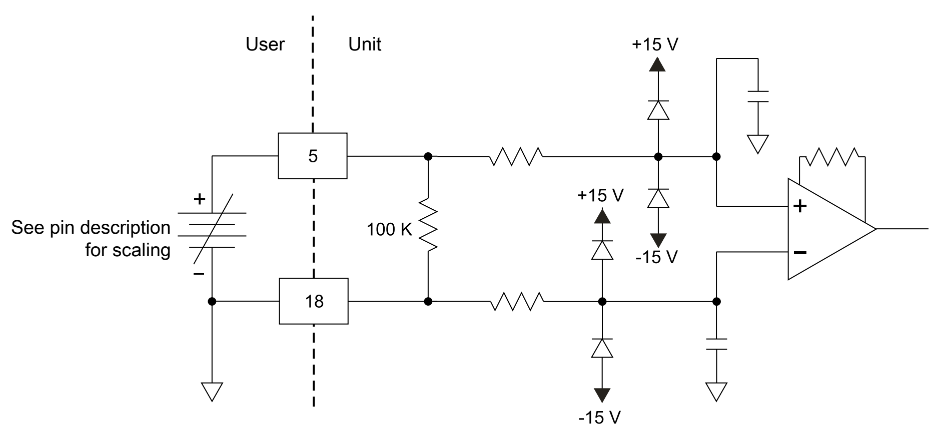


Figure 4-31. *SETPOINT (pins 5 and 18)*

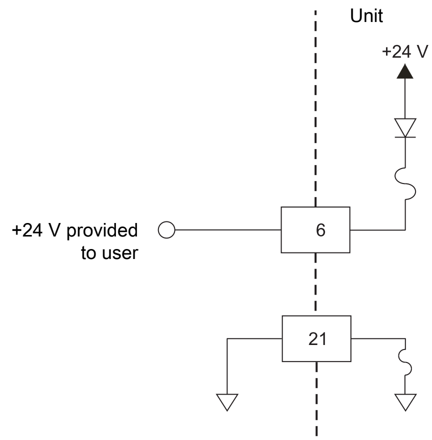


Figure 4-32. +24 VDC (pins 6 and 21)

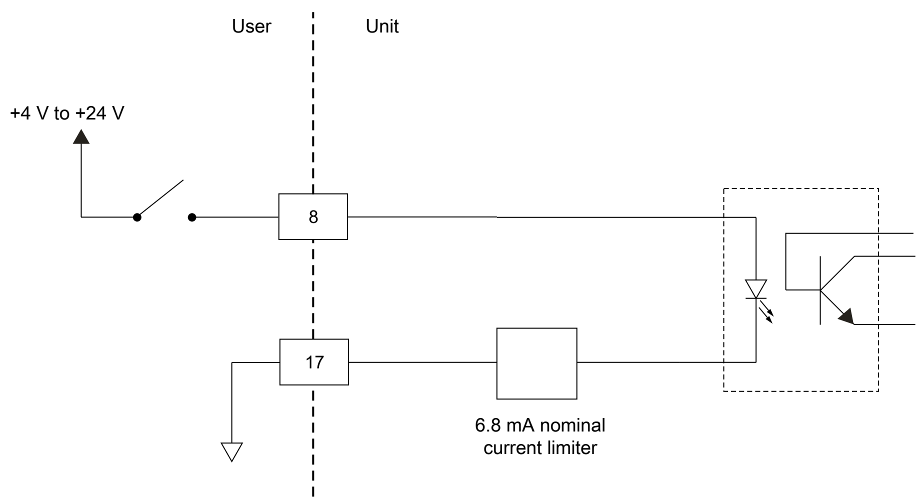


Figure 4-33. FWD/LOAD PWR REGULATION (pins 8 and 17)

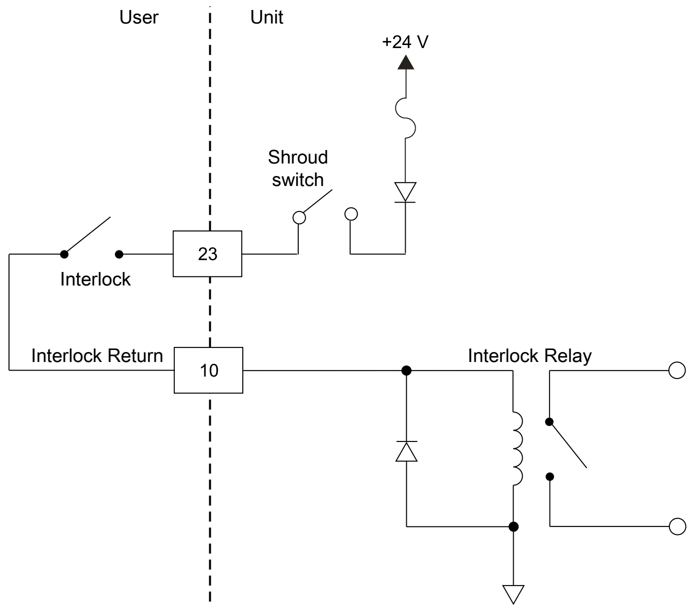


Figure 4-34. INTERLOCK LOOP (pins 23 and 10)

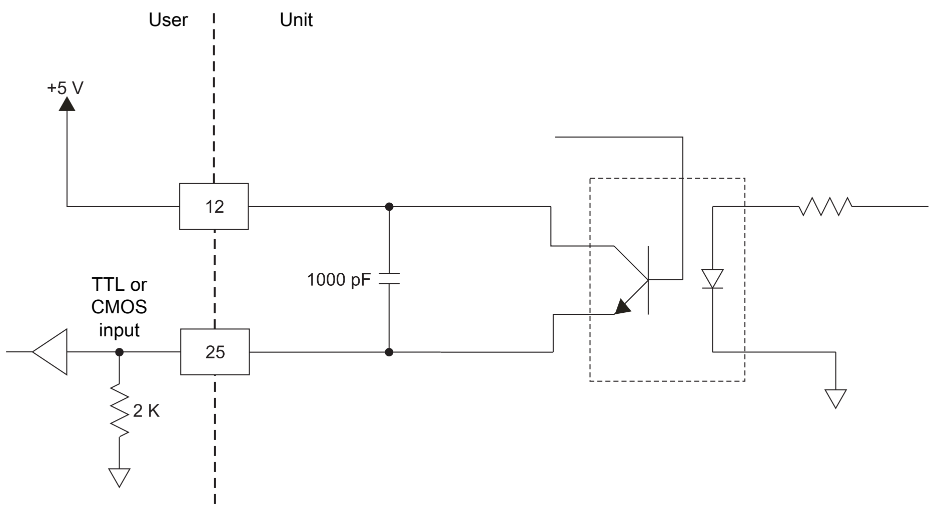


Figure 4-35. CEX LOCK (pins 12 and 25)

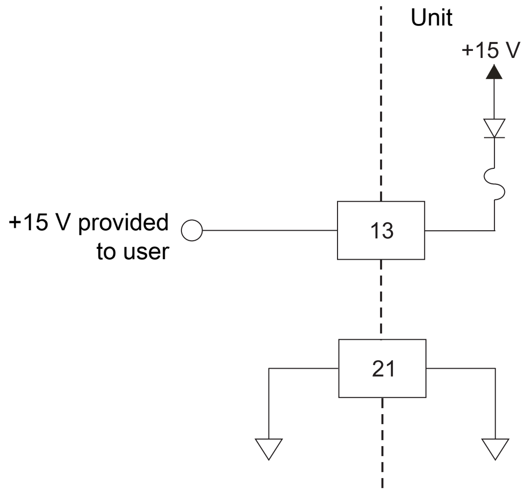


Figure 4-36. *+15 VDC (pins 13 and 21)*

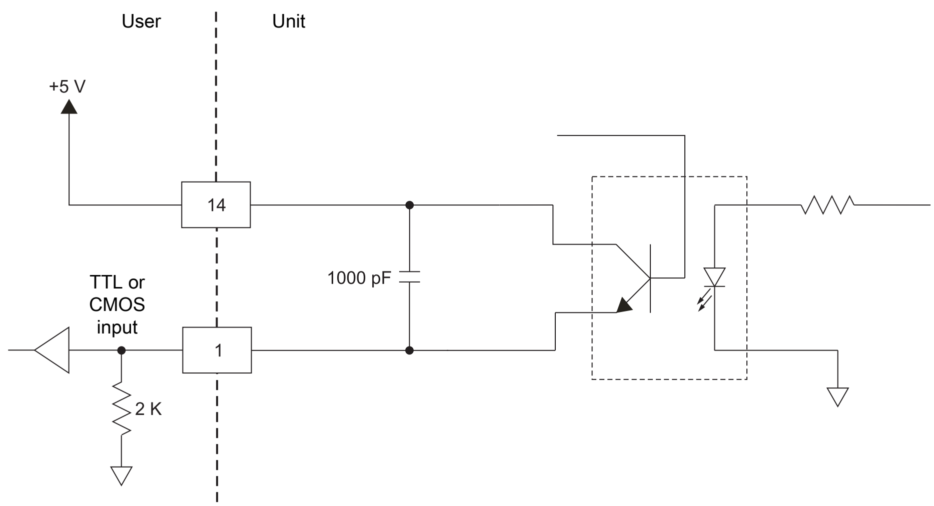


Figure 4-37. *SETPOINT STATUS (pins 14 and 1)*

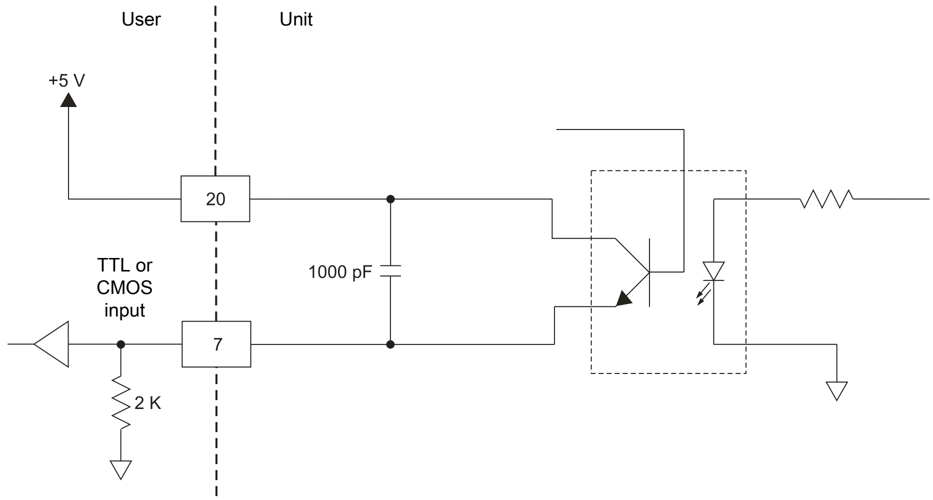


Figure 4-38. *RF ON STATUS (pins 20 and 7)*

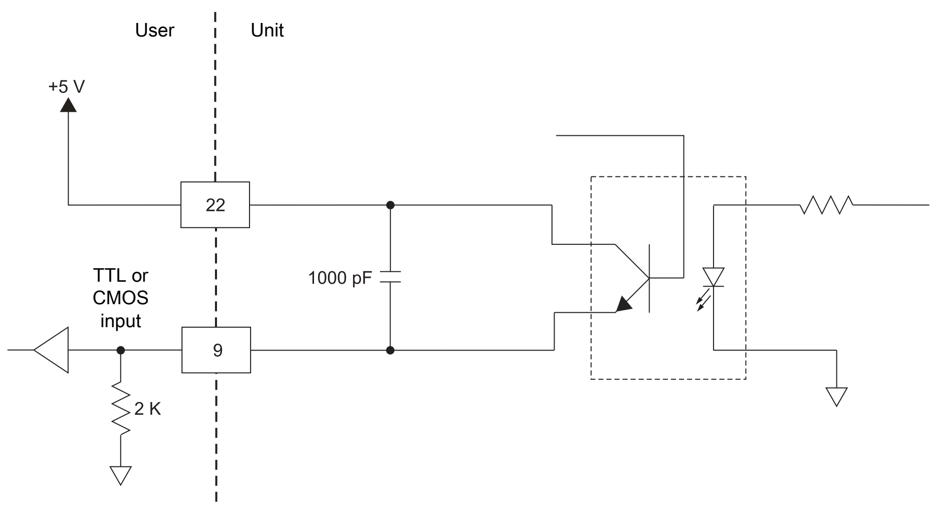


Figure 4-39. *OVERTEMP (pins 22 and 9)*

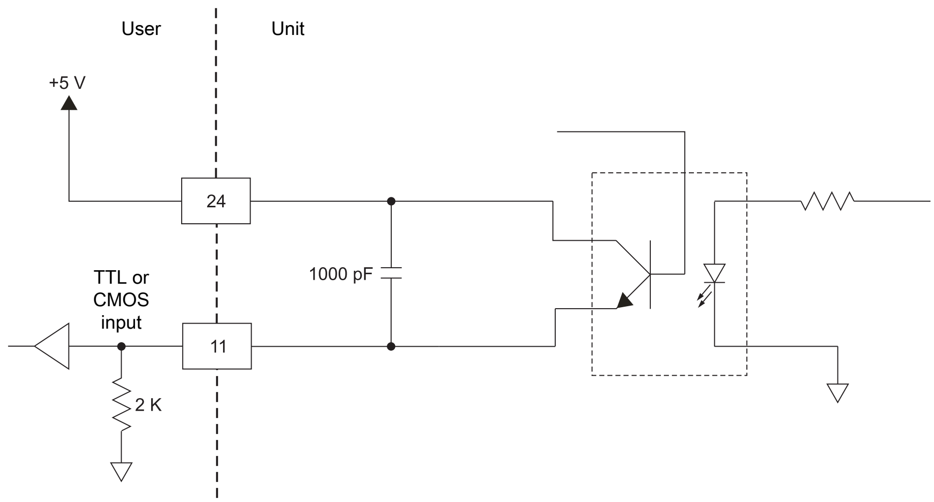


Figure 4-40. *DC BUS OK (pins 24 and 11)*

25-Pin Custom 1 User Port

Some Paramount generator units have a 25-pin Custom 1 **User** port. Other units have other 25-pin **User** ports. To determine if your unit has the 25-pin custom 1 **User** port, use the following configuration note.

ATTENTION:

CONFIGURATION NOTE

To determine which User port a unit has, you can access the product identification number (PIN) that the unit returns when it receives command 221. The 31 characters (0 through 30) in this PIN provide information about the configuration of the unit. You can also retrieve the PIN using Virtual Front Panel (VFP). Character 8 indicates the User port installed in the unit.

Example PIN: 2 2 3 2 1 0 0 1 2 2 2 1 1 0 1 1 2 7 1 1 1 0 0 0 0 0 0 0 0 0 0

Possible values for character 8 are:

- 2 = Apex compatible User port
- 9 = Apex G compatible User port
- 3 = RFG compatible User port
- 8 = Custom 1 User port

PIN DESCRIPTIONS FOR CUSTOM 1 USER PORT

For all isolated transistor outputs:

- Transistor off (switch open) - VCEmax = 30 VDC (IC < 500 µA)

- Transistor on (switch closed) - ICEmax = 10 mA (VCE < 2 V)

For all ground referenced logic level inputs:

- High = > 5 mA into 1000 Ω, 24 VDC maximum nominal voltage (30 VDC absolute maximum)
- Low = 0.0 VDC minimum to 0.3 VDC maximum, or open

*Table 4-6. 25-pin Custom 1 **User** port pin descriptions*

Signal Pin	Related Pin	Name	Signal Type	Description
1	14	*INTERLOCK LOOP RETURN*	Signal return for pin 14	Interlock loop for use with pin 14
2		*SIGNAL/ CHASSIS GROUND, PULSE OUTPUT SELECT, AND FREQUENCY SELECT RETURN*	Chassis ground	Single ended return path for pins 4 and 13. Return current maximum rating < 100 mA.
3	16	*FORWARD/ LOAD POWER REGULATION RETURN*	Signal return for pin 16	Signal return for pin 16
4	2	*RESERVED* or *FIXED/ VARIABLE FREQUENCY SELECT*	Digital input	No connection or Single ended input, return must be on pin 2, signal chassis ground. • Applying a positive DC voltage between 4 V and 24 V to this pin causes the generator to operate in variable frequency mode. • Applying < 300 mV DC or an open connection to this pin causes the generator to default to fixed frequency mode.
5	18	*RF POWER ON RETURN*	Signal return for pin 18	Signal return for pin 18

Table 4-6. 25-pin Custom 1 User port pin descriptions (Continued)

Signal Pin	Related Pin	Name	Signal Type	Description
6	19	*RF ON STATUS RETURN*	Signal return for pin 19	Signal return for pin 19
7	20	*GENERATOR STATUS RETURN*	Signal return for pin 20	Signal return for pin 20
8	21	*LOW SCALE ENABLE RETURN*	Signal return for pin 21	Signal return for pin 21
9	22	*SET POINT RETURN*	Signal return for pin 22	Signal return for pin 22
10	23	*DELIVERED POWER MONITOR RETURN*	Signal return for pin 23	Signal return for pin 23
11	24	*REFLECTED POWER MONITOR RETURN*	Signal return for pin 24	Signal return for pin 24
12	25	*FORWARD POWER MONITOR RETURN*	Signal return for pin 25	Signal return for pin 25
13	2	*PULSE OUTPUT SELECT*	Digital input	Single ended input, return must be on pin 2, signal chassis ground. • Applying a positive DC voltage between 4 V and 24 V to this pin causes the generator to operate in pulse mode. • Applying < 300 mV DC or an open connection to this pin causes the generator to default to normal power operation (no pulsing). The factory default values for pulsing frequency and duty cycle are both 0. These parameters must be changed to valid values through a host port or digital interface to enable pulsing mode operation.

*Table 4-6. 25-pin Custom 1 **User** port pin descriptions (Continued)*

Signal Pin	Related Pin	Name	Signal Type	Description
14	1	*INTERLOCK LOOP*	+24 V interlock supply voltage	This version includes a dry interlock box, which changes the function of the interlock loop to an RF cable sense switch. When this accessory is connected and no RF power cable is present, the user interface pins 14 and 1 are open. Connection of the RF power cable engages a mechanical switch which closes pins 14 and 1. With the dry interlock box removed, the following requirements apply: • External interlock circuit, internal voltage supplied. • An external closure between pins 14 and 1 is required to complete the interlock chain and enable generator power supply. • External circuit should be capable of switching 100 mA at 24 VDC.
15	2	*+15 VDC*	User voltage	User voltage for interface purposes. Rated 100 mA maximum. Return referenced to chassis ground on pin 2.
16	3	*FORWARD/ LOAD POWER REGULATION*	Digital input	Applying a positive DC voltage between 4 V and 24 V to this pin causes the generator to regulate on load power. Applying < 1 VDC or an open connection to this pin causes the generator to default to forward power regulation.
17	n/a	HF generator key	n/a	No connection
18	5	*RF POWER ON*	Digital input	When a positive voltage between 4 V and 24 V is applied to this pin, RF output is enabled. Once the output is on, a voltage of 1.5 VDC or less disables the RF output.
19	6	*RF ON STATUS*	Digital output	When RF power is on, a low (opto-coupler output) impedance is created between this pin and pin 6 (6 mA maximum).

Table 4-6. 25-pin Custom 1 User port pin descriptions (Continued)

Signal Pin	Related Pin	Name	Signal Type	Description
20	7	*GENERATOR STATUS*	Digital output	When a fault is active, a low (opto-coupler output) impedance is created between this pin and pin 7 (6 mA maximum).
21	8	*LOW SCALE ENABLE*	Digital input	Applying a positive DC voltage between 4 V and 24 V to this pin (return on pin 8) causes the generator to change the scaling of the following analog inputs and outputs as specified below: • *SET POINT* (see pin 22) • *DELIVERED POWER MONITOR* (see pin 23) • *REFLECTED POWER MONITOR* (see pin 24) • *FORWARD POWER MONITOR* (see pin 25) When low scale mode is enabled, the scaling of the signals specified above changes to the following: • From: 0 to 10 V = 0 to maximum rated power • To: 0 to 10 V = 0 to 1/10th of maximum rated power No connection to this pin causes the generator to default to 0 to 10 V = 0 to maximum rated power scaling.
22	9	*SET POINT*	Analog input	This pin linearly controls the RF output of the generator. Depending on the scaling set with pin 21: • 0 to 10 V = 0 to maximum rated power output • Or, in low scale mode: 0 to 10 V = 0 to 1/10th of maximum rated power output
23	10	*DELIVERED POWER MONITOR*	Analog output	This signal provides a linearly scaled readback of delivered power.

Table 4-6. 25-pin Custom 1 User port pin descriptions (Continued)

Signal Pin	Related Pin	Name	Signal Type	Description
				Depending on the scaling set with pin 21: • 0 to 10 V = 0 to maximum rated power output • Or, in low scale mode: 0 to 10 V = 0 to 1/10th of maximum rated power output
24	11	*REFLECTED POWER MONITOR*	Analog output	This signal provides a linearly scaled readback of reflected power. Depending on the scaling set with pin 21: • 0 to 10 V = 0 to maximum rated power output • Or, in low scale mode: 0 to 10 V = 0 to 1/10th of maximum rated power output
25	12	*FORWARD POWER MONITOR*	Analog output	This signal provides a linearly scaled readback of forward power. Depending on the scaling set with pin 21: • 0 to 10 V = 0 to maximum rated power output • Or, in low scale mode: 0 to 10 V = 0 to 1/10th of maximum rated power output

WIRING DIAGRAMS FOR CUSTOM 1 USER PORT

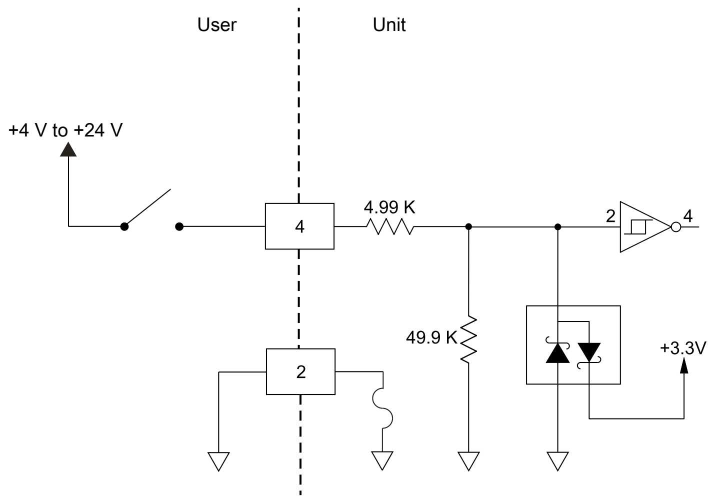


Figure 4-41. FIXED/VARIABLE FREQUENCY SELECT (pins 4 and 2)

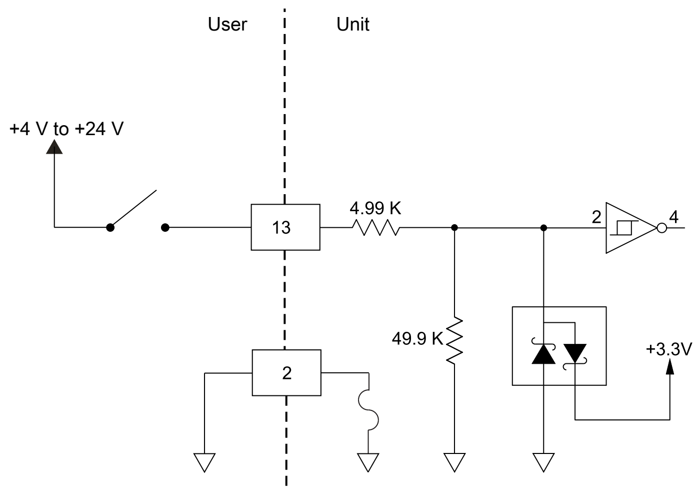
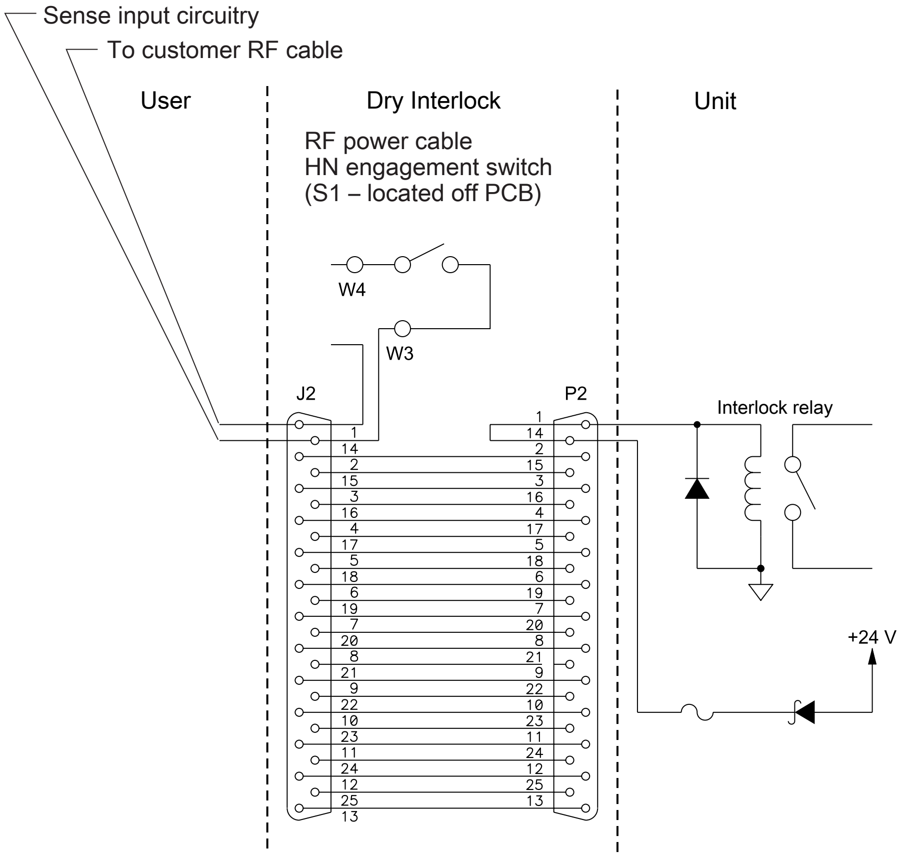


Figure 4-42. PULSE OUTPUT SELECT (pins 13 and 2)



*When RF cable HN connector is present on gerator side (S1 - open), pins 1 and 14 are closed.

**When RF cable HN connector is not present (S1 - open), pins 1 and 14 are open.

Figure 4-43.   INTERLOCK LOOP (pins 14 and 1)

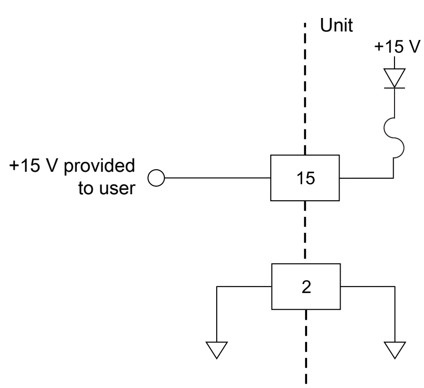


Figure 4-44.   +15 VDC (pins 15 and 2)

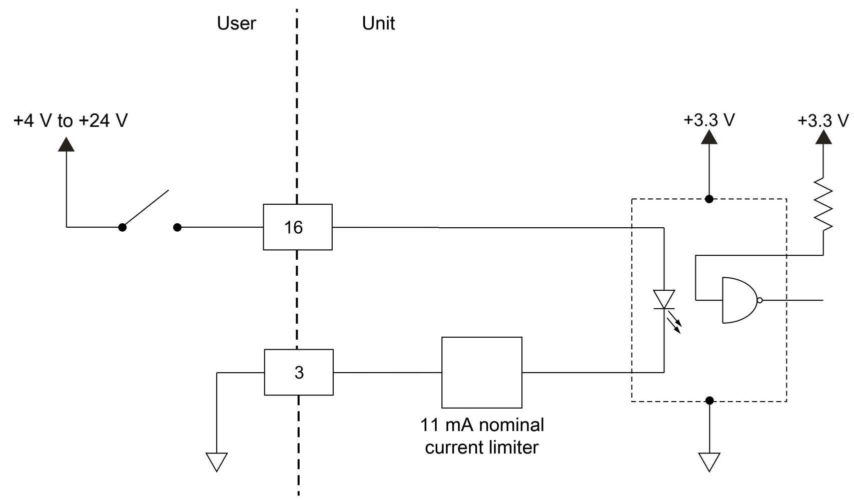


Figure 4-45. FORWARD/LOAD POWER REGULATION (pins 16 and 3)

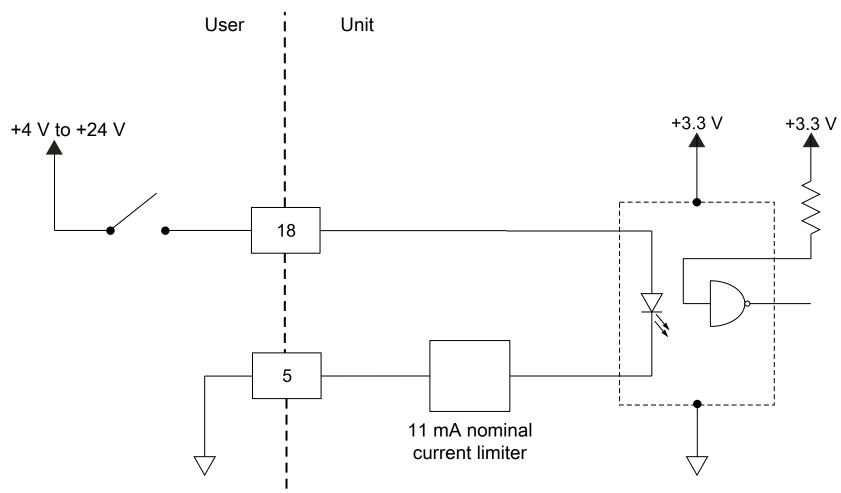


Figure 4-46. RF POWER ON (pins 18 and 5)

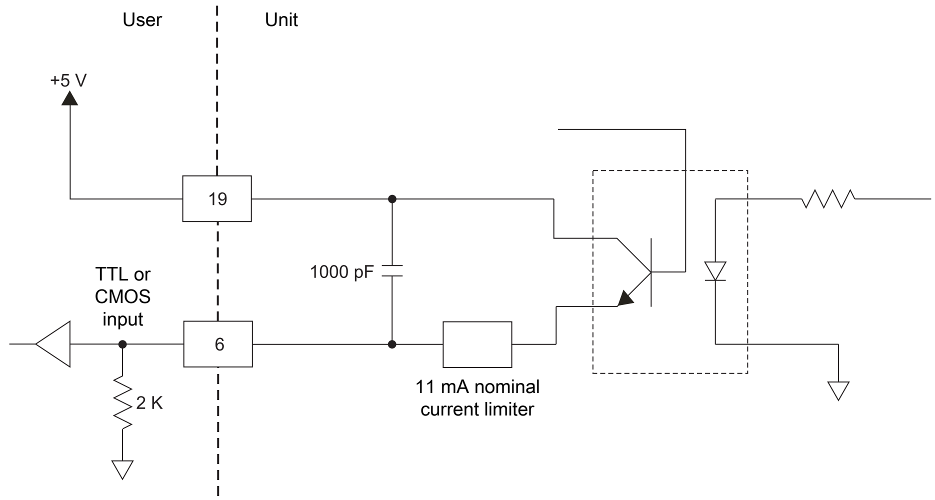


Figure 4-47. RF ON STATUS (pins 19 and 6)

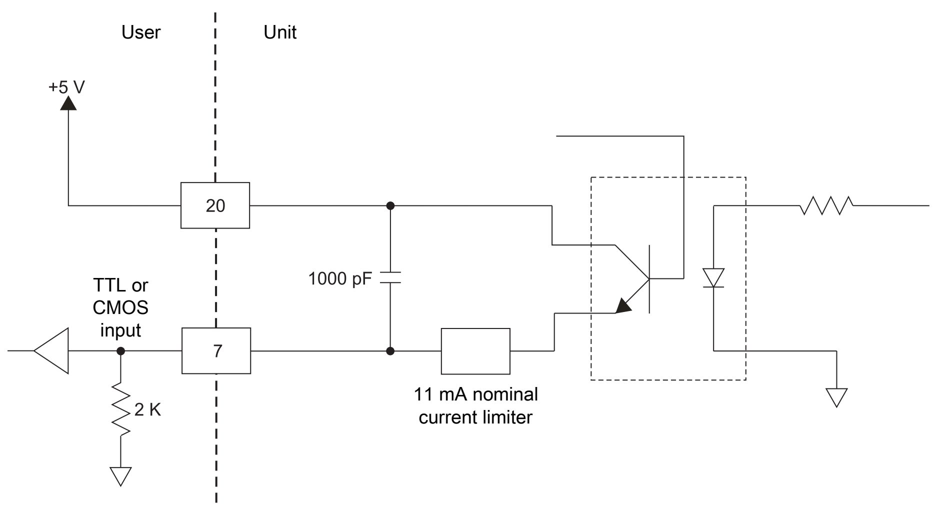


Figure 4-48. GENERATOR STATUS (pins 20 and 7)

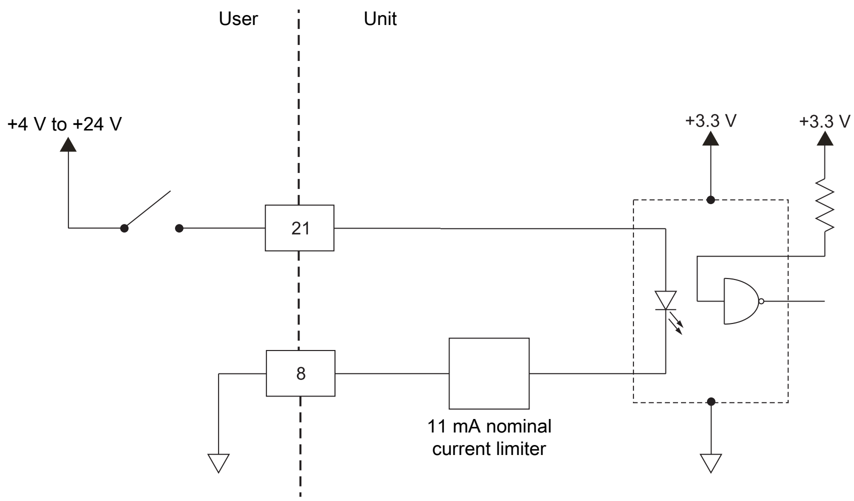


Figure 4-49. LOW SCALE ENABLE (pins 21 and 8)

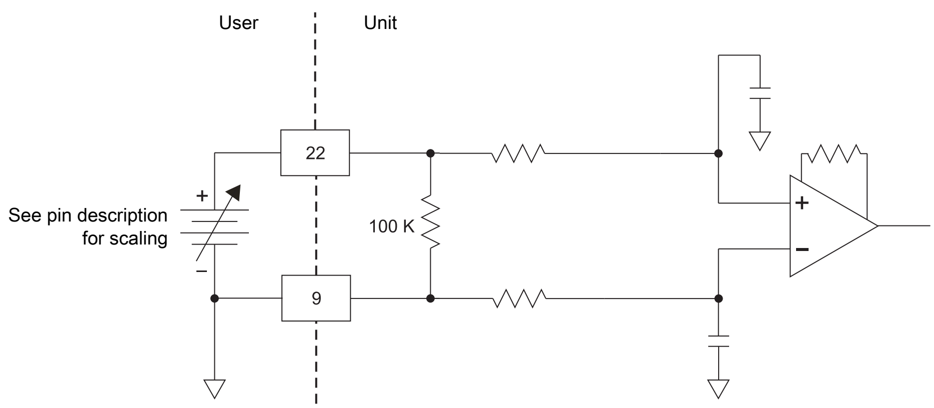


Figure 4-50. SET POINT (pins 22 and 9)

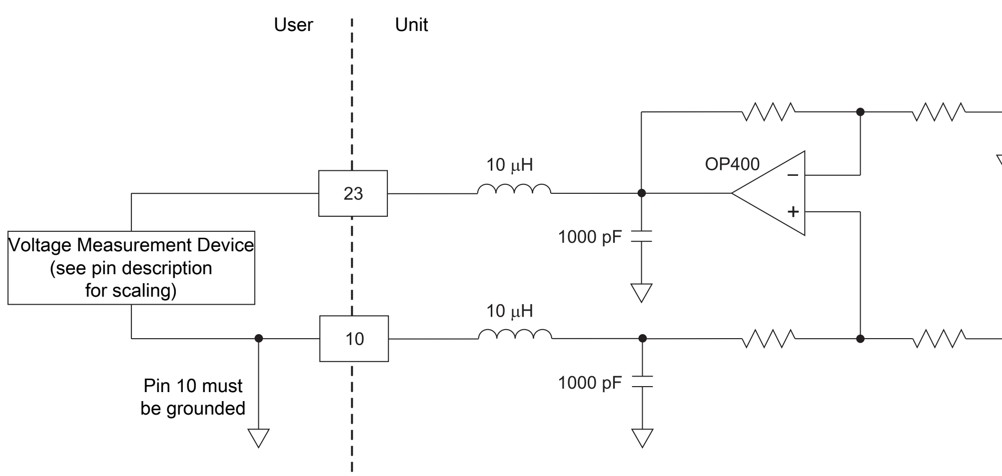


Figure 4-51. DELIVERED POWER MONITOR (pins 23 and 10)

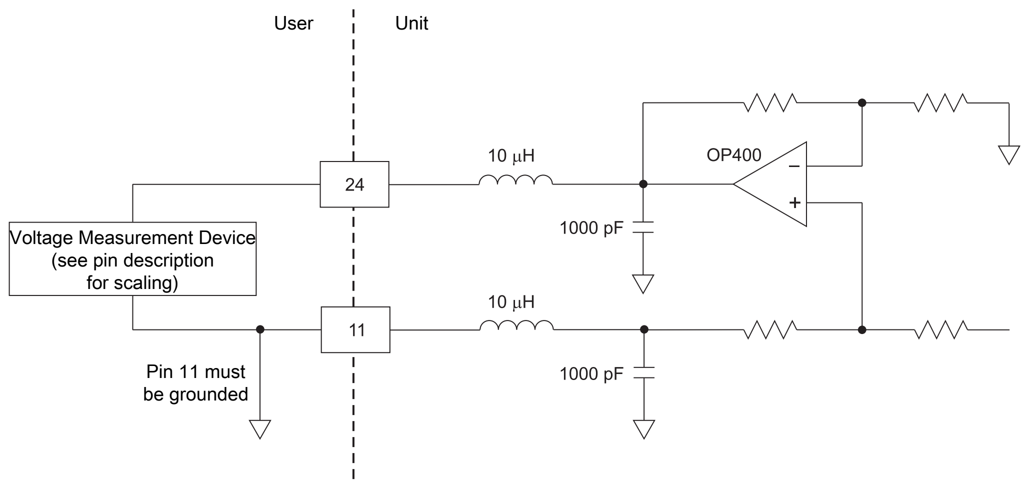


Figure 4-52. REFLECTED POWER MONITOR (pins 24 and 11)

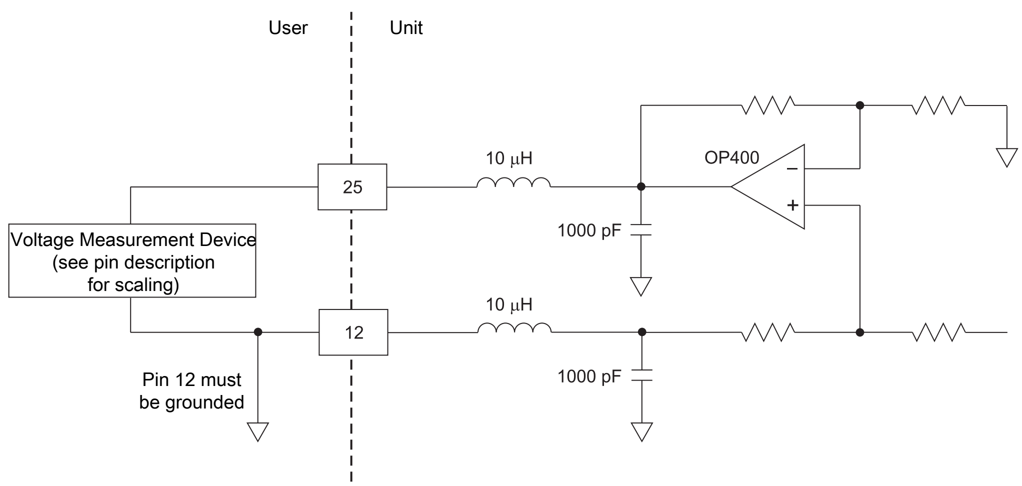


Figure 4-53. FORWARD POWER MONITOR (pins 25 and 12)

SERVICE INTERFACE

The Paramount generator provides a communication interface, labeled **Service**, through a serial port on the generator's front panel. The primary intent of this interface is to allow a host computer to connect directly to the Paramount generator to communicate with it through Virtual Front Panel (VFP). VFP is an Advanced Energy software product that allows you to monitor and control the generator.

Service Port Connector

Located on the front panel of the Paramount generator, the **Service** port connector is a 9-pin, female, shielded, subminiature-D serial connector that provides RS-232 communication for interfacing with a host computer.

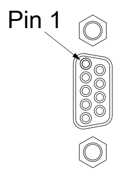


*Figure 4-54. **Service** port connector*

Service Port Pin Descriptions

*Table 4-7. Pin descriptions for the **Service** port*

Signal Pin	Name	Description
1	None	Not connected
2	*TX*	RS-232 transmit data output
3	*RX*	RS-232 transmit data input
4	None	Not connected
5	*DIGITAL GROUND*	This pin connects to the digital ground of the controller.
6 through 8	None	Not connected
9	Reserved	Reserved. Do not use.

SERIAL INTERFACE

The Paramount unit provides a serial communications interface through the **Serial** port. This interface allows the Paramount unit to interface with a host computer using the AE Bus protocol.

To obtain a basic sample of host software for the **Serial** port, please call AE Global Services.

AE manufactures a more full-function interface software for some products, called Virtual Front Panel, which allows you to use a host computer to communicate with the unit through the **Serial** port. To find out more about this software, please call AE Global Services.

Serial Connector

Located on the rear panel of the Paramount unit, the **Serial** port connector is a 9-pin, female, shielded, subminiature-D connector for interfacing with a host computer. An eight-switch DIP (dual in-line package) is adjacent to the connector for setting the unit address, baud rate, and RS-232/RS-485 communication mode.

Use only a shielded cable when connecting to the **Serial** port connector.

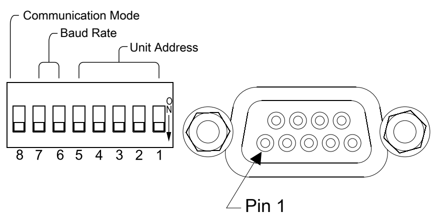


Figure 4-55. Serial port connector

Serial Port Pin Descriptions

Table 4-8. Serial port pin descriptions

Signal Pin	Name	Description
1	RESERVED	Reserved for future use
2	tx RS232	RS-232 transmit data
3	rx RS232	RS-232 receive data
4	RESERVED	Reserved for future use
5	Digital Ground	This pin connects to the digital ground of the controller
6	RS485 -	RS-485 LOW
7	RS485 +	RS-485 HIGH
8	RESERVED	Reserved for future use
9 [1]	RESERVED (FACTORY)	Reserved for future use

[1] Do not connect pins marked *RESERVED*. Do not ground this factory reserved pin. Grounding this pin disrupts the operation of the unit.

AE Bus Transmission Parameters

The communications capability of the **Serial** port is limited to the following parameters:

- RS-232 or RS-485 transmission standard
- Baud rates:
  - 9600
  - 19,200
  - 57,600
  - 115,200
- Paramount unit addresses 1 to 31
- Odd parity
- One start bit, eight data bits, one stop bit
- Low-order bytes transmitted before high-order bytes (little endian)

The timeout period for the Paramount unit 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.

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

The Paramount unit sends data through pin 2 (*TX RS-232*). This pin must be connected to the receive pin (*RX RS-232*) on the host computer's serial connector. The receive pin is normally pin 2 for a standard, 9-pin serial port.

If you are using RS-485, the Paramount unit sends and receives data differentially. Thus, pin 6 (*RS-485-*) and pin 7 (*RS-485+*) are RS-485 transmit and receive lines.

Serial Port Dip Switches

DIP SWITCH AND SWITCH SETTINGS

Use the DIP switch to set the unit AE Bus address, the baud rate, and the communication mode for your unit.

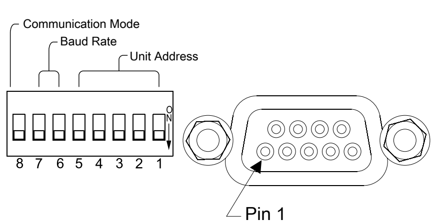


Figure 4-56. Serial DIP switch

The DIP switch contains eight individual switches. Setting a switch to the "on" position means sliding the switch toward the numbers on the DIP, and setting a switch to the "off" position means sliding it away from the numbers.

SWITCHES

The first five switches (1 to 5) specify the address of the unit, which a host computer must include in the message packet it sends.

The next two switches (6 and 7) specify the AE Bus port's baud rate. Switch 8 sets communication mode, either RS-232 or RS-485.

The factory sets your unit to RS-232 communication mode. To change the communication mode to RS-485, set switch 8 and cycle power.

SETTING THE BAUD RATE

Use DIP switches 6 and 7 to set the serial AE Bus port's baud rate. Use switch 8 to select communication mode, either RS-232 or RS-485.

Table 4-9. DIP switch settings for variable baud rate, switches 6 and 7

Baud	Switch 6	Switch 7
9600	on	on
19,200	on	off
57,600	off	on
115,200	off	off

SETTING THE COMMUNICATION MODE

Table 4-10. DIP switch settings for communication mode, switch 8

Switch Position	Communication Mode
On	RS-232
Off	RS-485

SETTING THE UNIT AE BUS ADDRESS

Use the DIP switch to set the unit's AE Bus address.

Table 4-11. AE Bus address settings

Address	Switch 1	Switch 2	Switch 3	Switch 4	Switch 5
0	Do not assign this address to a unit; it is the AE Bus broadcast address—all AE Bus units receive a message sent to this address by the host, but will not reply. If you set the address to 0, the unit automatically re-assigns the address to 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
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

Table 4-11. AE Bus address settings (Continued)

Address	Switch 1	Switch 2	Switch 3	Switch 4	Switch 5
31	off	off	off	off	off

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 Paramount unit. 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 a communications message packet.

- Header (address and the length of Data field)
- Command Number
- Optional Length byte
- Data
- Checksum

Figure 4-57 shows the organization of these fields in the AE Bus message packet. The subsequent paragraphs describe each field in detail.

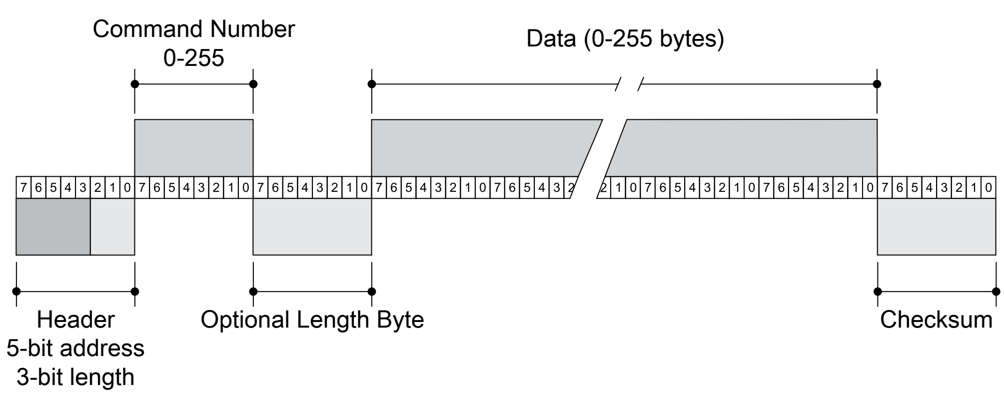


Figure 4-57. Graphic representation of a message packet

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 Paramount unit, for example). If the packet is going to the host, the address specifies the packet origin (from the Paramount unit). 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, which the Paramount unit does not support.

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.

☞ **Important**

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.

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 Paramount unit, the value specifies the command to which it is responding.

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) equals 7 (07h), and the Optional Length byte contains 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 Paramount unit expects zero to six data bytes. However, if the value in the Header field is 7 (07h), the Paramount unit 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 4-12.

Table 4-12. 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.

Creating an Ideal Communications Transaction

Figure 4-58 illustrates the steps in an ideal communications transaction between a host computer and the Paramount unit.

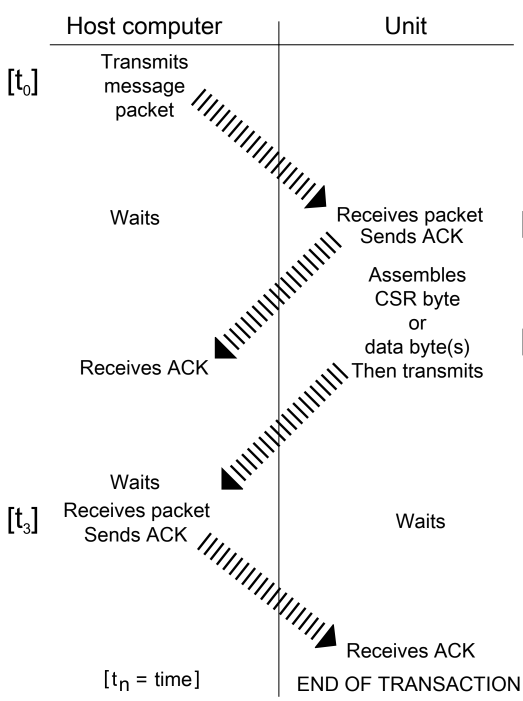


Figure 4-58. AE Bus communications transaction

T_0: HOST TRANSMITS MESSAGE PACKET

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

- If the address does not match, the Paramount unit does not respond to the host computer; the Paramount unit 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 Paramount unit sends a negative acknowledgment (NAK), hexadecimal 15h, to the host computer.
- If the address matches and the message is intact, the Paramount unit sends an acknowledgment (ACK), hexadecimal 06h, to the host computer.

If the Paramount unit 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. The power supply sends CSR code 0 when it has accepted the command.

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

AE BUS COMMUNICATIONS TRANSACTION EXAMPLE

Figure 4-59 illustrates the steps in an example communications transaction between a host computer and the Paramount unit.

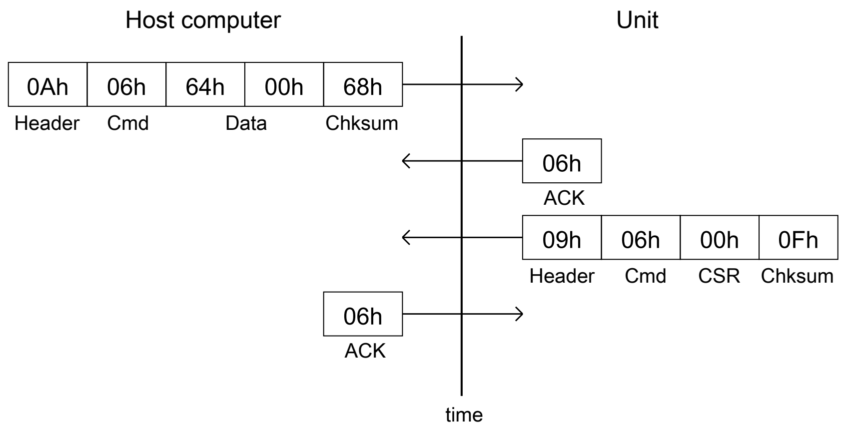


Figure 4-59. Communications transaction example

AE HOST COMMANDS

The following sections describe the command status response (CSR) codes returned by the Paramount unit in response to an AE Host command, as well as the complete set of AE Host commands. You can use these commands with one or more of the following interfaces (depending on your unit's configuration):

- AE Bus (serial)
- Ethernet
- EtherCAT

AE Host Command Status Response (CSR) Codes

When the Paramount unit receives a command requesting a change in unit operation (command numbers 1 through 127), or when the Paramount unit receives any command that it rejects (command numbers 1 through 255), it responds 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.

Table 4-13. AE command status response (CSR) codes

Code	Meaning
0	Command accepted.
The following CSR codes are sent in response to a command that was not accepted and provide an indication of why the command was not accepted.	
1	Control mode is incorrect.
2	Output is on (change not allowed).
4	Command specifies a value that exceeds the limit for that parameter.
5	**User** port off signal is active.
7	One or more faults are active.
8	Setpoint ramping is active.
9	Command's data byte count is incorrect.
12	Feature is not available on this unit.
17	Minimum off time is active.
19	Recipe feature is active.
28	Setpoint exceeds user limit.
30	EEPROM read/write error.
41	One or more warnings are active.
42	DHCP is active.
50	Frequency is out of range.
51	Duty cycle is out of range.
52	Minimum On or Off time is violated.
61	Real time clock was busy.
63	Flash mode is active.
99	Command not accepted (there is no such command).

AE Host Command Set

This table includes commands for features that might not be implemented in all units. If you issue a command for a feature that a unit does not have, the unit returns command status response (CSR) **12**, feature is not available on this unit.

- Commands **1** to **127** request a change to the Paramount unit, such as changing a setting in the unit. The unit responds to these commands by sending a CSR code. This single-byte response indicates whether the unit has accepted or rejected the command and, in the case of rejection, includes the reason the unit could not respond to the command.

- Commands **128** to **255** request information from the unit, such as unit settings. The unit responds to these commands by sending the data requested if the command was successful, and a CSR error code if the command was not successful.

Table 4-14. AE Host Commands

Command	Description	Data Bytes Sent	Data Bytes Returned
1 **RF off**	Turns RF output off. Accepted regardless of control mode. This command explicitly clears all latched faults, but does not clear faults that are currently active. Command **162** reports this value.	0	1
2 **RF on**	Turns RF output on if there are no active or latched faults. The RF output is on even if a valid setpoint has not been issued. If the unit has received a valid setpoint, the generator will begin delivering power when it accepts this command. The unit accepts this command only when in host control mode. The unit will not accept this command if the RF output is already on. Command **162** reports this value.	0	1
3 **set regulation mode**	Sets the regulation mode. The unit accepts this command only when in host control mode. The regulation mode can be changed between forward, delivered, and VA limit power regulation modes while the RF output is on. All other mode changes must be performed with the output power turned off. Send 1 data byte: • Byte 0 = Regulation mode number: ◦ 6 = Forward ◦ 7 = Delivered or load ◦ 8 = External (DC bias); use this setting only when your unit has a user card that supports external regulation ◦ 9 = VA limit Command **154** reports this value.	1	1
4 **set user power limit**	Sets the user power limit in watts. The unit retains the user reflected power limit as long as power is applied. You cannot change the power limit while the unit is on. The user power limit command is accepted	2	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	in external regulation mode, but has no effect since the setpoint is not in watts. Valid values are from the low power limit to the unit maximum power. ☞ **Important** The user power limit is directly related to the current regulation mode. For example, when in load regulation mode, the user power limit will limit delivered power. Send 2 data bytes: • Bytes 0 and 1 = Power limit in watts Command **169** reports this value.		
5 **set user reflected power limit**	Sets the user reflected power limit. The user reflected power limit affects all regulation modes. The unit retains the user reflected power limit as long as power is applied. You cannot change the user reflected power limit while the RF output is on. Valid values are 100 W to the maximum reflected power limit as shown in the electrical specifications. Send 2 data bytes: • Bytes 0 and 1 = Reflected power limit in watts (LSB first) Command **170** reports this value.	2	1
6 **set user external feedback limit**	Sets the user external feedback limit in volts. Use this setting only when using the external (DC bias) regulation mode. The unit retains the user external feedback limit as long as power is applied. You cannot change the user external feedback limit while the RF output is on. The maximum valid value for the user external feedback limit is equal to the maximum external feedback value (reported by command **171**). The following equation defines the minimum valid value for the user external feedback limit: $F_{min} = (F_{max} \times L) / M$	2	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	where • F_{min} is the user external feedback limit minimum, the minimum value you can set with this command. • F_{max} is the maximum external feedback value, a user-settable value (command **9**). • L is the low power limit, a default value. • M is the unit maximum power, a default value. Send 2 data bytes: • Bytes 0 and 1 = External feedback limit in volts (LSB first) Command **171** reports this value.		
7 **restore factory defaults**	Restores all nonvolatile RAM values to the factory preset values. You cannot use this command while RF output is on. The unit resets after issuing this command, and new settings do not take effect until the unit resets. Send 2 data bytes: • Byte 0 = 0 (restore all factory default values) • Byte 0 = 1 (restore all factory default values except network parameters) • Byte 1 = Must be set to 0	2	1
8 **set power setpoint**	Specifies the unit setpoint. Accepted only when host control mode is active. The setpoint is not allowed to change while a recipe is active. Specifies a power or voltage setpoint, depending on the enabled features in the unit. Your unit might not have all of these features: • For standard units operating in power regulation mode, this command sets the setpoint in watts. For HALO units operating in power regulation mode, this command sets the setpoint in tenths of watts.	2	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	In power regulation mode, the setpoint cannot exceed the unit's maximum output power or the user power limit. • When the unit is operating in external (DC bias) regulation mode, this command sets the setpoint in volts. In external (DC bias) regulation mode, the setpoint cannot exceed the maximum external feedback value or user external feedback limit. Send 2 data bytes: • Bytes 0 and 1: Power setpoint in watts, tenths of watts, or volts Command **164** reports this value.		
9 **set maximum external feedback value (NV)**	Sets the maximum external feedback value in volts. Use this setting only when using the external (DC bias) regulation mode. The unit stores the maximum external feedback value in nonvolatile memory. You cannot change this value while the RF output is on. Valid values are 10 V to 65,535 V. The user external feedback limit is set equal to the new maximum external feedback value (see command **6**). The factory default value is set by an EEPROM. Send 3 data bytes: • Bytes 0 and 1 = Maximum external feedback value in volts (LSB first) • Byte 2 = Dummy byte for RFXII compatibility Command **171** reports this value.	3	1
14 **set active control mode**	Sets the control mode. This mode cannot be changed while the RF output is on. Send 1 data byte. Byte 0 = Control mode: • 2 = Host • 4 = **User** port (analog) • 8 = Diagnostic • 16 = DeviceNet	1	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	• 32 = EtherCAT ☞ **Important** The DeviceNet board automatically sets the unit into DeviceNet control mode when you connect the DeviceNet cable. There is no other way to force the unit into DeviceNet control mode. While operating in DeviceNet control mode, you must disconnect the cable to take control away from DeviceNet. You might also be able to change control mode if the DeviceNet board experiences a DeviceNet power fault. ☞ **Important** When operating in EtherCAT control mode, only the EtherCAT interface can put the unit into EtherCAT control mode. If the unit is in EtherCAT control mode and the EtherCAT interface is actively communicating with the unit, the unit can only be changed to host control mode. Command **155** reports this value.		
21 **set recipe parameters (NV)**	The recipe feature allows you to program up to 15 individual recipes of up to 15 recipe steps each. Recipe parameters that you set are then stored in nonvolatile memory. This command is used to set up all parameters necessary to run a recipe, and must be issued multiple times in order to set up all the global parameters and recipe step parameters that comprise a complete recipe. Each time you send this command, you can set one of the following for one recipe: • A global recipe parameter that affects the entire recipe • One of several parameters for one of the steps in the recipe	8	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	Recipe parameters cannot be changed while a recipe is running. When running a recipe, the unit will attempt to execute the number of recipe steps programmed into the global number of recipe steps parameter. However, if the recipe step type for a particular recipe step is programmed with a value of 0, then that recipe step will be skipped while executing the recipe. Some of the recipe step parameters are optional, and will be ignored if the parameter value is set to the disabled state. This allows you to construct a recipe that only alters the parameters you are interested in. See the description for each recipe step parameter for details. When a recipe is started by turning the RF output on, the values of all parameters that can be altered by the recipe are saved. If the final output state parameter is set to a value of 0, the unit will turn off after all recipe steps and iterations are complete. All recipe parameters will be restored to their previous state, as they were before the recipe was run. When the final output state parameter is set to 1, the unit will remain on when all recipe steps and iterations are complete, and control will be returned to the interface that is currently in control. The factory default value for all recipe parameters except recipe step duration is disabled. The factory default for recipe step duration is 1. Recipe mode is only applicable when the unit is configured for forward or load regulation modes. For detailed information about how the recipe feature works and about the parameters listed below, see the recipes feature information. Send 8 data bytes. • Byte 0 = Recipe number. This value specifies the recipe that will be changed. Valid values are 1 to 15. • Byte 1 = Recipe parameter type. Sets the type of parameter that will be set. This selection affects the parameters that are available to Byte 3:		

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	◦ 0 = Set global recipe parameter ◦ 1 = Set recipe step parameters • Byte 2 = Recipe step number. This value sets the step that will be programmed if you selected option 1 in Byte 1. If you selected option 0 in Byte 1, this value is ignored. Valid values are 1 to 15. • Byte 3 = Recipe parameter selection. This value selects the parameter that will be set. The available parameters depend on the selection in Byte 1. The list of parameters for this byte also notes the valid values for each of the selections. If Byte 1 = 0 (global recipe parameter): ◦ 0 = Number of recipe steps. Sets the total number of steps in the selected recipe. Valid values are 1 to 15. ◦ 1 = Number of recipe iterations. Sets the number of times the recipe will be executed before it is complete. Valid values are 1 to 65,535. If the number of recipe iterations is set to 65,535, the recipe will run indefinitely. ◦ 2 = Final output state. If this parameter is set to 0, the unit will turn off after all recipe steps and iterations are complete, and will then restore all of the previously saved values. If this parameter is set to 1, the unit keeps RF output on when all the recipe steps and iterations are complete, and retains the parameter values as they are during the last step of the recipe. Unit control is returned to the interface that is currently set to control the unit. If Byte 1 = 1 (set recipe step parameter): ◦ 0 = Recipe step type. Sets the units for the step duration. This selection can also disable the recipe step. Valid values: ▪ 0 = Disabled		

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	▪ 1 = Timed ▪ 2 = Joules ◦ 1 = Recipe step duration. This value specifies the duration of the step in units of 0.01 seconds for timed recipe steps, or joules for joule recipe steps. Valid values are 1 to 2,147,483,647. ◦ 2 = Power setpoint. Sets the power output of the unit for the recipe step. Set this value in watts for standard units. For HALO units, set this value in tenths of watts. This value cannot be greater than the maximum power output for the unit. You must set this value for each enabled step in the recipe. ◦ 3 = Setpoint ramp mode. Valid values: ▪ 0 = Disable ramping for this step ▪ 1 = Slope ▪ 2 = Timed ◦ 4 = Setpoint ramp rate. Sets the rate of ramping for the step. If the ramp mode is set to slope, this value sets watts per second ramp rate. If the ramp mode is set to timed, this value sets the number of milliseconds for the ramp. If the ramp mode is set to disabled, this value is ignored. Setting this parameter to 0 disables ramping for this step. Valid values are 0 to 65,535. ◦ 5 = Frequency mode. Valid values: ▪ 0 = Fixed frequency mode. This value sets the unit to fixed frequency mode if the fixed frequency value is nonzero. Setting both this value and the fixed frequency value to 0 disables frequency mode for the step. ▪ 1 = Variable frequency mode ◦ 6 = Fixed frequency value. This value specifies the output frequency of the		

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	generator in kHz when fixed frequency mode was selected with the frequency mode step parameter. This value must be within the frequency range for the generator. Setting both this value and the frequency mode to 0 disables frequency mode for the step. • Bytes 4 to 7 = Recipe parameter value. Contains the value for the parameter specified in the previous byte (Byte 3). Command **188** reports these values.		
26 **set pulsing configuration (NV)**	Controls pulsing configuration. This command allows you to send subcommands. The name and function of a subcommand depend on the value of the first two data bytes. You cannot use pulsing and arc management at the same time. This command allows you to toggle between pulsing and arc management. Bytes 0 and 1 (the pulsing command parameter) can include values 1 to 11. You cannot use values 1, 5, or 8 while RF output is turned on. You can use value 7 only while operating in explicit enable mode (see value 6). A parameter value of 0 for subcommand 9 disables the pulse maximum on-time function. A parameter value of 0 for subcommand 11 disables the slave duty cycle function. The parameter value for subcommand 4 cannot exceed the pulse period when operating in master mode. Subcommands 9 and 11 both have the effect of modifying the output duty cycle when operating in slave mode. Only one of these subcommands can be active at one time. If either subcommand 9 or subcommand 11 is active when another subcommand is received to set the other one of these subcommands active, then the received subcommand will be rejected and return CSR 12. The pulse maximum on-time subcommand also limits the pulse on time in master mode. For subcommand 8, mode 0 is not stored in nonvolatile memory. After an AC power cycle event,	6	1

Table 4-14. AE Host Commands (Continued)

<table>
<tr><th>Command</th><th>Description</th><th>Data Bytes Sent</th><th>Data Bytes Returned</th></tr>
<tr><td></td><td>
the mode is restored to the default based on the PIN number.
The parameters are saved to the currently active memory as specified by subcommand 5, and could be nonvolatile depending on the current configuration. This command is accepted in all control modes, unless the PIN number for the analog user card is equal to 8. In that case, this command is only accepted in host control mode.
<table>
<tr><th>Bytes 0 and 1 =</th><th>Subcommand</th></tr>
<tr><td>1</td><td>Pulsing mode</td></tr>
<tr><td>2</td><td>Pulse sync output</td></tr>
<tr><td>3</td><td>Reserved</td></tr>
<tr><td>4</td><td>Sync input delay</td></tr>
<tr><td>5</td><td>Memory mode</td></tr>
<tr><td>6</td><td>Explicit enable mode</td></tr>
<tr><td>7</td><td>Pulsing enable command</td></tr>
<tr><td>8</td><td>Pulsing/arc management mode</td></tr>
<tr><td>9</td><td>Pulse maximum on-time</td></tr>
<tr><td>10</td><td>Pulse sync output mode</td></tr>
<tr><td>11</td><td>Slave duty cycle</td></tr>
<tr><td>12</td><td>Reserved</td></tr>
<tr><td>13</td><td>Reserved</td></tr>
</table>
</td><td></td><td></td></tr>
<tr><td>26
set pulsing mode
(subcommand 1)</td><td>
Sets the unit pulsing mode to master or slave. You cannot use this subcommand while RF output is on.
Send 6 data bytes:

Bytes 0 and 1 = 1 (set pulsing mode)
Bytes 2 and 3 = Pulsing mode (LSB first):
1 = Master mode
2 = Slave mode
Bytes 4 and 5 = Reserved

Command 172; B0 = 1 reports these values.
</td><td>6</td><td>1</td></tr>
</table>

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
26 **enable pulse sync output** (subcommand 2)	Enables or disables pulse sync output. Send 6 data bytes: • Bytes 0 and 1 = 2 (enable/disable pulse sync output) • Bytes 2 and 3 = Pulse sync output state: ◦ 0 = Pulse sync output off ◦ 1 = Pulse sync output on • Bytes 4 and 5 = Reserved Command **172**; B0 = 2 reports these values.	6	1
26 **set sync input delay** (subcommand 4)	Sets sync input delay in µs. The parameter value for subcommand 4 cannot exceed the pulse period when operating in master mode. Send 6 data bytes: • Bytes 0 and 1 = 4 (set sync input delay) • Bytes 2 to 5 (unsigned long) = Sync input delay in µs (valid values are 0 µs to 250,000 µs) Command **172**; B0 = 4 reports this value.	6	1
26 **set memory mode** (subcommand 5)	Sets the unit memory mode to RAM or NVRAM. The unit saves parameters to the currently active memory as specified by this value. Future parameter changes will also be saved to the current active memory. You cannot use this subcommand while RF output is on. Send 6 data bytes: • Bytes 0 and 1 = 5 (set memory mode) • Bytes 2 and 3 = Memory mode: ◦ 0 = RAM ◦ 1 = NVRAM • Bytes 4 and 5 = Reserved Command **172**; B0 = 5 reports these values.	6	1
26 **set explicit enable mode** (subcommand 6)	Sets explicit enable mode. When in explicit enable mode, you can use command **26** (subcommand 7) to turn pulsing on or off while RF output is on.	6	1

Table 4-14. AE Host Commands (Continued)

<table>
<tr><th>Command</th><th>Description</th><th>Data Bytes Sent</th><th>Data Bytes Returned</th></tr>
<tr><td></td><td>Send 6 data bytes:
• Bytes 0 and 1 = 6 (set explicit enable mode)
• Bytes 2 and 3 = Explicit/implicit enable mode:
◦ 0 = Implicit enable
◦ 1 = Explicit enable
• Bytes 4 and 5 = Reserved
Command 172; B0 = 6 reports these values.</td><td></td><td></td></tr>
<tr><td>26
pulsing on/off
(subcommand 7)</td><td>Turns pulsing on or off while RF output is on. You can only use this subcommand while operating in explicit enable mode (see command 26 [subcommand 6]).
Send 6 data bytes:
• Bytes 0 and 1 = 7 (pulsing on/off)
• Bytes 2 and 3 = Pulsing status:
◦ 0 = Pulsing off
◦ 1 = Pulsing on
◦ 2 = Pulsing on plus variable frequency enabled
• Bytes 4 and 5 = Reserved
Command 172; B0 = 7 reports these values.</td><td>6</td><td>1</td></tr>
<tr><td>26
set pulsing/arc management mode
(subcommand 8)</td><td>Enables or disables pulsing and arc management. You cannot use pulsing and arc management at the same time. This subcommand allows you to toggle between pulsing and arc management. You cannot use this subcommand while RF output is on.
Send 6 data bytes:
• Bytes 0 and 1 = 8 (set pulsing/arc management mode)
• Bytes 2 and 3 = Pulsing/arc management mode:
◦ 0 = Pulsing and arc management disabled
◦ 1 = Pulsing enabled
◦ 2 = Arc management enabled</td><td>6</td><td>1</td></tr>
</table>

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	• Bytes 4 and 5 = Reserved Command **172**; B0 = 8 reports these values.		
26 **set pulse maximum on-time** (subcommand 9)	Sets pulse maximum on-time in µs. A value of 0 disables the pulse maximum on-time function. When operating in slave mode, setting this parameter can effectively modify the output duty cycle. Only one method using either command **26** (subcommand 9) or command **26** (subcommand 11) can be active at one time. If either parameter is active and a subcommand is received to set the other parameter to active, the subcommand just sent will be rejected and return CSR 12. Command **26** (subcommand 9) also limits the pulse on time in master mode. A parameter value of 0 for subcommand 9 disables the pulse maximum on-time function. Send 6 data bytes: • Bytes 0 and 1 = 9 (set pulse maximum on-time) • Bytes 2 to 5 (unsigned long) = Pulse maximum on-time in µs (valid values are 0 and the range 5 µs to 250,000 µs) Command **172**; B0 = 9 reports this value.	6	1
26 **set pulse sync output mode** (subcommand 10)	Sets the pulse sync output mode for both master and slave operation. Send 6 data bytes: • Bytes 0 and 1 = 10 (set pulse sync output mode) • Bytes 2 and 3 = Pulse sync output mode: ◦ 1 = Master mode: ▪ Mode 0 = Pulse sync output tracks RF output ▪ Mode 1 = Pulse sync output is free running ◦ 2 = Slave mode: ▪ Mode 0 = Slave pass-through mode off ▪ Mode 1 = Slave pass-through mode on • Bytes 4 and 5 = Reserved Command **172**; B0 = 10 reports this value.	6	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
26 **set slave duty cycle** (subcommand 11)	Sets the slave duty cycle in tenths of a percent. A value of 0 disables the slave duty cycle function. When operating in slave mode, setting this parameter can effectively modify the output duty cycle. Only one method, command **26** (subcommand 9) or command **26** (subcommand 11) can be active at one time. If either parameter is active and a subcommand is received to set the other parameter to active, the subcommand just sent will be rejected and return CSR 12. Send 6 data bytes: • Bytes 0 and 1 = 11 (set slave duty cycle) • Bytes 2 to 5 = Slave duty cycle in tenths of a percent as unsigned long (valid values vary from unit to unit) Command **172**; B0 = 11 reports this value.	6	1
28 **set active recipe (NV)**	Sets the recipe that will run when RF output is enabled. Setting this value to 0 disables the recipe feature. The active recipe cannot be changed while a recipe is running. Send 2 data bytes: • Bytes 0 and 1 = Recipe number (valid values are 0 to 15) Command **189** reports this value.	2	1
31 **set setpoint ramping configuration (NV)**	Sets the setpoint ramping configuration. You can set one of two ramp modes: • Slope • Timed (milliseconds) You can also set the memory mode for the setpoint ramping parameters to either volatile or nonvolatile. The factory default value for both the memory mode and the ramping parameters are factory configured.	6 or 8	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	The ramp up and ramp down parameters can be set independently: • When operating in power regulation modes, in slope mode the ramp parameters represent the ramp rate in units of watts per second. • When operating in external voltage regulation mode, in slope mode the ramp parameters represent the ramp rate in units of volts per second. The acceptable range for the ramp up and ramp down parameters in slope mode is 0 milliseconds to 65,535 milliseconds. In timed mode, the ramp parameters represent the time in milliseconds to complete the setpoint change, regardless of the magnitude of the setpoint change. The acceptable range for the ramp up and ramp down parameters in timed mode is 0 milliseconds to 65,535 milliseconds. For both modes, you can set either the ramp up or the ramp down parameter to 0, but you cannot set both to 0. This command is available while the unit is operating in external regulation mode. While setpoint ramping is enabled, the high bandwidth user card analog setpoint tracking mode is disabled You can set the setpoint ramp parameters while the RF output is on. The ramp parameters cannot change during a setpoint ramp that is currently in progress. The setpoint will not ramp in either mode if the setpoint change is less than 3 W (this value might be different for some units). Attempting to change the ramp parameters while the unit is ramping will cause the unit to reject the command and respond with CSR 8. The ramp parameters are not allowed to change while a recipe is active. You can send either a 6-byte version of the command (which does not allow you to set the memory mode) or an 8-byte version of the command (which does allow you to set the memory mode).		

Table 4-14. AE Host Commands (Continued)

<table>
<tr><th>Command</th><th>Description</th><th>Data Bytes Sent</th><th>Data Bytes Returned</th></tr>
<tr><td></td><td>6-byte version:
Send 6 data bytes (three 16-bit values):
• Bytes 0 and 1 = Ramp mode
◦ 0 = Disabled
◦ 1 = Slope
◦ 2 = Timed (in milliseconds)
• Bytes 2 and 3 = Ramp up parameter (in W/s, V/s, or time in milliseconds)
• Bytes 4 and 5 = Ramp down parameter (in W/s, V/s, or time in milliseconds)
8-byte version:
Send 8 bytes containing either the memory mode selection or the ramping data.
To send ramping data:
• Bytes 0 and 1 = 1 (ramping data)
• Bytes 2 and 3 = Ramp mode:
◦ 0 = Disabled
◦ 1 = Slope
◦ 2 = Timed
• Bytes 4 and 5 (16-bit value) = Ramp up parameter (in W/s, V/s, or time in milliseconds)
• Bytes 6 and 7 (16-bit value) = Ramp down parameter (in W/s, V/s, or time in milliseconds)
To send memory mode:
• Bytes 0 and 1 = 2 (memory mode)
• Bytes 2 and 3 = Memory mode setting:
◦ 0 = Volatile
◦ 1 = Nonvolatile
• Bytes 4 to 7 = Reserved (set to 0)
Command 151 reports this value.</td><td></td><td></td></tr>
</table>

Table 4-14. AE Host Commands (Continued)

<table>
<tr><th>Command</th><th>Description</th><th>Data Bytes Sent</th><th>Data Bytes Returned</th></tr>
<tr><td>32
set CEX phase offset (NV)</td><td>Sets the phase offset for CEX mode. Settings are stored in nonvolatile memory. Default value is 0. Valid values are 0 to 3,600, representing 0 to 360 degrees in 0.1 degree increments. The unit adds this value to the factory preset phase offset calibration value.
Send 3 data bytes:
• Byte 0 = 0
• Bytes 1 and 2 = Phase offset in tenths of degrees (unsigned short)
Command 132 reports this value.</td><td>3</td><td>1</td></tr>
<tr><td>36
set arc management parameters</td><td>Configures arc management. Arc management is not available while pulsing mode is enabled. The unit stores parameters marked NV in nonvolatile memory (the values remain available when you cycle power to the unit).
With the exception of bytes 4, 5, and 10, this command cannot be used while RF output is on.
This command allows you to send subcommands. The name and function of a subcommand depend on the value of the first byte:
<table>
<tr><th>Byte 0 =</th><th>Subcommand</th></tr>
<tr><td>0</td><td>Arc suppression-time (NV)</td></tr>
<tr><td>1</td><td>Initial delay time (NV)</td></tr>
<tr><td>2</td><td>Setpoint delay time (NV)</td></tr>
<tr><td>3</td><td>Number of attempts (NV)</td></tr>
<tr><td>4</td><td>Reflected power limit mode (NV)</td></tr>
<tr><td>5</td><td>Enable external arc input (NV)</td></tr>
<tr><td>6</td><td>RF power latch state (NV)</td></tr>
<tr><td>7</td><td>Arc output signal control</td></tr>
<tr><td>8</td><td>Reflection coefficient window (NV)</td></tr>
<tr><td>9</td><td>Reset cumulative arc events (NV)</td></tr>
</table></td><td>3</td><td>1</td></tr>
</table>

Table 4-14. AE Host Commands (Continued)

<table>
<tr><th>Command</th><th>Description</th><th>Data Bytes Sent</th><th>Data Bytes Returned</th></tr>
<tr><td></td><td><table><tr><th>Byte 0 =</th><th>Subcommand</th></tr><tr><td>10</td><td>Gamma arc detection mode (NV)</td></tr><tr><td>11</td><td>Reflected power threshold for arc detection (NV)</td></tr></table></td><td></td><td></td></tr>
<tr><td>36
set arc suppression time (NV)
(subcommand 0)</td><td>The amount of time (µs) that the unit turns RF off when it detects an arc. If the first attempt does not quench the arc, the unit doubles the suppression time on each following attempt until it extinguishes the arc, it reaches the maximum number of attempts, or it reaches the maximum arc suppression time.
Setting this parameter to 0 disables the arc management algorithm but leaves the arc counter enabled. The valid arc suppression time range is 5 µs to 511 µs.
Send 3 data bytes:
• Byte 0 = 0 (set arc suppression time)
• Bytes 1 and 2 = Arc suppression time value (µs)
Command 199; B0 = 3 reports this value.</td><td>3</td><td>1</td></tr>
<tr><td>36
set initial delay time (NV)
(subcommand 1)</td><td>Specifies the amount of time in milliseconds that must elapse before the unit enables the arc management algorithm after turning RF output on. The arc counter also remains disabled during this time. The valid initial delay time range is 0 milliseconds to 10 seconds.
Send 3 data bytes:
• Byte 0 = 1 (set initial delay time)
• Bytes 1 and 2 = Initial delay time value (milliseconds)
Command 199; B0 = 8 reports this value.</td><td>3</td><td>1</td></tr>
<tr><td>36
set setpoint delay time (NV)
(subcommand 2)</td><td>The unit temporarily disables arc management each time it receives a new setpoint that results in a difference of greater than the setpoint delay threshold from the previous setpoint. This parameter specifies the amount of time in µs that must elapse before the unit re-enables the arc management algorithm after a significant setpoint change. The arc</td><td>3</td><td>1</td></tr>
</table>

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	counter also remains disabled during this time. The valid setpoint delay time range is 0 milliseconds to 5,000 milliseconds. Send 3 data bytes: • Byte 0 = 2 (set setpoint delay time) • Bytes 1 and 2 = Setpoint delay time value (milliseconds) Command **199**; B0 = 9 reports this value.		
36 **set number of attempts (NV)** (subcommand 3)	Specifies the number of times the arc management algorithm attempts to quench an arc before terminating its attempts. If the unit reaches the maximum number of attempts, the arc management algorithm becomes disabled and the unit sets the output to the state (on or off) specified by the RF power latch state parameter (command **36**; B0 = 6). If the unit turns output off, it also asserts the arc management fault to indicate the reason for turning off. If the output remains on, the unit re-enables the arc management algorithm. The valid range of attempts is 0 to 250. Setting this parameter to 0 specifies that there is no maximum number of attempts, and the arc management algorithm will continue to quench the arc indefinitely. Send 3 data bytes: • Byte 0 = 3 (set number of attempts) • Bytes 1 and 2 = Number of attempts (0 to 250) Command **199**; B0 = 10 reports this value.	3	1
36 **set reflected power limit mode (NV)** (subcommand 4)	Enables or disables the reflected power limit arc detection mode. When this mode is enabled, the unit considers an arc to be present when reflected power reaches its maximum limit. Send 3 data bytes: • Byte 0 = 4 (set reflected power limit mode) • Bytes 1 and 2 = Reflected power limit status: 　◦ 0 = Disabled	3	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	◦ 1 = Enabled Command **199**; B0 = 4 reports this value.		
36 **enable external arc input (NV)** (subcommand 5)	This parameter controls the mode that indicates that an arc is considered to be present based on the state of the external arc input (slave mode). Valid values are 0 (disabled) or 1 (enabled). If enabled, the unit determines that an arc exists if a logic high pulse is present on the **Sync In** connector from a master unit. Send 3 data bytes: • Byte 0 = 5 (enable external arc input) • Bytes 1 and 2 = Enable external arc input status: ◦ 0 = Disabled ◦ 1 = Enabled Command **199**; B0 = 5 reports this value.	3	1
36 **set RF power latch state (NV)** (subcommand 6)	Controls the mode that indicates whether the unit should turn off output when the arc management algorithm terminates because it has reached its maximum number of attempts. Send 3 data bytes: • Byte 0 = 6 (set RF power latch state) • Bytes 1 and 2 = RF power latch state: ◦ 0 = RF turns off ◦ 1 = RF stays on Command **199**; B0 = 6 reports this value.	3	1
36 **set arc output signal control** (subcommand 7)	Controls whether the **Sync Out** connector outputs the arc indication signal. This parameter is volatile and defaults to enabled each time you cycle power to the unit. Send 3 data bytes: • Byte 0 = 7 (set arc output signal control) • Bytes 1 and 2 = Arc output signal control status: ◦ 0 = Disabled	3	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	◦ 1 = Enabled Command **199**; B0 = 7 reports this value.		
36 **set reflection coefficient window (NV)** (subcommand 8)	Sets the value to be added to nominal gamma to determine high and low thresholds. The unit adds this value to nominal gamma to determine the high threshold and subtracts this value from nominal gamma to determine the low threshold. The unit of measure is 0.01 $gamma^2$. The valid range is 1 to 100. Send 3 data bytes: • Byte 0 = 8 (set reflection coefficient window) • Bytes 1 and 2 = Reflection coefficient window value Command **199**; B0 = 11 reports this value.	3	1
36 **reset cumulative arc events (NV)** (subcommand 9)	Resets the cumulative arc events value to 0. The only valid parameter value for this subcommand is 0. Send 3 data bytes: • Byte 0 = 9 (reset cumulative arc events) • Bytes 1 and 2 = 0 Command **199**; B0 = 12 reports this value.	3	1
36 **set gamma arc detection mode (NV)** (subcommand 10)	Controls the mode that indicates if an arc is considered to be present when the value of gamma is outside the threshold window. Send 3 data bytes: • Byte 0 = 10 (set gamma arc detection mode) • Bytes 1 and 2: ◦ 0 = Disabled ◦ 1 = Enabled Command **199**; B0 = 13 reports this value.	3	1
36 **set reflected power threshold**	Sets the threshold to which the reflected power measurement is compared when determining if an arc has occurred. The valid range of values is 0 to the maximum reflected power limit of the generator.	3	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
for arc detection (NV) (subcommand 11)	Send 3 data bytes: • Byte 0 = 11 (set reflected power threshold in watts for arc detection) • Bytes 1 and 2 = 0 (from 0 to maximum reflected power limit of the generator) Command **199**; B0 = 14 reports this value.		
38 **set tuning timeout value (NV)**	Sets the time in milliseconds that the generator is allowed to tune without finding a match before it turns off RF output and activates a fault. The unit stores this setting in nonvolatile memory. You cannot change this mode while RF output is on. The maximum value is 60,000. A value of 0 disables tuning timeout, causing the generator to tune indefinitely. This command applies only when the Type III tuning algorithm is active. Send 4 data bytes: • Bytes 0 to 3 = Tuning timeout value in milliseconds Command **138** reports this value.	4	1
39 **set communications watchdog timer**	Sets the communications watchdog timer value in milliseconds. Each communications interface has a unique watchdog timer that operates independently of all other interfaces. You can set up any combination of enable, disable, or timeout values among the interfaces. A value of 0 disables the watchdog timer. The timer value is volatile and defaults to 0 each time you turn the unit on. The maximum value is 65,535 milliseconds. The unit stores the watchdog timer value internally in 10-millisecond increments, and truncates any fractional remainder. The unit accepts a value of 1 to 9, but stores it as a timeout period of 10 milliseconds. Send 3 data bytes: • Byte 0 = Must be set to 0, 1, or 2 • Bytes 1 and 2 = Timer value in milliseconds as an unsigned short Command **139** reports this value.	3	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
40 **set host port timeout (NV)**	Sets the amount of time that the generator waits between bytes from the host before resetting and waiting for a new packet. Each Serial interface has its own unique host port timeout. Setting the host port timeout value for a given port (for example, port A) requires receiving this command from that port (port A). This command applies to serial ports only. Send 2 data bytes representing units of 10 milliseconds (send LSB first) for the timeout value. Valid values are 2 to 500 (20 milliseconds to 5.00 seconds): • Byte 0 and 1 = Timeout value Command **140** reports this value.	2	1
44 **set minimum tuning frequency (NV)**	Sets the minimum frequency in kHz that the generator uses for frequency tuning. The unit stores this parameter in nonvolatile memory. You cannot change this setting while RF output is on. The minimum frequency must be within the unit frequency range, less than or equal to the current start frequency, and less than or equal to the maximum tuning frequency. This command applies only when the Type III tuning algorithm is active. Send 4 data bytes: • Bytes 0 to 3 = Minimum tuning frequency Command **144** reports this value.	4	1
45 **set maximum tuning frequency (NV)**	Sets the maximum frequency in kHz that the generator uses for frequency tuning. The unit stores this parameter in nonvolatile memory. You cannot change this setting while RF output is on. The maximum frequency must be within the unit frequency range, greater than or equal to the current start frequency, and greater than or equal to the minimum tuning frequency. This command applies only when the Type III tuning algorithm is active. Send 4 data bytes: • Bytes 0 to 3 = Maximum tuning frequency Command **145** reports this value.	4	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
46 **set tuning start frequency (NV)**	Sets the frequency in kHz at which the generator starts frequency tuning when operating in fixed ignition mode. The unit stores this parameter in nonvolatile memory. You cannot change this setting while RF output is on. The tuning start frequency must be greater than or equal to the minimum tuning frequency and less than or equal to the maximum tuning frequency. This command applies only when the Type III tuning algorithm is active. Send 4 data bytes: • Bytes 0 to 3 = Tuning start frequency Command **146** reports this value.	4	1
48 **set fixed or variable frequency mode (NV)**	Sets the frequency control mode. You can change this mode while the RF output is on. The frequency mode cannot be changed to variable unless the unit is configured for variable frequency operation. While the RF output is on, changing to fixed frequency mode causes the unit to change immediately to the previously set fixed frequency. Changing to variable frequency mode causes the unit to output the initial frequency determined by the ignition mode first, and then to begin sweeping according to the frequency tuning algorithm. The unit stores this value in nonvolatile memory. Depending on the type of user card installed, this command can only be accepted when host control mode is active. The frequency mode is not allowed to change while a recipe is active. Send 1 data byte: • Byte 0 = 0 (fixed frequency mode) • Byte 0 = 1 (variable frequency mode) Command **148** reports this value.	1	1
58 **set retuning threshold (NV)**	Sets the tuning criteria level at which the frequency tuning algorithm determines that the generator requires retuning. The unit stores this parameter in nonvolatile memory. You cannot change this setting while RF output is on. Valid values are 1 to 3,000. This command applies only when the Type III tuning algorithm is active.	4	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	Send 4 data bytes: • Bytes 0 to 3 = Retuning threshold value Command **158** reports this value.		
60 **set tune delay (NV)**	Sets the time in milliseconds that the frequency tuning algorithm waits before beginning to tune the generator automatically. The unit stores this parameter in nonvolatile memory. You cannot change this setting while RF output is on. The maximum tune delay value is 60,000. This command applies only when the Type III tuning algorithm is active. Variable length transmit data. Send 2 data bytes: • Bytes 0 and 1 = Tune delay value in milliseconds Optional 4-byte version. Send 4 data bytes: • Bytes 0 to 3 = Tune delay value in milliseconds Command **160** reports this value.	2 or 4	1
61 **set fixed frequency**	Sets the generator output frequency in kHz when operating in fixed frequency mode. You can change the generator frequency while the RF output is on when operating in the fixed frequency mode. The fixed frequency is not allowed to change while a recipe is active. The fixed frequency value must be within the unit frequency range. Send 4 data bytes: • Bytes 0 to 3 = Generator frequency in kHz Command **161** reports this value.	4	1
69 **set serial port address and baud rate (NV)**	Sets the Serial address, baud rate, and RS-485 mode for the **Service** port on the front panel. The port must be active in the unit configuration. You cannot use this command to change the configuration of the port labeled **Serial**; you can change the **Serial** port configuration on the rear panel only by using the DIP switches. This command is successful only when issued from the **Serial** port or **ENET** port.	4	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned

	Default values for the serial ports:
	• Serial address = 1
	• Baud = 19,200
	• RS-485 mode = Off
	☞ **Important**
	The Serial broadcast mode is not supported, therefore if the Serial address is 0, the unit uses the default address of 1.
	Send 4 data bytes:
	• Byte 0 = **Serial** port selection. Valid value is 1:
	  ◦ 1= **Service** port
	• Byte 1 = Serial address, 1 to 31
	• Byte 2 = Baud rate 0 to 6:
	  ◦ 0 = 2400 baud
	  ◦ 1 = 4800 baud
	  ◦ 2 = 9600 baud
	  ◦ 3 = 19200 baud
	  ◦ 4 = 38400 baud
	  ◦ 5 = 57600 baud
	  ◦ 6 = 115200 baud
	• Byte 3 = RS-485 mode 0 or 1:
	  ◦ 0 = Off
	  ◦ 1 = On
	Command **212** reports this value.		

70 **set real-time clock**	Sets the system real-time clock to the time/date specified. The data transmitted must be encoded in binary coded decimal (BCD) format. For example, to set the seconds to 48, the data value transmitted must be 0x48. The real-time clock features automatic leap year compensation for years up to 2100. Send 7 data bytes: • Byte 0 = Seconds (valid values are 0 to 59)	7	1

Table 4-14. AE Host Commands (Continued)

<table>
<tr><th>Command</th><th>Description</th><th>Data Bytes Sent</th><th>Data Bytes Returned</th></tr>
<tr><td></td><td>Byte 1 = Minutes (valid values are 0 to 59)
Byte 2 = Hours (valid values are 0 to 23)
Byte 3 = Day of the week (valid values are 1 to 7; 1 = Sunday to 7 = Saturday)
Byte 4 = Date (valid values are 1 to 31)
Byte 5 = Month (valid values are 1 to 12)
Byte 6 = Year (valid values are 00 to 99)
Command 215 reports this value.</td><td></td><td></td></tr>
<tr><td>71
set system control</td><td>Sets a variety of system control parameters.
This command requires that you send a variable number of data bytes. The first data byte specifies the requested action; the following data bytes specify values. For example, if Byte 0 = 1, the command sets the default gateway. See below for more information.
This command allows you to send subcommands. The name and function of a subcommand depends on the value of the first byte:<table><tr><th>Byte 0 =</th><th>Subcommand</th></tr><tr><td>0</td><td>IP address</td></tr><tr><td>1</td><td>Default gateway</td></tr><tr><td>2</td><td>Subnet mask</td></tr><tr><td>5</td><td>DHCP client enable</td></tr><tr><td>200</td><td>Domain name</td></tr><tr><td>202</td><td>DNS server IP address</td></tr><tr><td>203</td><td>DNS configuration</td></tr></table>☞ Important
AE commands use little endian byte ordering (LSB first). For example, if the IP address is 10.1.2.3, then send the bytes:
Byte 0 = 0 (set IP address)
Byte 1 = 3
Byte 2 = 2
Byte 3 = 1
Byte 4 = 10</td><td>2, 3, 5, or 1 to 65</td><td>1</td></tr>
</table>

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	Command **204** reports these values.		
71 **set IP address (NV)** (subcommand 0)	Sets the unit network IP address. Make sure to check with your network administrator before setting any IP address on an established network. The unit stores the address in nonvolatile memory. Once you set the parameters, you must cycle power to the unit for the new parameters to take effect. Note that the IP address is sent LSB first; that is, Byte 1 = least significant octet of the IP address. This subcommand will only be accepted if the DHCP client is disabled. Send 5 data bytes: • Byte 0 = 0 (set IP address) • Bytes 1 to 4 = IP address Command **204**; B0 = 0 reports this value.	5	1
71 **set default gateway address (NV)** (subcommand 1)	Sets the unit network default gateway address. The unit stores the address in nonvolatile memory and restores it each time you cycle power. Once you set the parameters, you must cycle power to the unit for the new parameters to take effect. Note that the default gateway address is sent LSB first; that is, Byte 1 = least significant octet of the default gateway address. This subcommand will only be accepted if the DHCP client is disabled. Send 5 data bytes: • Byte 0 = 1 (set default gateway address) • Bytes 1 to 4 = Default gateway address value Command **204**; B0 = 1 reports this value.	5	1
71 **set subnet mask (NV)** (subcommand 2)	Sets the unit network subnet mask. The unit stores the subnet mask in nonvolatile memory and restores it each time you cycle power. Once you set the parameters, you must cycle power to the unit for the new parameters to take effect. Note that the subnet mask is sent LSB first; that is, Byte 1 = least significant octet of the subnet mask. This subcommand will only be accepted if the DHCP client is disabled.	5	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	Send 5 data bytes: • Byte 0 = 2 (set subnet mask) • Bytes 1 to 4 = mask Command **204**; B0 = 2 reports this value.		
71 **set DHCP client enable (NV)** (subcommand 5)	Sets the unit network DHCP client enable mode. The unit stores the DHCP client enable mode in nonvolatile memory and restores the setting each time you cycle power. Once you set the parameters, you must cycle power to the unit for the new parameters to take effect. Send 2 data bytes: • Byte 0 = 5 (set DHCP client enable) • Byte 1 = DHCP client enable mode 0 or 1: ◦ 0 = Disabled ◦ 1 = Enabled Command **204**; B0 = 5 or 8 reports this value.	2	1
71 **set domain name (NV)** (subcommand 200)	Sets the network domain name. The domain name is stored in nonvolatile memory and is restored each time the unit is powered on. The length of the domain name is 0 to 64 ASCII characters. Valid characters for the domain name are letters, digits, hyphens, and dots. This subcommand will only be accepted if DHCP mode is disabled. The factory default value is null. Send a variable number of data bytes based on the length of the domain name: • Byte 0 = 200 (set domain name) • Variable number of bytes (0 to 64) = Domain name in ASCII characters Command **204**; B0 = 200 reports this value.	Varies	1
71 **set DNS server IP address (NV)** (subcommand 202)	Sets the IP address for the DNS server. The DNS server IP address is stored in nonvolatile memory and is restored each time the unit is powered on. This value should be sent LSB first. That is, data Byte 1 = the least significant octet of the DNS server IP address. This subcommand will only be accepted if	5	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	DHCP mode is disabled. The factory default value is equal to the value of the default gateway address. Send 5 data bytes: • Byte 0 = 202 (set DNS server IP address) • Bytes 1 to 4 = DNS server IP address Command **204**; B0 = 202 reports this value.		
71 **set DNS configuration (NV)** (subcommand 203)	Sets the DNS configuration to one of two modes. • Mode 0 = The DHCP server will not be requested to perform DNS updates, nor will the client perform any DNS updates. • Mode 1 = The DHCP server will be requested to perform the IP-address-to-FQDN (PTR RR) updates, and the FQDN-to-address (A RR) updates will be performed by the client. This setting is stored in nonvolatile memory and is restored each time the unit is powered on. Send 3 data bytes: • Byte 0 = 203 (set DNS configuration) • Bytes 1 and 2 = DNS configuration mode 0 or 1: ◦ 0 = Mode 0 ◦ 1 = Mode 1 Command **204**; B0 = 203 reports this value.	3	1
93 **set pulsing frequency (NV)**	Sets the RF pulsing frequency in Hz. The input parameter value is 2 Hz to 100,000 Hz. This value has both a volatile and a nonvolatile storage mode, depending on the current configuration (see command **26**). This command is accepted in both master and slave modes, but will have no effect when operating in slave mode. When operating in master mode, setting the pulsing frequency to 0 disables pulsing. All restrictions on pulsing frequency, duty cycle, and minimum on-time apply to both master and slave modes.	4	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	In volatile storage mode, the unit will always come up with pulsing disabled until a valid command has been received for both pulsing frequency and duty cycle. Any combination of pulsing frequency and duty cycle that results in an output on or off time of less than 5 μs is invalid and will return a CSR error code. The maximum RF active measurement delay for pulsing is in effect for all pulse on times greater than or equal to the inflection point, which is set by command **118** (subcommand 77), set pulsing measurement delays. The pulse on time can be reduced below the inflection point to a minimum of 5 μs, but with reduced measurement accuracy. Send 4 data bytes: • Bytes 0 to 3 = Pulsing frequency in Hz Command **193** reports this value.		
95 **set diagnostic command**	Controls the diagnostic self-test. The unit must be in diagnostic control mode before using this command (see command **14**). Sending a 0 disables the self-test and clears the self-test results from the previous run (if any). Sending a value of 1 clears the self-test results from the previous run (if any) and starts the diagnostic self-test. This command will fail when the RF output is on. If this command is sent when a diagnostic self-test is in progress, the unit will return CSR 12. Send 1 byte: • Byte 0 = Enable/disable diagnostics: ◦ 0 = Disable diagnostics mode ◦ 1 = Enable diagnostic mode and start diagnostics Command **244** returns the results from the diagnostic self-test.	1	1
96 **set pulsing duty cycle (NV)**	Sets the RF pulsing duty cycle in percentage. The valid input parameter value is 1% to 99% when the pulsing frequency is in the range of 4 Hz to 2 kHz and represents the output on-time.	2	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	The unit can store this value in volatile or nonvolatile memory. You can set the memory mode (volatile or nonvolatile memory) with command **26**. ☞ **Important** This command is accepted in both master and slave modes, but it has no effect when operating in slave mode If the unit is a master unit, setting the pulsing duty cycle to 0 disables pulsing. If the master unit is operating in volatile storage mode, the unit always comes up with pulsing disabled. You must enter a valid command for pulsing frequency and duty cycle to enable pulsing. Any combination of pulsing frequency and duty cycle that results in an output on-time or off-time less than 5 µs is invalid and returns a CSR error code. The maximum RF active measurement delay for pulsing is in effect for all pulse on times greater than or equal to the inflection point, which is set by command **118** (subcommand 77). The pulse on time can be reduced below the inflection point to a minimum of 5 µs, but with reduced measurement accuracy. All restrictions on pulsing frequency, duty cycle, and minimum on-time apply to both master and slave modes.		

Pulsing Frequency (Hz)	Minimum Duty Cycle (%)	Maximum Duty Cycle (%)
2	50	50
3	24	76
4 to 2,000	1	99
> 2,000	Limited by minimum on-	Limited by minimum on-

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	<table><tr><th>Pulsing Frequency (Hz)</th><th>Minimum Duty Cycle (%)</th><th>Maximum Duty Cycle (%)</th></tr><tr><td></td><td>or off-time of 5 µs</td><td>or off-time of 5 µs</td></tr></table> Send 2 data bytes: • Bytes 0 and 1 = Duty cycle in % Command **196** reports this value.		
118 **set operational parameters**	This command allows you to send subcommands to set several operational parameters. The name and function of a subcommand depend on the value of the first two bytes: <table><tr><th>Bytes 0 and 1</th><th>Subcommand</th></tr><tr><td>1</td><td>Set frequency step minimum</td></tr><tr><td>2</td><td>Set frequency step maximum</td></tr><tr><td>3</td><td>Set step up gain</td></tr><tr><td>4</td><td>Set step down gain</td></tr><tr><td>6</td><td>Set gamma threshold high</td></tr><tr><td>7</td><td>Set gamma threshold low</td></tr><tr><td>8</td><td>Set maximum tuning count</td></tr><tr><td>15</td><td>Set ignition mode</td></tr><tr><td>16</td><td>Set CEX lock mode</td></tr><tr><td>17</td><td>Set tuning scan step size</td></tr><tr><td>20</td><td>Set CEX output mode</td></tr><tr><td>21</td><td>Set gamma threshold mode</td></tr><tr><td>22</td><td>Set tuning step time</td></tr><tr><td>23</td><td>Set tuning gain delay</td></tr><tr><td>43</td><td>Set IMD filter frequency</td></tr><tr><td>44</td><td>Set CEX output phase offset</td></tr><tr><td>45</td><td>Set user power correction</td></tr><tr><td>47</td><td>Set auto stability configuration</td></tr><tr><td>52</td><td>Set frequency tuning mode</td></tr></table>	varies	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	Bytes 0 and 1 / Subcommand 53 — Set user readback filter configuration 66 — Set reflected power timer 67 — Set sweep auto frequency mode 69 — Set pulsing measurement warning threshold 72 — Set user card low scale enable mode 73 — Set statistics pulse mask time 74 — Set statistics sample rate 75 — Set statistics sample count 77 — Set pulsing measurement delays 78 — Set sweep frequency step direction 79 — Set control loop gain 81 — Set sweep gamma average mask enable 83 — Set sweep skip frequency range 86 — Set statistics acquisition mode 93 — Set fixed frequency control 94 — Set frequency tuning mask time 300 — Set RF bias DAC manual mode 301 — Set RF bias DAC offset Command **248** reports these values.		
118 **set frequency step minimum (NV)** (subcommand 1)	Sets the frequency step minimum used during the tuning process. This is the smallest step size used by the frequency tuning algorithm when making frequency step changes. Valid values for frequency step minimum are 10 Hz to 96,000 Hz. The frequency step minimum cannot be greater than the frequency step maximum. This is the smallest step size used by the tuning algorithm when making frequency step changes.	6	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	This subcommand applies only when the Type III tuning algorithm is active. Send 6 data bytes: • Bytes 0 and 1 = 1 (set frequency step minimum), LSB first • Bytes 2 to 5 = Frequency step minimum value Command **248**; B0 = 1 reports this value.		
118 **set frequency step maximum (NV)** (subcommand 2)	Sets the frequency step maximum used during the frequency tuning process. This is the largest step size used by the frequency tuning algorithm when making frequency step changes. Valid values for frequency step maximum must be greater than or equal to frequency step minimum, and less than or equal to 200,000 Hz. The actual frequency step maximum used by the frequency tuning algorithm is determined by the frequency step minimum multiplied by a power of 2. Therefore, the actual frequency step maximum is the value sent by this subcommand reduced to the next lower power of 2. This subcommand applies only when the Type III tuning algorithm is active. Send 6 data bytes: • Bytes 0 and 1 = 2 (set frequency step maximum), LSB first • Bytes 2 to 5 = Frequency step maximum value Command **248**; B0 = 2 reports this value.	6	1
118 **set step up gain (NV)** (subcommand 3)	Sets the step up gain used during the frequency tuning process. This parameter sets the magnitude of frequency step increase when the error is decreasing (frequency step size is increasing). A value of *n* sets the gain to 2*n*. Valid values are 1 to 7. This subcommand applies only when the Type III tuning algorithm is active. Send 4 data bytes: • Bytes 0 and 1 = 3 (set step up gain), LSB first	4	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	• Bytes 2 and 3 = Step up gain value Command **248**; B0 = 3 reports this value.		
118 **set step down gain (NV)** (subcommand 4)	Sets the step down gain used during the frequency tuning process. This parameter sets the magnitude of frequency step decrease when the error is increasing (frequency step size is decreasing). A value of *n* sets the gain to 2-*n*. Valid values are 1 to 7. This subcommand applies only when the Type III tuning algorithm is active. Send 4 data bytes: • Bytes 0 and 1 = 4 (set step down gain), LSB first • Bytes 2 and 3 = Step down gain value Command **248**; B0 = 4 reports this value.	4	1
118 **set gamma threshold high (NV)** (subcommand 6)	Sets the gamma threshold high used during the frequency tuning process. The generator uses the high threshold after first attempting (and failing) to achieve a tuning criteria less than the low threshold. Valid values for gamma threshold high must be greater than or equal to gamma threshold low and less than or equal to 3,000. This subcommand applies only when the Type III tuning algorithm is active. Send 4 data bytes: • Bytes 0 and 1 = 6 (set gamma threshold high), LSB first • Bytes 2 and 3 = Gamma threshold high value Command **248**; B0 = 6 reports this value.	4	1
118 **set gamma threshold low (NV)** (subcommand 7)	Sets the gamma threshold low used during the frequency tuning process. The generator first attempts to achieve a tuning criterion less than the low threshold. If the unit cannot find a tuning criterion less than the low threshold, and if the maximum tuning counter expires, the generator gives up and tries the high threshold. Valid values for	4	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	gamma threshold low must be less than or equal to gamma threshold high. This subcommand applies only when the Type III tuning algorithm is active. Send 4 data bytes: • Bytes 0 and 1 = 7 (set gamma threshold low), LSB first • Bytes 2 and 3 = Gamma threshold low value Command **248**; B0 = 7 reports this value.		
118 **set maximum tuning count (NV)** (subcommand 8)	Sets the maximum tuning count used during the frequency tuning process. This first sets the number of attempts to tune to the low threshold before then trying the high threshold. Valid values are 0 to 65,535. This subcommand applies only when the Type III tuning algorithm is active. Send 4 data bytes: • Bytes 0 and 1 = 8 (set maximum tuning count, LSB first) • Bytes 2 and 3 = Maximum tuning count Command **248**, B0 = 8 reports this value.	4	1
118 **set ignition mode (NV)** (subcommand 15)	Sets the frequency tuning ignition mode: • Fixed frequency mode: The generator first turns on at the specified start frequency (see command **46**), and then begins tuning. • Variable frequency mode: The generator first turns on at the maximum frequency, and will then compute the gamma^2 value and compare it to the ignition threshold. If the gamma^2 value is less than the threshold, the unit declares ignition and begins tuning from that frequency. If the unit does not detect ignition, it steps the frequency down and repeats the process until it detects ignition, or until the tuning timeout has expired (see command **38**). • Frequency scan mode: The unit first scans the frequency band for the lowest gamma^2 value.	4	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	The frequency tuning algorithm begins tuning from that frequency. The unit will not accept this subcommand if RF output is on. This subcommand applies only when the Type III tuning algorithm is active. Send 4 data bytes: • Bytes 0 and 1 = 15 (set ignition mode) • Bytes 2 and 3 = Ignition mode 0, 1, 2, or 3: ◦ 0 = Fixed frequency ignition mode ◦ 1 = Variable frequency ignition mode ◦ 2 = Scan frequency ignition mode Command **248**; B0 = 15 reports this value.		
118 **set CEX lock mode (NV)** (subcommand 16)	Sets the CEX lock mode. When CEX is enabled, the CEX input is phase-locked to the RF output. This command is only available when the unit is factory configured to enable the CEX feature. Send 4 data bytes: • Bytes 0 and 1 = 16 (set CEX lock mode) • Bytes 2 and 3 = CEX lock mode 0, 1, 2, or 3: ◦ 0 = CEX disabled ◦ 1 = Lock to output ◦ 2 = Lock to output ◦ 3 = Lock to output Command **248**; B0 = 16 reports this value.	4	1
118 **set tuning scan step size (NV)** (subcommand 17)	Sets the tuning scan step size used in scan frequency ignition mode. You cannot change this value while RF output is on. The valid range of values is 5,296 Hz to 193,353 Hz. This subcommand applies only when the Type III tuning algorithm is active. Send 6 data bytes: • Bytes 0 and 1 = 17 (set tuning scan step size) • Bytes 2 to 5 = Tuning scan step size in Hz Command **248**; B0 = 17 reports this value.	6	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
118 **set CEX output mode (NV)** (subcommand 20)	Sets the CEX output mode. You can control the signal that is output from the **CEX Out** connector using this subcommand. This subcommand is only available when the unit is factory configured to enable the CEX feature. ☞ **Important** If CEX lock mode is changed from lock to output mode to disabled, then CEX output will be turned off and command **248** (subcommand 20) will report mode 2 (CEX output off). The previous CEX output mode is remembered, and if the CEX lock mode is subsequently changed to lock to output mode, the previously stored output mode is restored. Send 4 data bytes: • Bytes 0 and 1 = 20 (set CEX output mode) • Bytes 2 and 3 = CEX output mode 0, 1, or 2: ◦ 0 = CEX output on ◦ 1 = CEX output on ◦ 2 = CEX output off Command **248**; B0 = 20 reports this value.	4	1
118 **set gamma threshold mode (NV)** (subcommand 21)	Sets the gamma threshold mode. In mode 0, the tuning algorithm uses the gamma threshold high value set by command **118** (subcommand 6). In mode 1, the tuning algorithm uses the power profile to limit gamma threshold high to values that will not exceed the generator's ability to deliver the power requested by the setpoint command (command **8**). This subcommand applies only when the Type III tuning algorithm is active. Send 4 data bytes: • Bytes 0 and 1 = 21 (set gamma threshold mode) • Bytes 2 and 3 = Gamma threshold mode 0 or 1: ◦ 0 = User gamma threshold high ◦ 1 = Power profile gamma threshold high Command **248**; B0 = 21 reports this value.	4	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
118 **set tuning step time (NV)** (subcommand 22)	Sets the tuning step time. This command is not available while the RF output is on. Valid values are 8 µs to 4,096 µs. The resolution for setting tuning step time is currently 1.016 µs. The unit rounds all values of tuning step time to the nearest multiple of 1.016 µs. This subcommand applies only when the Type III tuning algorithm is active Send 4 data bytes: • Bytes 0 and 1 = 22 (set tuning step time) • Bytes 2 and 3 = Tuning step time in µs Command **248**; B0 = 22 reports this value.	4	1
118 **set tuning gain delay (NV)** (subcommand 23)	Sets the tuning gain delay. Valid values are 0 to 7. This parameter specifies the delay before increasing the step size after a change in direction. This subcommand applies only when the Type III tuning algorithm is active. Send 4 data bytes: • Bytes 0 and 1 = 23 (set tuning gain delay) • Bytes 2 and 3 = Tuning gain delay 0 to 7 Command **248**; B0 =23 reports this value.	4	1
118 **set IMD filter frequency (NV)** (subcommand 43)	Sets the frequency in kHz used by the IMD filter. The frequency range is 325 kHz to 460 kHz. You can also send a value of 0, which disables this feature. Send 4 data bytes: • Bytes 0 and 1 = 43 (set IMD filter frequency) • Bytes 2 and 3 = IMD filter frequency in kHz Command **248**; B0 = 43 reports this value.	4	1
118 **set CEX output phase offset (NV)** (subcommand 44)	Sets the CEX output phase offset value in tenths of degrees. This subcommand is only available when the unit is factory configured to enable the CEX feature. Valid values are 0 to 3,600, representing 0 to 360 degrees in 0.1-degree increments.	4	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	Send 4 data bytes: • Bytes 0 and 1 = 44 (set CEX output phase offset) • Bytes 2 and 3 = CEX output phase offset value in tenths of degrees Command **248**; B0 = 44 reports this value.		
118 **set user power correction (NV)** (subcommand 45)	Sets the user power correction coefficient in hundredths of a percent. This parameter specifies an amount of correction that is applied to the user setpoint to adjust RF output power. A value of 0 is also valid and disables the user power correction feature. This subcommand is only available when the unit is factory configured to enable the user power correction feature. The range of valid values is also factory configured. ☞ **Important** The user power correction feature is not applicable while operating in external regulation mode. Send 4 data bytes: • Bytes 0 and 1 = 45 (set user power correction coefficient) • Bytes 2 and 3 (signed short) = User power correction coefficient in hundredths of a percent Command **248**; B0 = 45 reports this value.	4	1
118 **set auto-stability configuration (NV)** (subcommand 47)	Sets the configuration parameters for the auto-stability feature. This feature will temporarily be disabled when RF Bias DAC manual mode is enabled. Send 6 data bytes: • Bytes 0 and 1 = 47 (set auto-stability configuration) • Bytes 2 and 3 (NV) = Auto-stability configuration parameter 1 to 8: ◦ 1 = Auto-stability mode (NV)	6	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	◦ 2 = Auto-stability start delay (NV) ◦ 3 = Auto-stability enter threshold (NV) ◦ 4 = Auto-stability exit threshold (NV) ◦ 5 = Auto-stability ramp rate (NV) ◦ 6 = Auto-stability step size (NV) ◦ 7 = Auto-stability tuning threshold 1 (NV) ◦ 8 = Auto-stability tuning threshold 2 (NV) • Bytes 4 and 5 = Auto-stability configuration value: ◦ Where parameter = 1 (set auto-stability mode): ▪ Mode 0 = Disabled ▪ Mode 1 = Standard search mode ▪ Mode 2 = Wide search mode ▪ Mode 3 = Narrow search mode ▪ Mode 4 = Reversing search mode ◦ Where parameter = 2 (set auto-stability start delay): ▪ Valid values are 0 milliseconds to 65,535 milliseconds. ◦ Where parameter = 3 (set auto-stability enter threshold): ▪ Valid values are 0 to 3,000. ◦ Where parameter = 4 (set auto-stability exit threshold): ▪ Valid values are 0 to 3,000. ◦ Where parameter = 5 (set auto-stability ramp rate): ▪ Valid values are 0 to 9,929 in units of 0.1 µs. ◦ Where parameter = 6 (set auto-stability step size):		

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	▪ Valid values are 1 to 256 in units of counts. ◦ Where parameter = 7 (set auto-stability tuning threshold 1): ▪ Valid values are 0 to 4,096. ◦ Where parameter = 8 (set auto-stability tuning threshold 2): ▪ Valid values are 0 to 4,096. Command **248**; B0 = 47 reports this value.		
118 **set frequency tuning mode (NV)** (subcommand 52)	This subcommand sets various frequency tuning modes. This parameter specifies the behavior when switching between tuning modes while RF is on. Variable length transmit data. Send 4 data bytes: • Bytes 0 and 1 = 52 (set frequency tuning mode), LSB first • Bytes 2 and 3 = Variable to fixed frequency tuning mode ☞ **Important** Sending this command with 4 transmit data bytes sets the variable to fixed frequency tuning mode. Optional 6-byte command transmit format. Send 6 data bytes: • Bytes 0 and 1 = 52 (set frequency tuning mode), LSB first • Bytes 2 and 3 = Frequency tuning mode command: ◦ Tuning mode command 0 = Set variable to fixed frequency tuning mode ◦ Tuning mode command 1 = Set fixed to variable frequency tuning mode • Bytes 4 and 5 = Tuning mode:	4 or 6	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	◦ When tuning mode command = 0: Set variable to fixed frequency tuning: mode: ▪ Mode 0 = Remain at tuned frequency ▪ Mode 1 = Jump to fixed frequency value ▪ Mode 2 = Ramp to fixed frequency value ◦ When tuning mode command = 1: Set fixed to variable frequency tuning mode: ▪ Mode 0 = Start tuning from current fixed frequency ▪ Mode 1 = Start tuning from start frequency Command **248**; B0 = 52 reports this value.		
118 **set user readback filter configuration (NV)** (subcommand 53)	Sets the user readback filter configuration. When Byte 2 = 1, the fast readback update feature will be enabled, which also enables the filtering of forward power, reflected power, and impedance from both the analog port and the Serial interface. The filter time constant is adjustable from 7 µs to 432,537 µs. Send 7 data bytes: • Bytes 0 and 1 = 53 (set user readback filter configuration) • Byte 2 = Enables/disables fast user readback updates: ◦ 0 = Disable ◦ 1 = Enable • Bytes 3 to 6 = User readback filter time constant in µs (signed long) Command **248**; B0 = 53 reports this value.	7	1
118 **set reflected power timer** (subcommand 66)	Sets the configuration parameters for the reflected power timer feature. This feature sets the maximum amount of time that the unit will keep the RF output turned on when the measured reflected power is greater than the specified threshold. There are independent timers for the reflected power timer fault and warning. Each timer has an associated reflected power threshold and timeout value. The reflected power threshold and timeout value set the	6 or 8	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	amount of time that can elapse before the unit will assert a fault or warning when the measured reflected power is greater than the corresponding threshold. Each timer will begin counting when the generator measures reflected power greater than the corresponding threshold. If reflected power stays above the specified threshold continuously for longer than the timeout period, the generator will assert the appropriate fault or warning. If the reflected power timer fault is activated, the RF output will be turned off. The reflected power timer warning will not turn off the RF output when it is asserted. The timers will stop counting if the measured reflected power drops to more than 5 W below the associated threshold, and the timeout counter will be reset. The timer will resume counting if the generator again measures reflected power greater than the threshold. The reflected power timer parameters are retained as long as AC power is applied. The initial value for reflected power timeout is set to 0, which disables the timer. The initial value for reflected power threshold is set equal to the user reflected power limit. Send 6 data bytes: • Bytes 0 and 1 = 66 (set reflected power timer) • Bytes 2 and 3 = Reflected power timer subcommand (LSB first): ◦ Subcommand 1 = Set reflected power fault timeout ◦ Subcommand 2 = Set reflected power fault threshold ◦ Subcommand 5 = Set reflected power warning threshold ◦ Subcommand 6 = Reset reflected power warning count ◦ Subcommand 7 = Reset reflected power fault count		

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned

	• Bytes 4 and 5 = Reflected power time configuration value (LSB first)
	  ◦ Subcommand 1 = Set reflected power timeout value:
	    ▪ Valid values are 0 seconds to 3,600 seconds
	  ◦ Subcommand 2 = Set reflected power fault threshold value:
	    ▪ Valid values are 10 W to the user reflected power limit (see command **5**)
	  ◦ Subcommand 5 = Set reflected power warning threshold:
	    ▪ Valid values are 10 W to the user reflected power limit (see command **5**)
	  ◦ Subcommand 6 = Reset reflected power warning count:
	    ▪ Value must be set to 0
	  ◦ Subcommand 7 = Reset reflected power fault count:
	    ▪ Value must be set to 0
	8-byte command transmit format for subcommands 3 and 4
	Send 8 data bytes:
	• Bytes 0 and 1 = 66 (set reflected power timer)
	• Bytes 2 and 3 = Reflected power timer subcommand number (LSB first)
	  ◦ Subcommand 3 = Set reflected power fault timeout
	  ◦ Subcommand 4 = Set reflected power warning timeout
	• Bytes 4 to 7 = Reflected power timer configuration value (LSB first)
	  ◦ Subcommand 3 = Set reflected power fault timeout. Valid values are 0 µs to 3,600,000 µs		

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	◦ Subcommand 4 = Set reflected power warning timeout. Valid values are 0 µs to 3,600,000 µs ☞ **Important** The reflected power timer parameters are retained as long as AC power is applied. The initial value for both fault and warning timeout values is set to 0 which disables the timers. The initial value for both fault and warning threshold values is set equal to the user reflected power limit. The granularity for commands 3 and 4 is 4 milliseconds. The parameter value received is rounded down to the nearest multiple of 4 milliseconds. The reflected power is checked at an interval of 4 milliseconds. Command **248**; B0 = 66 reports this value.		
118 **set sweep auto frequency mode (NV)** (subcommand 67)	Sets the sweep auto-frequency mode. This mode determines the RF output frequency that, while pulsing, the generator will first output on the rising edge of each pulse. When disabled, the frequency will be the same frequency as at the end of the previous pulse. When enabled, the RF output frequency that is present when sweep is first enabled is stored internally. The RF output is controlled to that stored frequency on the rising edge of each pulse. Once the RF output is back on, the tuning algorithm controls the frequency according to the sweep configuration. The unit will also make the direction of the first frequency tuning step according to the sweep frequency step direction (see command **118** [subcommand 78]), and the frequency step size will be the frequency step maximum size. This subcommand applies only when the Type III tuning algorithm is active. Send 4 data bytes: • Bytes 0 and 1 = 67 (set sweep auto frequency mode)	4	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	• Bytes 2 and 3 (unsigned short) = Sweep auto-frequency mode 0 or 1: ◦ 0 = Disabled ◦ 1 = Enabled Command **248**; B0 = 67 reports this value.		
118 **set pulsing measurement warning threshold (NV)** (subcommand 69)	Sets the warning thresholds for pulsing frequency and duty cycle. When the actual measured error percentage exceeds this threshold, a warning is activated. This alerts the user that the actual pulsing frequency or duty cycle does not match the requested value. Valid values are 0% to 100%. Any value from 0 to 3 disables the corresponding warning. Send 6 data bytes: • Bytes 0 and 1 = 69 (set pulsing measurement warning threshold) • Bytes 2 and 3 = Pulsing measurement warning threshold selection, 1 or 2: ◦ 1 = Set pulse frequency warning threshold ◦ 2 = Set pulse duty cycle warning threshold • Bytes 4 and 5 = Pulse warning threshold in % (valid values are 0 to 100) Command **248**; B0 = 69 reports this value.	6	1
118 **set user card low scale enable mode** (subcommand 72)	Sets the user card low scale enable mode, which determines the scaling of the user card analog setpoint input and analog power monitor output. This mode is only active while operating in user control mode and has no effect in any other control mode. When disabled, the standard scale factor is in effect, and no analog inputs nor outputs are modified in any way. When enabled, the setpoint generated by the user card analog setpoint input is divided by 10, such that a 10 V setpoint input will generate a setpoint equal to 10% of full scale. The power monitor values are multiplied by 10 such that a power value equal to 10% of full scale generates a 10 V analog power monitor output. This parameter is volatile and defaults to disabled each time the generator is power cycled. Some units do	4	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	not accept this command in all control modes. This command will not be accepted if a recipe is active. Send 4 data bytes: • Bytes 0 and 1 = 72 (set user card low scale enable mode) • Bytes 2 and 3 (unsigned short) = User card low scale enable mode 0 or 1: ◦ 0 = Disabled ◦ 1 = Enabled Command **248**; B0 = 72 reports this value.		
118 **set statistics pulse mask time (NV)** (subcommand 73)	This command sets the statistics pulse mask time in either time or % mode. The statistics pulse mask time determines the portion of the pulse that is masked off and excluded for statistics measurements. When setting the statistics pulse mask time in time mode, the mask time begins when the measurement mask time has expired. The mask time begins when the measurement mask time has expired. When setting the statistics pulse mask time in % mode, the mask time begins at the beginning of the pulse. The range of valid values for statistics pulse mask time in time mode is 0 to 10,000, representing 0 µs to 1,000.0 µs. The range of valid values for statistics pulse mask time in % mode is 0% to 99%. The actual mask time in % mode cannot exceed 4.16 µs. The actual mask time can be shorter or longer than the requested mask time (see command **248** [subcommand 73]). ☞ **Important** The pulse mask mode must match the parameter type requested in order for the command to be successful. Variable length transmit data. Send 4 data bytes: • Bytes 0 and 1 = 73 (set statistics pulse mask time), LSB first	4 or 6	1

Table 4-14. AE Host Commands (Continued)

<table>
<tr><th>Command</th><th>Description</th><th>Data Bytes Sent</th><th>Data Bytes Returned</th></tr>
<tr><td></td><td>
Bytes 2 and 3 = Statistics pulse mask time in tenths of µs (unsigned short)
Optional 6-byte command transmit format
Send 6 data bytes:

Bytes 0 and 1 = 73 (set statistics pulse mask time), LSB first
Bytes 2 and 3 = 0 (set statistics pulse mask mode):
0 = Time mode
1 = % mode
Bytes 2 and 3 = 1 (set statistics pulse mask time in tenths of µs
Bytes 2 and 3 = 3 (set statistics pulse mask time in %)
Bytes 4 and 5 = Statistics pulse mask time

Command 248; B0 = 73 reports this value.
</td><td></td><td></td></tr>
<tr><td>118
set statistics sample rate (NV)
(subcommand 74)</td><td>
Sets the statistics sample rate. The statistics sample rate is only accepted while in statistics sample mode, and determines the rate at which data samples are obtained and used to calculate the statistical data.
Send 6 data bytes:

Bytes 0 and 1 = 74 (set statistics sample rate)
Bytes 2 and 3 = Statistics sample rate selection to subcommand 1:
Subcommand 1 = Set statistics sample rate for power measurements
Bytes 4 and 5 = Statistics sample rate (LSB first):
When subcommand in Bytes 2 and 3 = 1, valid values are 1 µs to 125 µs

Command 248; B0 = 74 reports this value.
</td><td>6</td><td>1</td></tr>
</table>

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
118 **set statistics sample count (NV)** (subcommand 75)	Sets the statistics sample count or pulse count. The statistics sample count or pulse count determines the number of data samples obtained and used to calculate the statistical data. The statistics pulse count is applicable in pulse mode and determines the number of pulses used to calculate the statistical data. Send 6 data bytes: • Bytes 0 and 1 = 75 (set statistics sample count) • Bytes 2 and 3 = Statistics sample count selection 1 or 2: ◦ Subcommand 1 = Set statistics sample count for statistics sample mode ◦ Subcommand 2 = Set statistics pulse count for statistics pulse mode • Bytes 4 and 5 = Statistics sample count value (LSB first): ◦ When subcommand = 1, valid values are 1 to 4,096 ◦ When subcommand = 2, valid values are 1 to 4,096 Command **248**; B0 = 75 reports this value.	6	1
118 **set pulsing measurement delays (NV)** (subcommand 77)	Sets the delay times and inflection point for control loop/measurement updates during pulsing. The maximum measurement delay must be greater than or equal to the minimum measurement delay. The inflection point must be greater than or equal to twice the maximum measurement delay. If the inflection point is set to minimum, then the maximum measurement delay can be increased to inflection point –5 µs). Send 8 data bytes: • Bytes 0 and 1 = 77 (set pulsing measurement delays), LSB first • Bytes 2 and 3 = Minimum measurement delay (valid range is 1 µs to 4 µs) • Bytes 4 and 5 = Maximum measurement delay (valid range is 1 µs to 496 µs)	8	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	• Bytes 6 and 7 = Inflection point (valid range is 25 µs to 1,000 µs) Command **248**; B0 = 77 reports this value.		
118 **set sweep frequency step direction (NV)** (subcommand 78)	Sets the sweep frequency step direction. The specified direction is only used for the first frequency step after RF is turned on when the unit has sweep auto frequency mode disabled. If sweep auto frequency mode is enabled, then the step direction applies to the first frequency step after the rising edge of each pulse while pulsing. Applies only when the Type III tuning algorithm is active, and is not available while the RF output is on. Send 4 data bytes: • Bytes 0 and 1 = 78 (set sweep frequency step direction), LSB first • Bytes 2 and 3 = Sweep frequency step direction (unsigned short): ◦ 0 = Step up (increase frequency) ◦ 1 = Step down (decrease frequency) Command **248**; B0 = 78 reports this value.	4	1
118 **set control loop gain** (subcommand 79)	Sets the control loop gain used by the power control loop. Valid values for control loop gain are 49 to 500. This parameter is volatile and is not retained after an AC power cycle. Send 4 data bytes: • Bytes 0 and 1 = 79 (set control loop gain), LSB first • Bytes 2 and 3 = Control loop gain value Command **248**; B0 = 79 reports this value.	4	1
118 **set sweep gamma average mask enable (NV)** (subcommand 81)	Sets the sweep gamma average mask enable. When enabled, the sweep gamma average mask causes all gamma squared samples to be discarded except for the last one immediately prior to the tuning frequency step. When disabled, the unit accumulates all the gamma squared average data and uses the data to determine the next frequency step. This subcommand applies only when the Type III tuning	4	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	algorithm is active, and is not available while the RF output is on. Send 4 data bytes: • Bytes 0 and 1 = 81 (set sweep gamma average mask enable), LSB first • Bytes 2 and 3 = Sweep gamma average mask enable (unsigned short): ◦ 0 = Disabled ◦ 1 = Enabled Command **248**; B0 = 81 reports this value.		
118 **set sweep skip frequency range (NV)** (subcommand 83)	Sets the sweep skip frequency range in kHz. The minimum and maximum of the frequency range must be within the unit frequency range, and the maximum must be greater than or equal to the minimum. Additionally, the range specified must not be greater than 200 kHz. Setting both minimum and maximum frequencies to 0 disables this feature. When this feature is enabled, the tuning algorithm will exclude or skip frequencies within the specified range when automatically tuning the generator. If the tuning algorithm attempts to go to a frequency that is within the skip frequency range, the frequency will jump to either the minimum or maximum skip frequency, depending on the sweep direction. The factory default values for minimum and maximum skip frequency are both 0, causing this feature to be disabled by default. This subcommand is not available while the RF output is on. Send 12 data bytes: • Bytes 0 and 1 = 83 (set sweep skip frequency range), LSB first • Bytes 2 and 3 = 1 (set sweep skip frequency range) • Bytes 4 to 7 = Skip frequency range minimum in kHz	12	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	• Bytes 8 to 11 = Skip frequency range maximum in kHz Command **248**; B0 = 83 reports this value.		

118
set statistics acquisition mode (NV)
(subcommand 86)
	Sets the statistics acquisition mode. In statistics sample mode, the data samples are obtained using the statistics sample rate and statistics sample count parameters. This mode does not perform averaging over each pulse while pulsing to calculate the statistics data. In statistics pulse mode, the data samples are obtained using the statistics pulse count parameter. This mode performs averaging over each pulse, and then uses those averages to calculate the statistics data. This mode also performs averaging over the pulse period when configured to run in CW mode. In pulsing master mode, averaging is based on the master pulsing frequency. In pulsing slave mode, averaging is based on the frequency present on the *PSYNC* input connector. If the master pulsing frequency is 0 or the *PSYNC* input signal is not present, the averaging is configured to average over the pulse period of a 1 kHz pulsing frequency. The factory default value is statistics sample mode. It returns only a CSR.
	
	Send 4 data bytes:
	
	• Bytes 0 and 1 = 86 (set statistics acquisition mode), LSB first
	
	• Bytes 2 and 3 = Statistics acquisition mode (unsigned short):
	
	  ◦ 1 = Statistics sample mode
	
	  ◦ 2 = Statistics pulse mode
	
	Command **248**; B0 = 86 reports this value.
		4	1

118 **set fixed frequency control (NV)** (subcommand 93)	Sets fixed frequency control parameters. This subcommand sets the ramp time for fixed frequency ramping in milliseconds. This ramp time is used while operating in fixed frequency mode when changing the fixed frequency from one value to another. This subcommand is also used when changing the frequency mode from frequency tuning mode to	6	1

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	fixed frequency mode, while in the mode to ramp to the fixed frequency (see command **118** [subcommand 52]). Send 6 data bytes: • Bytes 0 and 1 = 93 (set fixed frequency control) • Bytes 2 and 3 = Fixed frequency control command: ◦ 1 = Set fixed frequency ramp time • Bytes 4 and 5 = Fixed frequency control command data value: ◦ When fixed frequency control command = 1: Fixed frequency ramp time in milliseconds		
118 **set frequency tuning mask time (NV)** (subcommand 94)	Sets the frequency tuning mask time in %. The frequency tuning mask time determines the portion of the pulse that is masked off and excluded for measurements related to frequency tuning. The frequency tuning mask time begins at the beginning of the pulse. The range of valid values for frequency tuning mask time is 0% to 99%. The actual mask time cannot exceed approximately 125 milliseconds. The actual mask time can be shorter or longer than the requested mask time (see command **248** [subcommand 94]). Send 6 data bytes: • Bytes 0 and 1 = 94 (set frequency tuning mask time) • Bytes 2 and 3 = Frequency tuning mask time selection: ◦ 1 = Set frequency tuning mask time • Bytes 4 and 5 = Frequency tuning mask time value in %	6	1

Table 4-14. AE Host Commands (Continued)

<table>
<tr><th>Command</th><th>Description</th><th>Data Bytes Sent</th><th>Data Bytes Returned</th></tr>
<tr><td>118
set RF bias DAC manual mode
(subcommand 300)</td><td>Sets RF bias DAC manual mode. In lookup table mode, the RF bias DAC value is determined by the frequency lookup table. In manual mode, the RF bias DAC value is determined by subtracting the RF bias DAC offset from the RF bias DAC calibration value. This parameter is volatile and not retained after an AC power cycle. This subcommand is not available while the RF output is on.
Send 4 data bytes:
• Bytes 0 and 1 = 300 (set RF bias DAC manual mode)
• Bytes 2 and 3 (unsigned short) = RF bias DAC manual mode:
◦ 0 = Lookup table mode
◦ 1 = Manual mode
Command 248; B0 = 300 reports this value.</td><td>4</td><td>1</td></tr>
<tr><td>118
set RF bias DAC offset
(subcommand 301)</td><td>Sets the RF bias DAC offset in DAC counts. The maximum valid value for RF bias DAC offset is equal to the RF bias DAC calibration value – auto stability table coefficient 0. The minimum value for RF bias DAC offset is 0. This parameter is volatile and is not retained after an AC power cycle.
This subcommand cannot be sent unless the unit is in RF bias DAC manual mode; this subcommand is not available while the RF output is on.
Send 4 data bytes:
• Bytes 0 and 1 = 301 (Set RF bias DAC offset)
• Bytes 2 and 3 (unsigned short) = RF Bias DAC Offset
Command 248; B0 = 301 reports this value.</td><td>4</td><td>1</td></tr>
<tr><td>128
report power supply type</td><td>Reports the power supply type.
You can send 0 data bytes, or you can send 1 data byte.
Send 0 data bytes.
Returns a nonterminated 9-character ASCII string that represents the power supply type (for example, PARAMOUNT).</td><td>0 or 1</td><td>9 or 10 ASCII characters</td></tr>
</table>

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	Send 1 data byte: Returns the power supply name. You might want to use this value when communicating with the unit through a network connection. • Byte 0 = 3 Returns 10 bytes: • Bytes 0 to 3 = 4 ASCII characters: P M N T • Bytes 4 to 9 = 6-digit ASCII representation of the 3 least significant bytes of the unit MAC ID		
129 **report power supply size**	Reports either the power supply size (in watts) in 4 or 6 digits, or the low power limit (in watts) in 6 digits, depending on the data bytes sent. Send 0 data bytes. Returns 4 data bytes: • Byte 0 to 3 = Power supply size in watts formatted to 4 ASCII digits, right justified Send 1 data byte: • Byte 0 = 0: Returns 6 data bytes = Power supply size formatted to 6 ASCII digits, right justified • Byte 0 = 1: Returns 6 data bytes = Low power limit formatted to 6 ASCII digits, right justified	0 or 1	4 or 6 ASCII characters
130 **report software part number**	Returns a nonterminated ASCII string that represents the AE software part number (for example, “7432006”). You can use this number in conjunction with the revision number returned by command **198** to identify the software in the unit. Sending a request data byte is optional. If command **130** is issued with 0 data bytes, it returns the ColdFire® application firmware part number. Send 1 data byte: • Byte 0 = Software part number request 0 to 6:	0 or 1	7 ASCII characters

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	◦ 0 = Application firmware part number ◦ 3 = Bootloader firmware part number ◦ 4 = Communication card application firmware part number (if present) ◦ 5 = Communication card bootloader firmware part number (if present) ◦ 6 = Communication card FPGA firmware part number (if present) Returns 7 data bytes: • Bytes 0 to 6 = ASCII string representing the software part number.		
132 **report CEX phase offset**	Reports the phase offset for CEX mode. Valid values are 0 to 3,600, representing 0 to 360 degrees in 0.1 degree increments. The unit adds this value to the factory preset phase offset calibration value. Send 1 data byte: • Byte 0 = 0 (request CEX phase offset) Returns 2 data bytes: • Bytes 0 and 1 = Phase offset in tenths of degrees (unsigned short) Set this value with command **32**.	1	2
138 **report tuning timeout value**	Reports the time in µs that the generator is allowed to tune without finding a match before it turns off RF output and activates a fault. The maximum tuning timeout value is 60,000. A value of 0 disables the tuning timeout feature, causing the generator to tune indefinitely. This subcommand applies only when the Type III tuning algorithm is active. Returns 4 data bytes: • Bytes 0 to 3 = Time in milliseconds Set this value with command **38**.	0	4
139 **report comm watchdog timer**	Reports the communications watchdog timer value in milliseconds. Since each interface has a unique watchdog timer, the value reported is the value associated with the interface to which the request	1	2

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	was sent. A value of 0 indicates that the watchdog timer is disabled. This parameter is volatile and defaults to 0 each time you turn the unit on. The maximum value is 65,535. The unit stores the watchdog timer value internally in 10-millisecond increments, and truncates any fractional remainder. The unit reports all values in multiples of 10 milliseconds. Send 1 data byte: • Byte 0 = 0 (report comm watchdog timer) Returns 2 data bytes: • Bytes 0 and 1 = Watchdog timer value in milliseconds (unsigned short) Set this value with command **39**.		
140	Reports the current host port timeout value for the serial port that received the command. This value can be different for the different serial ports. Host port timeout value is the maximum time allowed between bytes received. This value is in units of 10 milliseconds. The allowable range of values is 2 to 500, representing 20 milliseconds to 5.00 seconds. Returns 2 data bytes: • Bytes 0 and 1 = Host port timeout value (LSB first) Set this value with command **40**.	0	2
144 **report minimum tuning frequency**	Reports the minimum frequency in kHz that the generator uses for frequency tuning. The minimum tuning frequency must be within the unit frequency range. The tuning frequency must also be less than or equal to the current start frequency and maximum tuning frequency. This command applies only when the Type III tuning algorithm is active. The unit stores this parameter in nonvolatile memory. Returns 4 data bytes: • Bytes 0 to 3 = Frequency in kHz Set this value with command **44**.	0	4

Table 4-14. AE Host Commands (Continued)

<table>
<tr><th>Command</th><th>Description</th><th>Data Bytes Sent</th><th>Data Bytes Returned</th></tr>
<tr><td>145
report maximum tuning frequency</td><td>Reports the maximum frequency in kHz that the generator uses for frequency tuning. The maximum tuning frequency must be within the unit frequency range. This frequency must also be greater than or equal to the current start frequency and minimum tuning frequency. This command applies only when the Type III tuning algorithm is active. The unit stores this parameter in nonvolatile memory.
Returns 4 data bytes:
• Bytes 0 to 3 = Frequency in kHz
Set this value with command 45.</td><td>0</td><td>4</td></tr>
<tr><td>146
report tuning start frequency</td><td>Reports the frequency in kHz at which the generator starts frequency tuning when operating in fixed ignition mode. The tuning start frequency must be greater than or equal to the current minimum tuning frequency and less than or equal to the current maximum tuning frequency. This command applies only when the Type III tuning algorithm is active. The unit stores this parameter in nonvolatile memory.
Returns 4 data bytes:
• Bytes 0 to 3 = Frequency in kHz
Set this value with command 46.</td><td>0</td><td>4</td></tr>
<tr><td>147
report generator actual frequency</td><td>Reports generator frequency.
<table>
<tr><th>When Operating In This Mode ...</th><th>This Command Reports ...</th><th>Same As Command ...</th></tr>
<tr><td colspan="3">Output on</td></tr>
<tr><td>Fixed frequency</td><td>Fixed frequency set by command 61 (set fixed frequency)</td><td>161 (report fixed frequency)</td></tr>
<tr><td>Variable frequency</td><td>Output frequency that is being controlled by the frequency tuning algorithm</td><td>N/A</td></tr>
<tr><td colspan="3">Output off</td></tr>
</table></td><td>0</td><td>4</td></tr>
</table>

Table 4-14. AE Host Commands (Continued)

<table>
<tr><th>Command</th><th>Description</th><th>Data Bytes Sent</th><th>Data Bytes Returned</th></tr>
<tr><td></td><td>
<table>
<tr><th>When Operating In This Mode ...</th><th>This Command Reports ...</th><th>Same As Command ...</th></tr>
<tr><td>Fixed frequency</td><td>Fixed frequency set by command 61</td><td>161 (report fixed frequency)</td></tr>
<tr><td>Variable frequency and fixed frequency ignition mode</td><td>Tuning start frequency</td><td>146 (report tuning start frequency)</td></tr>
<tr><td>Variable frequency and variable frequency ignition mode</td><td>Maximum tuning frequency</td><td>145 (report maximum tuning frequency)</td></tr>
<tr><td>Variable frequency mode and frequency scan ignition mode</td><td>Minimum tuning frequency</td><td>144 (report minimum tuning frequency)</td></tr>
</table>
In either fixed or variable mode, if the RF output is off when you send this command, the unit reports the frequency that it will first output the next time you turn the unit on.
Returns 4 data bytes:
• Bytes 0 to 3 = Actual generator output frequency in kHz</td><td></td><td></td></tr>
<tr><td>148
report fixed or variable frequency mode</td><td>Reports the frequency mode. You can send 0 data bytes or 1 data byte.
Send 0 data bytes.</td><td>0 or 1</td><td>1 or 2</td></tr>
</table>

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	Returns 1 data byte reporting the frequency mode: • 0 = Fixed frequency mode • 1 = Variable frequency mode Send 1 data byte: • Byte 0 = 0 (report frequency mode with 2-byte response) Returns 2 data bytes: • Bytes 0 and 1 = Frequency mode: 　◦ 0 = Fixed frequency mode 　◦ 1 = Variable frequency mode Set this value with command **48**.		
151 **report setpoint ramping configuration**	This command reports the setpoint ramping configuration, which includes both the setpoint ramping parameters and setpoint ramping memory mode. Two memory modes are available as sloped mode and timed (milliseconds) mode, and can be selected as either volatile or nonvolatile. When nonvolatile memory mode is selected, the setpoint ramping parameters are saved in nonvolatile memory and restored after AC power is cycled. When transmitting data using the 6-byte format, only the setpoint ramping parameters can be sent. When transmitting data using the 8-byte format, both the setpoint ramping parameters and setpoint ramping memory mode commands can be sent. Ramp up and ramp down parameters are set independently. When operating in power regulation modes, in slope mode, ramp parameters represent the ramp rate in watts per second. When operating in external voltage regulation mode, in slope mode, the ramp parameters represent the ramp rate in units of volts per second. The acceptable range for the ramp up and ramp down parameters in slope mode is 0 to 65,535. In timed mode, the ramp parameters represent the time in µs to complete the setpoint change, regardless of the magnitude of the setpoint change. The acceptable range for ramp up and ramp	0 or 2	6 or 8

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	down parameters in timed mode is 0 milliseconds to 65,535 milliseconds. ☞ **Important** For both modes you can set either the ramp up or the ramp down parameter to 0, but you cannot set both to 0. You can set the setpoint ramp parameters while the RF output is on, but the ramp parameters cannot change during a setpoint ramp that is currently in progress. The setpoint will not ramp in either mode if the setpoint change is less than 3 W (this value might be different for some units). You can also read back the memory mode for the setpoint ramping parameters (volatile or nonvolatile). This command is also available while operating in external regulation mode. For some units, this command does not accept send data bytes and returns 6 data bytes. For other units, this command can accept 2 send data bytes and returns either 6 or 8 data bytes. These units return the 8-byte version when they receive the 2 send bytes, and return the 6-byte version when there are 0 send data bytes. For units that allow you to set the memory mode for the ramping parameters, the 8-byte version of the command allows you to read back the memory mode setting. ☞ **Important** Sending Bytes 0 and 1 is optional. If command **151** is issued with 0 transmit data bytes, the setpoint ramping parameters are reported with a 6-byte response. If command **151** is issued with both Bytes 0 and 1, the 8-byte response is reported.		

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	Send 0 data bytes: • Setpoint ramping parameters are reported with a 6-byte response Send 2 data bytes: • Bytes 0 and 1 = Configuration command (requests configuration command with 8-byte response): ◦ Configuration command 1 = Report setpoint ramping parameters ◦ Configuration command 2 = Report setpoint ramping memory mode **Standard 6-byte report** Returns 6 data bytes: • Bytes 0 and 1 = Ramp mode: ◦ 0 = Disabled ◦ 1 = Slope ◦ 2 = Timed (in milliseconds) • Bytes 2 and 3 = Ramp up (in W/sec, V/sec, or time in milliseconds) • Bytes 4 and 5 = Ramp down (in W/sec, V/sec, or time in milliseconds) **8-byte report** Returns 8-byte setpoint ramping parameters report: • Where configuration command = 1 (ramping data command): ◦ Bytes 0 and 1 = 1 (report setpoint ramping data) ◦ Bytes 2 and 3 = Ramp mode: ▪ 0 = Disabled ▪ 1 = Slope ▪ 2 = Timed (in milliseconds)		

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	◦ Bytes 4 and 5 = Ramp up (in W/sec, V/sec, or time in milliseconds) ◦ Bytes 6 and 7 = Ramp down (in W/sec, V/sec, or time in milliseconds) • Where configuration command = 2 (memory mode command): ◦ Bytes 0 and 1 = 2 (report setpoint ramping memory mode) ◦ Bytes 2 and 3 = Memory mode: ▪ 0 = Volatile ▪ 1 = Nonvolatile ◦ Bytes 4 and 5 = 0 ◦ Bytes 6 and 7 = 0 Set this value with command **31**.		
154 **report regulation mode**	Reports the active regulation mode. You can send 0 data bytes or 1 data byte. Send 0 data bytes. Returns 1 data byte: • Byte 0 = Regulation mode (1-byte response): ◦ 6 = Forward ◦ 7 = Delivered or real ◦ 8 = External (DC bias) ◦ 9 = VA limit Send 1 data byte: • Byte 0 = 0 (regulation mode with 2-byte response) Returns 2 data bytes: • Bytes 0 and 1 = Regulation mode (2-byte response): ◦ 6 = Forward ◦ 7 = Delivered or real	0 or 1	1 or 2

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	◦ 8 = External (DC bias) ◦ 9 = VA limit Set this value with command **3**.		
155 **report active control mode**	Reports the active control mode. You can send 0 data bytes or 1 data byte. Send 0 data bytes. Returns 1 data byte: • Byte 0 = Control mode (1-byte response): ◦ 2 = Host ◦ 4 = **User** port (analog) ◦ 8 = Diagnostic mode ◦ 16 = DeviceNet ◦ 32 = EtherCAT32 Send 1 data byte: • Byte 0 = 0 (control mode with 2-byte response) Returns 2 data bytes: • Bytes 0 and 1 = Control mode (2-byte response): ◦ 2 = Host ◦ 4 = **User** port (analog) ◦ 8 = Diagnostic mode ◦ 16 = DeviceNet ◦ 32 = EtherCAT ☞ **Important** The DeviceNet board automatically sets the unit into DeviceNet control mode when you connect the DeviceNet cable. There is no other way to force the unit into DeviceNet control mode. While operating in DeviceNet control mode, you must disconnect the DeviceNet cable to take control away from DeviceNet. You might also be able to change control mode if the DeviceNet board experiences a DeviceNet power fault.	0 or 1	1 or 2

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	☞ **Important** When operating in EtherCAT control mode, only the EtherCAT interface can put the unit into EtherCAT control mode. If the unit is in EtherCAT control mode and the EtherCAT interface is actively communicating with the unit, the unit can only be changed to host control mode. Set this value with command **14**.		
158 **report retuning threshold**	Reports the tuning criteria level at which the frequency tuning algorithm determines that the generator requires retuning. Valid values for retuning threshold are 1 to 3,000. This command applies only when the Type III tuning algorithm is active. Returns 4 data bytes: • Bytes 0 to 3 = Retuning criteria Set this value with command **58**.	0	4
159 **report tuning time**	Reports the time in milliseconds from an RF on (command **2**) to the first time that the tuning algorithm declares the generator to be tuned. This command applies only when the Type III tuning algorithm is active. Returns 4 data bytes: • Bytes 0 to 3 = Time in milliseconds	0	4
160 **report tune delay**	Reports the time in milliseconds that the frequency tuning algorithm waits before beginning to automatically tune the generator. The maximum tune delay value is 60,000 μs. This command applies only when the Type III tuning algorithm is active. The unit stores this parameter in nonvolatile memory. Returns 4 data bytes: • Bytes 0 to 3 = Time in milliseconds Set this value with command **60**.	0	4
161 **report fixed frequency and frequency range**	Reports the output frequency when the generator is operating in fixed frequency mode. The fixed frequency value must be within the unit frequency range. This command can also be used to report the frequency range.	0 or 1	4

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	Send 0 data bytes or 1 data byte (sending 1 data byte is optional). If you send 0 data bytes, the command returns the fixed frequency in kHz. If you send 1 data byte, select a parameter to return: • Byte 0: 　◦ 0 = Generator fixed frequency in kHz 　◦ 1 = Generator fixed frequency in Hz 　◦ 2 = Generator maximum frequency in Hz 　◦ 3 = Generator minimum frequency in Hz 　◦ 8 = Generator center frequency in Hz Returns 4 data bytes: • Bytes 0 to 3 = Generator fixed frequency in kHz if 0 data bytes were sent, or the value selected in the send byte Set this value with command **61**.		
162 **report process status**	Reports the generator process status. Returns 4 data bytes (bit flags): • Byte 0 bits: 　◦ Bit 0 = Tuning status (0 = not tuned, 1 = tuned) 　◦ Bit 1 = Setpoint ramping (0 = not ramping, 1 = ramp in progress) 　◦ Bit 2 = Recipe active (0 = recipe inactive, 1 = recipe active) 　◦ Bit 3 = Recipe enabled (0 = recipe disabled, 1 = recipe enabled) 　◦ Bit 4 = Reserved 　◦ Bit 5 = RF output on (0 = off, 1 = on) 　◦ Bit 6 = RF on requested (0 = off, 1 = on) 　◦ Bit 7 = Setpoint tolerance (0 = in tolerance, 1 = out of tolerance)	0	4

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	• Byte 1 bits: ◦ Bits 0 to 2 = Reserved ◦ Bit 3 = Coldplate overtemperature fault (1 = fault) ◦ Bit 4 = Frequency mode (0 = fixed, 1 = variable) ◦ Bit 5 = Pulsing enabled (0 = disabled, 1 = enabled) ◦ Bit 6 = Arc management enabled (0 = disabled, 1 = enabled) ◦ Bit 7 = Interlock (0 = interlock closed, 1 = interlock open) • Byte 2 bits: ◦ Bits 0 and 1 = Reserved ◦ Bit 2 = High AC line voltage warning (1 = warning) ◦ Bit 3 = Reserved ◦ Bit 4 = Low AC line voltage warning (1 = warning) ◦ Bit 5 = Protection limit (1 = limit active) ◦ Bits 6 and 7 = Reserved • Byte 3 bits: ◦ Bit 0 = Reserved ◦ Bit 1 = Inverter not ready (1 = not ready) ◦ Bit 2 = Field Bus error (1 = error) ◦ Bit 3 = Reserved ◦ Bit 4 = CEX enabled (0 = CEX not enabled, 1 = CEX enabled) ◦ Bit 5 = Fault present (0 = no faults, 1 = fault exists) ◦ Bit 6 = Warning present (0 = no warnings, 1 = warning exists)		

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	◦ Bit 7 = CEX is locked (1 = CEX is locked) When either of the fault present or warning present bits are set, one or more active or latched faults or warnings currently exist in the unit. You can obtain a list of current faults or warnings by issuing command **223** with the appropriate parameter.		
164 **report setpoint and regulation mode**	Reports the RF output setpoint and regulation mode. The setpoint is reported as either power or voltage, depending on the enabled features in the unit. Your unit might not have all of these features. • For standard units operating in power regulation modes, setpoint is reported in watts. • For HALO units operating in power regulation modes, setpoint is reported in tenths of watts. • When the unit is operating in external (DC bias) regulation mode, setpoint is reported in volts. This command also returns the active regulation mode. Returns 3 data bytes (one 16-bit value, one 8-bit value): • Bytes 0 and 1 = Setpoint value (LSB first) • Byte 2 = Output regulation mode ◦ 6 = Forward ◦ 7 = Delivered or load ◦ 8 = External (DC bias) ◦ 9 = VA limit Set the setpoint with command **8** and the regulation mode with command **3**.	0	3
165 **report forward power**	Reports the forward power. For standard units, forward power is reported in watts. For HALO units, forward power is reported in tenths of watts.	0	2

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	Returns 2 data bytes: • Bytes 0 and 1 = Forward power value (LSB first)		
166 **report reflected power**	Reports the reflected power. For standard units, reflected power is reported in watts. For HALO units, reflected power is reported in tenths of watts. Returns 2 data bytes: • Bytes 0 and 1 = Reflected power value (LSB first)	0	2
167 **report delivered power**	Reports the delivered power. For standard units, delivered power is reported in watts. For HALO units, delivered power is reported in tenths of watts. Returns 2 data bytes: • Bytes 0 and 1 = Delivered power value (LSB first)	0	2
168 **report external feedback**	This command reports the external feedback value in volts as measured at the DC bias input on the user card. Not all units have the DC bias feature. If DC bias is not implemented, this command reports 0. Returns 2 data bytes: • Bytes 0 and 1 = External feedback (LSB first)	0	2
169 **report user power limit**	Reports the user power limit in watts. The unit retains the user power limit as long as power is applied. The user power limit is retained in external regulation mode, but has no effect since the setpoint is not in watts. Valid values are the low power limit to the unit maximum power. ☞ **Important** The user power limit is directly related to the current regulation mode. For example, when in load regulation mode, the user power limit will limit delivered power.	0	2

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	Returns 2 data bytes: • Bytes 0 and 1 = User power limit (LSB first) Set this value with command **4**.		
170 **report user reflected power limit**	Reports the user reflected power limit in watts. The user reflected power limit is in effect for all regulation modes and is retained as long as power is applied. Valid values are from 100 watts to the maximum reflected power limit for the unit as listed in the unit electrical specifications. The maximum reflected power limit is reported by sending this command with a parameter of 1. Send 0 data bytes (returns 2 data bytes). Send 1 data byte: • Byte 0 = 0 (requests the user reflected power limit in watts) • Byte 0 = 1 (requests the maximum reflected power limit in watts) Returns 2 data bytes: • Bytes 0 and 1 = User reflected power limit (LSB first) Set this value with command **5**.	0 or 1	2
171 **report user external feedback limit**	Reports the user external feedback limit in volts (see command **6**) or the maximum external feedback (see command **9**). Use this command only when operating in external (DC bias) regulation mode. Not all units have the DC bias feature. The maximum valid value for user external feedback limit is equal to the maximum external feedback value (set by command **9**). The following equation defines the minimum valid value for user external feedback limit: $F_{min} = (F_{max} \times L) / M$	0 or 1	2

Table 4-14. AE Host Commands (Continued)

<table>
<tr><th>Command</th><th>Description</th><th>Data Bytes Sent</th><th>Data Bytes Returned</th></tr>
<tr><td></td><td>where
F_{min} is the user external feedback limit minimum, the minimum value you can report with this command.
F_{max} is the maximum external feedback value, a user-settable value (command 9).
L is the low power limit, a default value.
M is the unit maximum power, a default value.
You can send 0 or 1 data bytes.
Send 0 data bytes.
Returns 2 data bytes:
Bytes 0 and 1 = User external feedback limit (LSB first)
Send 1 data byte:
Byte 0 = 0
Returns 2 data bytes representing the user external feedback limit in volts.
Byte 0 = 1
Returns 2 data bytes representing the maximum external feedback value in volts.
Set the user external feedback limit with command 6; set the maximum external feedback value with command 9.</td><td></td><td></td></tr>
<tr><td>172
report pulsing configuration</td><td>Reports pulsing configuration.
This command allows you to send subcommands. Each subcommand reports a different parameter.<table><tr><th>Subcommand Number</th><th>Parameter</th></tr><tr><td>1</td><td>Pulsing mode</td></tr><tr><td>2</td><td>Pulse sync output</td></tr><tr><td>3</td><td>Pulsing enabled</td></tr><tr><td>4</td><td>Sync input delay</td></tr><tr><td>5</td><td>Memory mode</td></tr></table></td><td>2</td><td>4</td></tr>
</table>

Table 4-14. AE Host Commands (Continued)

<table>
<tr><th>Command</th><th>Description</th><th>Data Bytes Sent</th><th>Data Bytes Returned</th></tr>
<tr><td></td><td>
<table>
<tr><th>Subcommand Number</th><th>Parameter</th></tr>
<tr><td>6</td><td>Explicit enable mode</td></tr>
<tr><td>7</td><td>Pulsing enable state</td></tr>
<tr><td>8</td><td>Pulsing/arc management mode</td></tr>
<tr><td>9</td><td>Pulse maximum on-time</td></tr>
<tr><td>10</td><td>Pulse sync output mode</td></tr>
<tr><td>11</td><td>Slave duty cycle</td></tr>
<tr><td>14</td><td>Minimum pulsing frequency</td></tr>
<tr><td>15</td><td>Maximum pulsing frequency</td></tr>
<tr><td>16</td><td>Minimum pulsing duty cycle</td></tr>
<tr><td>17</td><td>Maximum pulsing duty cycle</td></tr>
</table>
Command 26 sets these values.</td><td></td><td></td></tr>
<tr><td>172
report pulsing mode
(subcommand 1)</td><td>Reports the pulsing mode as master or slave.
Send 2 data bytes:
• Bytes 0 and 1 = 1 (report pulsing mode)
Returns 4 data bytes:
• Bytes 0 and 1 = Pulsing mode 1 or 2:
◦ 1 = Master mode
◦ 2 = Slave mode
• Bytes 2 and 3 = Reserved
Set this value with command 26; B0 = 1.</td><td>2</td><td>4</td></tr>
<tr><td>172
report pulse sync output
(subcommand 2)</td><td>Reports the status of the pulse sync output mode.
Send 2 data bytes:
• Bytes 0 and 1 = 2 (report pulse sync output)
Returns 4 data bytes:
• Bytes 0 and 1 = Pulse sync output 0 or 1:</td><td>2</td><td>4</td></tr>
</table>

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	◦ 0 = Pulse sync output off ◦ 1 = Pulse sync output on • Bytes 2 and 3 = Reserved Set this value with command **26**; B0 = 2.		
172 **report pulsing enabled** (subcommand 3)	Reports whether pulsing is enabled or disabled. Send 2 data bytes: • Bytes 0 and 1 = 3 (report pulsing enabled) Returns 4 data bytes: • Bytes 0 and 1 = Pulsing enabled: ◦ 0 = Pulsing disabled ◦ 1 = Pulsing enabled • Bytes 2 and 3 = Reserved	2	4
172 **report sync input delay** (subcommand 4)	Reports the value of the sync input delay in µs. Send 2 data bytes: • Bytes 0 and 1 = 4 (report sync input delay) Returns 4 data bytes: • Bytes 0 to 3 (unsigned long) = Sync input delay in µs (valid range of values is 0 µs to 250,000 µs) Set this value with command **26**; B0 = 4.	2	4
172 **report memory mode** (subcommand 5)	Reports the memory mode value. Send 2 data bytes: • Bytes 0 and 1 = 5 (report memory mode) Returns 4 data bytes: • Bytes 0 and 1 = Memory mode 0 or 1: ◦ 0 = RAM ◦ 1 = NVRAM • Bytes 2 and 3 = Reserved Set this value with command **26**; B0 = 5.	2	4

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
172 **report explicit enable mode** (subcommand 6)	Reports explicit enable mode. Send 2 data bytes: • Bytes 0 and 1 = 6 (report explicit enable mode) Returns 4 data bytes: • Bytes 0 and 1 = Explicit enable mode 0 or 1: ◦ 0 = Implicit enable ◦ 1 = Explicit enable • Bytes 2 and 3 = Reserved Set this value with command **26**; B0 = 6.	2	4
172 **report pulsing on/off state** (subcommand 7)	Reports whether pulsing has been commanded on or off. Send 2 data bytes: • Bytes 0 and 1 = 7 (report pulsing on/off state) Returns 4 data bytes: • Bytes 0 and 1 = Pulsing on or off: ◦ 0 = Pulsing off ◦ 1 = Pulsing on • Bytes 2 and 3 = Reserved Set this value with command **26**; B0 = 7.	2	4
172 **report pulsing sync/arc management mode** (subcommand 8)	Reports the status of the pulsing/arc management mode. Send 2 data bytes: • Bytes 0 and 1 = 8 (report pulsing/arc management mode) Returns 4 data bytes: • Bytes 0 and 1 = Report pulsing/arc management mode status: ◦ 0 = Pulsing and arc management disabled ◦ 1 = Pulsing enabled ◦ 2 = Arc management enabled	2	4

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	• Bytes 2 and 3 = Reserved Set this value with command **26**; B0 = 8.		
172 **report pulse maximum on-time** (subcommand 9)	Reports the pulse maximum on-time in µs. Send 2 data bytes: • Bytes 0 and 1 = 9 (report pulse maximum on-time) Returns 4 data bytes: • Bytes 0 to 3 = Pulse maximum on-time in µs (valid values are 0 and the range 5 µs to 250,000 µs). Parameter is an unsigned long. Set this value with command **26**; B0 = 9.	2	4
172 **report pulse sync output mode** (subcommand 10)	Reports the pulse sync output mode for both master and slave operation. Send 2 data bytes: • Bytes 0 and 1 = 10 (report pulse sync output mode) Returns 4 data bytes: • Master mode: Bytes 0 and 1 = pulse sync output mode: ◦ 0 = Pulse sync output tracks RF output ◦ 1= Pulse sync output is free running • Slave mode: Bytes 0 and 1 = pulse sync output mode: ◦ 0 = Slave pass-through mode off ◦ 1 = Slave pass-through mode on • Bytes 2 and 3: Reserved Set this value with command **26**; B0 = 10.	2	4
172 **report slave duty cycle** (subcommand 11)	Reports the slave duty cycle in tenths of a percent.	2	4

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	Send 2 data bytes: • Bytes 0 and 1 = 11 (report slave duty cycle) Returns 4 data bytes: • Bytes 0 to 3 (unsigned long) = Slave duty cycle in tenths of a percent (valid values vary from unit to unit) Set this value with command **26**; B0 = 11.		
172 **report minimum pulsing frequency** (subcommand 14)	Reports the minimum pulsing frequency in Hz. Send 2 data bytes: • Bytes 0 and 1 = 14 (report minimum pulsing frequency) Returns 4 data bytes: • Bytes 0 to 3 (unsigned long) = minimum pulsing frequency (valid values vary from unit to unit) Set this value with command **26**; B0 = 14.	2	4
172 **report maximum pulsing frequency** (subcommand 15)	Reports the maximum pulsing frequency in Hz. Send 2 data bytes: • Bytes 0 and 1 = 15 (report maximum pulsing frequency in Hz; valid values vary from unit to unit) Returns 4 data bytes: • Bytes 0 to 3 (unsigned long) = Maximum pulsing frequency in Hz (valid values vary from unit to unit) Set this value with command **26**; B0 = 15.	2	4
172 **report minimum pulsing duty cycle** (subcommand 16)	Reports the report minimum pulsing duty cycle in percent.	2	4

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	Send 2 data bytes: • Bytes 0 and 1 = 16 (report minimum pulsing duty cycle in percent; valid values vary from unit to unit) Returns 4 data bytes: • Bytes 0 and 1 = Maximum pulsing frequency in Hz (valid values vary from unit to unit) • Bytes 2 and 3 = Reserved Set this value with command **26**; B0 = 16.		
172 **report maximum pulsing duty cycle** (subcommand 17)	Reports the report maximum pulsing duty cycle in percent. Send 2 data bytes: • Bytes 0 and 1 = 17 (report maximum pulsing duty cycle in percent; valid values vary from unit to unit) Returns 4 data bytes: • Bytes 0 and 1 = Maximum pulsing frequency in Hz; valid values vary from unit to unit • Bytes 2 and 3 = Reserved Set this value with command **26**; B0 = 17.	2	4
188 **read recipe parameters**	Reports the value of parameters for the recipe feature. For more information on the parameters and valid ranges, see command **21** and the recipe feature information. You need to send this command multiple times to return all of the parameters associated with a recipe. Send 4 data bytes: • Byte 0 = Recipe number. Specifies the recipe number to report. Valid values are 1 to 15. • Byte 1 = Recipe parameter type. Sets the kind of parameter that will be reported. This selection affects the parameters that are available to Byte 3. Valid values:	4	4

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	◦ 0 = Report global recipe parameters. These are parameters that affect the entire recipe. ◦ 1 = Report recipe step parameters. These are parameters that only apply to the recipe step selected with Byte 2. • Byte 2 = Recipe step number. Specifies the step number for which the data will be reported. This value is only valid when Byte 1 = 1. • Byte 3 = Recipe parameter selection. Selects the parameter to report. The available choices depend on the selection in Byte 1. If Byte 1 = 0 (report global recipe parameters), valid values are: ◦ 0 = Number of recipe steps ◦ 1 = Number of recipe iterations ◦ 2 = Final output state. If this parameter is set to 0, the unit will turn off after all recipe steps and iterations are complete and will then restore all of the previously saved values. If this parameter is set to 1, the unit keeps RF output on when all the recipe steps and iterations are complete, and retains the parameter values as they are. Unit control is returned to the interface that is currently set to control the unit. If Byte 1 = 1 (report recipe step parameter values), valid values are: ◦ 0 = Recipe step type. Reported values: ▪ 0 = Disabled ▪ 1 = Timed ▪ 2 = Joules ◦ 1 = Recipe step duration. The value reported is either in hundredths of seconds (if the recipe step type is timed) or in joules (if the recipe step type is joules).		

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	◦ 2 = Power setpoint. Standard units report setpoint in watts. HALO units report setpoint in tenths of watts. ◦ 3 = Setpoint ramp mode. Reported values: ▪ 0 = Disabled ▪ 1 = Slope ▪ 2 = Timed ◦ 4 = Setpoint ramp rate. The ramp rate is reported in milliseconds for steps that are set to timed ramp mode, and in watts per second for steps that are set to slope mode. A value of 0 disables the ramp mode for the step. ◦ 5 = Frequency mode. Valid values: ▪ 0 = Fixed frequency mode. If both this value and the fixed frequency value are set to 0, frequency mode is disabled for this step. ▪ 1 = Variable frequency mode ◦ 6 = Fixed frequency value. This value is reported in kHz. If both this value and the frequency mode are set to 0, frequency mode is disabled for this step. Returns 4 data bytes containing the value for the parameter specified in the send command. Set these values with command **21**.		
189 **read recipe status**	Reports the recipe status, which includes the active recipe number, current recipe repetition, current recipe step, and recipe active status. Send 1 data byte: • Byte 0 must be set to 1. Returns 5 data bytes: • Byte 0 = Active recipe • Bytes 1 and 2 = Current recipe repetition • Byte 3 = Current recipe step (0 = no recipe is running)	1	5

Table 4-14. AE Host Commands (Continued)

<table>
<tr><th>Command</th><th>Description</th><th>Data Bytes Sent</th><th>Data Bytes Returned</th></tr>
<tr><td></td><td>Byte 4 = Status flags:
Bit 0: 1 = Recipe running
Bits 2 to 7 = Unused
Set these values with command 28.</td><td></td><td></td></tr>
<tr><td>193
report pulsing frequency</td><td>Reports the pulsing frequency in Hz. Valid values are 2 Hz to 100,000 Hz. Pulsing frequency has both a volatile and a nonvolatile storage mode, depending on the current configuration (see command 26). The unit reports this value from the currently active memory. This command is available in both master and slave modes.
All restrictions on pulsing frequency, duty cycle, and minimum on-time apply to both master and slave modes.
Returns 4 data bytes:
Bytes 0 to 3 = Pulsing frequency in Hz
Set these values with command 93.</td><td>0</td><td>4</td></tr>
<tr><td>196
report pulsing duty cycle</td><td>Reports the pulsing duty cycle in increments of 1%. Valid values are 1% to 99% when the pulsing frequency is in the range of 4 Hz to 2 kHz, and represents output on-time.
The duty cycle is limited outside of this range. See the table below for detailed information. Pulsing duty cycle has both a volatile and a nonvolatile storage mode, depending on the current configuration (see command 26). The duty cycle reported will be read from the currently active memory. This command is accepted in both master and slave modes. All restrictions on pulsing frequency, duty cycle, and minimum on-time apply to both master and slave modes.<table><tr><th>Pulsing Frequency (Hz)</th><th>Minimum Duty Cycle (%)</th><th>Maximum Duty Cycle (%)</th></tr><tr><td>2</td><td>50</td><td>50</td></tr><tr><td>3</td><td>24</td><td>76</td></tr><tr><td>4 to 2,000</td><td>1</td><td>99</td></tr></table></td><td>0</td><td>2</td></tr>
</table>

Table 4-14. AE Host Commands (Continued)

<table>
<tr><th>Command</th><th>Description</th><th>Data Bytes Sent</th><th>Data Bytes Returned</th></tr>
<tr><td></td><td>
<table>
<tr><th>Pulsing Frequency (Hz)</th><th>Minimum Duty Cycle (%)</th><th>Maximum Duty Cycle (%)</th></tr>
<tr><td>> 2,000</td><td>Limited by minimum on or off time of 5 µs</td><td>Limited by minimum on or off time of 5 µs</td></tr>
</table>
Returns 2 data bytes:
• Bytes 0 and 1= Pulsing duty cycle in %
Set these values with command 96.
</td><td></td><td></td></tr>
<tr><td>198
report software revision level</td><td>
Reports the software revision level as a 3-character (one letter and two numbers) ASCII string. You can use this revision in conjunction with the part number returned by command 130 to identify the software in the unit.
Sending a request data byte is optional. If you issue command 198 with 0 data bytes, it returns the ColdFire application firmware revision.
Send 1 data byte:
• Byte 0 = Software request
◦ 0 = ColdFire application firmware revision
◦ 1 = Motherboard FPGA firmware revision
◦ 4 = ColdFire bootloader firmware revision
◦ 5 = ColdFire FPGA firmware revision (if available)
◦ 6 = Communication card application firmware revision
◦ 7 = Communication card bootloader firmware revision
◦ 8 = Communication card FPGA firmware revision
Returns a 3-character ASCII string:
• Byte 0 = ASCII revision level letter
• Bytes 1 and 2 = ASCII revision level number (0 to 99)
</td><td>0 or 1</td><td>3 ASCII characters</td></tr>
</table>

Table 4-14. AE Host Commands (Continued)

<table>
<tr><th>Command</th><th>Description</th><th>Data Bytes Sent</th><th>Data Bytes Returned</th></tr>
<tr><td>199
report arc events (NV)</td><td>Reports arc management events and parameters. The unit stores parameters marked NV in nonvolatile memory (the values remain available when you cycle power to the unit).
This command allows you to send subcommands. The name and function of a subcommand depend on the value of the send byte:
<table>
<tr><th>Byte 0 =</th><th>Subcommand</th></tr>
<tr><td>1</td><td>Arc events per run</td></tr>
<tr><td>2</td><td>Arc events per second</td></tr>
<tr><td>3</td><td>Arc suppression time</td></tr>
<tr><td>4</td><td>Reflected power limit mode</td></tr>
<tr><td>5</td><td>Enable external arc input</td></tr>
<tr><td>6</td><td>RF power latch state</td></tr>
<tr><td>7</td><td>Arc output signal control</td></tr>
<tr><td>8</td><td>Initial delay time</td></tr>
<tr><td>9</td><td>Setpoint delay time</td></tr>
<tr><td>10</td><td>Number of attempts</td></tr>
<tr><td>11</td><td>Reflection coefficient window</td></tr>
<tr><td>12</td><td>Cumulative arc events</td></tr>
<tr><td>13</td><td>Gamma arc detection mode</td></tr>
<tr><td>14</td><td>Reflected power threshold for arc detection</td></tr>
</table>
Set these parameters with command 36.</td><td>1</td><td>4</td></tr>
<tr><td>199
report arc events per run
(subcommand 1)</td><td>Reports the number of arcs that have occurred since you turned RF on.
Send 1 data byte:
• Byte 0 = 1 (report arc events per run)
Returns 4 data bytes:
• Bytes 0 to 3 = Arc events per run</td><td>1</td><td>4</td></tr>
</table>

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
199 **report arc events per second** (subcommand 2)	Reports the number of arcs that have occurred in the previous full second of operation. Send 1 data byte: • Byte 0 = 2 (report arc events per second) Returns 4 data bytes: • Bytes 0 to 3 = Arc events per second	1	4
199 **report arc suppression time (NV)** (subcommand 3)	Reports the amount of time (in µs) that the unit turns RF off when it first detects an arc. If the first attempt does not quench the arc, the unit doubles the suppression time on each following attempt until it extinguishes the arc, it reaches the maximum number of attempts, or the maximum arc suppression time is reached. Setting this parameter to 0 disables the arc algorithm but leaves the arc counter enabled. The valid arc suppression time range is 5 µs to 511 µs. Send 1 data byte: • Byte 0 = 3 (report arc suppression time) Returns 4 data bytes: • Bytes 0 to 3 = Arc suppression time Set this value with command **36**; B0 = 0.	1	4
199 **report reflected power limit mode (NV)** (subcommand 4)	Reports the reflected power limit mode, in which the unit considers an arc to be present when reflected power reaches its maximum limit. Valid values are 0 (disabled) or 1 (enabled). Send 1 data byte: • Byte 0 = 4 (report reflected power limit mode) Returns 4 data bytes: • Bytes 0 to 3: ◦ 0 = Disabled ◦ 1 = Enabled Set this value with command **36**; B0 = 4.	1	4

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
199 **report enable external arc input (NV)** (subcommand 5)	Reports whether the unit should use the external arc input in addition to the internal arc management algorithm when determining if an arc is present. In slave mode, the external arc input comes from a master. If enabled, the unit determines that an arc is present if a logic high pulse is present on the **Sync In** connector from a master unit. Send 1 data byte: • Byte 0 = 5 (report enable external arc input) Returns 4 data bytes: • Bytes 0 to 3 = Enable external arc input value: ◦ 0 = Disabled ◦ 1 = Enabled Set this value with command **36**; B0 = 5.	1	4
199 **report RF power latch state (NV)** (subcommand 6)	Reports the mode that indicates whether the unit should turn off output when the arc management algorithm terminates because it has reached its maximum number of attempts. Send 1 data byte: • Byte 0 = 6 (report RF power latch state) Returns 4 data bytes: • Bytes 0 to 3 = RF power latch state value: ◦ 0 = RF turned off ◦ 1 = RF remains on Set this value with command **36**; B0 = 6.	1	4
199 **report arc output signal control** (subcommand 7)	Reports whether the external **Sync Out** connector outputs the arc indication signal. This parameter is volatile and defaults to 1 (output on) each time you cycle power to the unit. Send 1 data byte: • Byte 0 = 7 (report arc output signal control) Returns 4 data bytes: • Bytes 0 to 3 = Arc output signal control value:	1	4

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	◦ 0 = Output off ◦ 1 = Output on Set this value with command **36**; B0 = 7.		
199 **report initial delay time (NV)** (subcommand 8)	Reports the amount of time (in milliseconds) that must elapse before the unit enables the arc management algorithm after turning RF output on. The arc counter also remains disabled during this time. The valid initial delay time range is 0 milliseconds to 10 seconds. Send 1 data byte: • Byte 0 = 8 (report initial delay time) Returns 4 data bytes: • Bytes 0 to 3 = Initial delay time value Set this value with command **36**; B0 = 1.	1	4
199 **report setpoint delay time (NV)** (subcommand 9)	The unit temporarily disables the arc management algorithm and arc counter each time it receives a new setpoint that differs by the setpoint delay threshold from the previous setpoint. This parameter reports the amount of time (in milliseconds) that must elapse before the unit re-enables the arc management algorithm after a setpoint change of > 10 W. The valid setpoint delay time range is 0 milliseconds to 5,000 milliseconds. Send 1 data byte: • Byte 0 = 9 (report setpoint delay time) Returns 4 data bytes: • Bytes 0 to 3 = Setpoint delay time value in milliseconds Set this value with command **36**; B0 = 2.	1	4
199 **report number of attempts (NV)** (subcommand 10)	Reports the number of times the arc management algorithm attempts to quench an arc before terminating its attempts. If it reaches the maximum number of attempts, the arc management algorithm becomes disabled, and the unit sets the output to the state (on or off) specified by the RF power latch state parameter.	1	4

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	If output turns off, the unit also asserts the arc management fault to indicate the reason for turning off output. If RF output is left on, the arc management algorithm will be re-enabled. The valid range of attempts is 0 to 250. If this parameter is set to 0, there is no maximum number of attempts, and the arc management algorithm will continue to quench the arc indefinitely. Send 1 data byte: • Byte 0 = 10 (report number of attempts) Returns 4 data bytes: • Bytes 0 to 3 = Number of attempts value Set this value with command **36**; B0 = 3.		
199 **report reflection coefficient window (NV)** (subcommand 11)	Reports the value to be added to nominal gamma to determine high and low thresholds. The unit adds this value to nominal gamma to determine high threshold, and subtracts this value from nominal gamma to determine the low threshold. The unit of measure is 0.01 gamma[2]. The valid range is 1 to 100. Send 1 data byte: • Byte 0 = 11 (report reflection coefficient window) Returns 4 data bytes: • Bytes 0 to 3 = Reflection coefficient window value Set this value with command **36**; B0 = 8.	1	4
199 **report cumulative arc events (NV)** (subcommand 12)	Reports the total number of arcs that have occurred since the cumulative arc events counter was reset either by command **36**; B0 = 9, or by command **7**. Send 1 data byte: • Byte 0 = 12 (report cumulative arc events) Returns 4 data bytes: • Bytes 0 to 3 = Cumulative arc events value Reset this value with command **36**; B0 = 9.	1	4

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
199 **report gamma arc detection mode (NV)** (subcommand 13)	Reports the parameter that controls the mode which indicates that an arc is considered to be present when the value of gamma is outside the threshold window. Valid values for gamma arc detection mode are 0 (disabled) or 1 (enabled). Send 1 data byte: • Byte 0 = 13 (report gamma arc detection mode) Returns 4 data bytes: • Bytes 0 to 3 = Gamma arc detection mode: ◦ 0 = Disabled ◦ 1 = Enabled Set this value with command **36**; B0 = 10.	1	4
199 **report reflected power threshold for arc detection (NV)** (subcommand 14)	Reports the threshold that the reflected power measurement is compared to when determining if an arc has occurred. Send 1 data byte: • Byte 0 = 14 (report reflected power threshold for arc detection) Returns 4 data bytes: • Bytes 0 to 3 = Range of valid values for reflected power threshold for arc detection is 0 to maximum reflected power limit of the generator Set this value with command **36**; B0 = 11.	1	4
201 **report unit-on events**	Reports the number of unit-on events stored in nonvolatile memory. The unit increments the number of unit-on events each time you supply AC power to the generator. Returns 4 data bytes (one 32-bit value): • Bytes 0 to 3 = Number of unit-on events	0	4
202 **report output-on events**	Reports the number of output-on events stored in nonvolatile memory. The unit increments the number of output-on events each time you turn RF power on.	0	4

Table 4-14. AE Host Commands (Continued)

<table>
<tr><th>Command</th><th>Description</th><th>Data Bytes Sent</th><th>Data Bytes Returned</th></tr>
<tr><td></td><td>Returns 4 data bytes (one 32-bit value):
• Bytes 0 to 3 = Number of output-on events</td><td></td><td></td></tr>
<tr><td>203
report overtemp events</td><td>Reports the number of overtemperature events stored in nonvolatile memory. The unit increments the number of overtemperature events each time the coldplate temperature exceeds the fault threshold.
Returns 4 data bytes (one 32-bit value):
• Bytes 0 to 3 = Number of overtemperature events</td><td>0</td><td>4</td></tr>
<tr><td>204
report system control</td><td>Reports several system control parameters.
This command requires that you send 1, 3, or 4 data bytes to specify the requested data. For example, if sent data Byte 0 = 1, the command reports the default gateway.
This command allows you to send subcommands. The name and function of a subcommand depends on the value of the first byte:
<table>
<tr><th>Byte 0 =</th><th>Subcommand</th></tr>
<tr><td>0</td><td>Report IP address</td></tr>
<tr><td>1</td><td>Report default gateway address</td></tr>
<tr><td>2</td><td>Report subnet mask</td></tr>
<tr><td>3</td><td>Report MAC ID</td></tr>
<tr><td>4</td><td>Report PHY status</td></tr>
<tr><td>5</td><td>Report DHCP client enable (1 byte response)</td></tr>
<tr><td>8</td><td>Report DHCP client enable (2 byte response)</td></tr>
<tr><td>92</td><td>Report warning or fault description</td></tr>
<tr><td>97</td><td>Report CSR description</td></tr>
<tr><td>101</td><td>Report number of TCP connections</td></tr>
<tr><td>200</td><td>Report domain name</td></tr>
<tr><td>202</td><td>Report DNS server IP address</td></tr>
</table></td><td>1, 3, or 4</td><td>Variable</td></tr>
</table>

Table 4-14. AE Host Commands (Continued)

<table>
<tr><th>Command</th><th>Description</th><th>Data Bytes Sent</th><th>Data Bytes Returned</th></tr>
<tr><td></td><td><table><tr><th>Byte 0 =</th><th>Subcommand</th></tr><tr><td>203</td><td>Report DNS configuration</td></tr></table></td><td></td><td></td></tr>
<tr><td>204
report IP address (NV)
(subcommand 0)</td><td>Reports the unit network IP address. The unit stores the IP address in nonvolatile memory and restores it each time you turn the unit on. Note that the unit returns the IP address LSB first; that is, Byte 0 = least significant octet of the address.
Send 1 data byte:
• Byte 0 = 0 (report IP address)
Returns 4 data bytes:
• Bytes 0 to 3 = Network IP address
Set this value with command 71; B0 = 0.</td><td>1</td><td>4</td></tr>
<tr><td>204
report default gateway address (NV)
(subcommand 1)</td><td>This command reports the default gateway address. The unit stores the default gateway address in nonvolatile memory and restores it each time you turn the unit on. Note that the unit returns the default gateway address LSB first; that is, Byte 0 = least significant octet of the address.
Send 1 data byte:
• Byte 0 = 1 (report default gateway address)
Returns 4 data bytes:
• Bytes 0 to 3 = Default gateway address
Set this value with command 71; B0 = 1.</td><td>1</td><td>4</td></tr>
<tr><td>204
report subnet mask (NV)
(subcommand 2)</td><td>Reports the network subnet mask. The unit stores the subnet mask in nonvolatile memory and restores it each time you turn the unit on. Note that the unit returns the subnet mask LSB first; that is, Byte 0 = least significant octet of the mask.
Send 1 data byte.
• Byte 0 = 2 (report subnet mask)
Returns 4 data bytes:
• Bytes 0 to 3 = Subnet mask
Set this value with command 71; B0 = 2.</td><td>1</td><td>4</td></tr>
</table>

Table 4-14. AE Host Commands (Continued)

<table>
<tr><th>Command</th><th>Description</th><th>Data Bytes Sent</th><th>Data Bytes Returned</th></tr>
<tr><td>204
report MAC ID (NV)
(subcommand 3)</td><td>Reports the unit MAC ID. The unit stores the MAC ID in nonvolatile memory; you cannot change the MAC ID. The unit sends the MAC ID LSB first; that is, Byte 0 is the least significant byte.
Send 1 data byte:
• Byte 0 = 3 (report MAC ID)
Returns 6 data bytes:
• Bytes 0 to 5 = MAC ID</td><td>1</td><td>6</td></tr>
<tr><td>204
report PHY status
(subcommand 4)</td><td>Reports the network interface PHY status. When the link speed and link duplex are unknown (for example, when the cable is disconnected from the network), the status bits for these items are reported as 0.
Send 1 data byte:
• Byte 0 = 4 (report PHY status)
Returns 4 data bytes:
• Byte 0 = PHY status bit flags
◦ Bit 0 = PHY read failure (0 = OK, 1 = PHY read failure)
◦ Bit 1 = Auto negotiate status (0 = OK, 1 = Auto negotiate failure)
◦ Bit 2 = Link status (0 = Link is up, 1 = Link is down)
◦ Bit 3 = Remote fault (0 = OK, 1 = Remote fault failure)
◦ Bits 4 and 5 = Link speed
<table>
<tr><th>Bit 5</th><th>Bit 4</th><th>Value</th></tr>
<tr><td>0</td><td>0</td><td>10 Mbit</td></tr>
<tr><td>0</td><td>1</td><td>100 Mbit</td></tr>
<tr><td>1</td><td>0</td><td>Reserved</td></tr>
<tr><td>1</td><td>1</td><td>Reserved</td></tr>
</table></td><td>1</td><td>4</td></tr>
</table>

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	◦ Bit 6 = Link duplex (0 = Half duplex, 1 = Full duplex) ◦ Bit 7 = Reserved (reports as 0) • Bytes 1 to 3 = Reserved (reports as 0)		
204 **report DHCP client enable (NV)** (subcommand 5)	Reports the unit network DHCP client enable mode. The unit stores the DHCP client enable mode in nonvolatile memory and restores the DHCP client enable mode each time you turn the unit on. Send 1 data byte: • Byte 0 = 5 (report DHCP client enable mode) Returns 1 data byte: • Byte 0 = DHCP client enable mode: ◦ 0 = Disabled ◦ 1 = Enabled Set this value with command **71**; B0 = 5.	1	1
204 **report DHCP client enable (NV)** (subcommand 8)	Reports the unit network DHCP client enable mode. The unit stores the DHCP client enable mode in nonvolatile memory and restores the DHCP client enable mode each time you turn the unit on. Send 1 data byte: • Byte 0 = 8 (report DHCP client enable) Returns 2 data bytes: • Bytes 0 and 1 = DHCP client enable mode: ◦ 0 = Disabled ◦ 1 = Enable Set this value with command **71**; B0 = 5.	1	2
204 **report warning or fault description** (subcommand 92)	Reports the description for a specified warning or fault. Send 4 data bytes: • Byte 0 = 92 (report warning or fault description) • Byte 1 = Type of description:	4	Variable: up to 250 ASCII characters Fixed: 80 ASCII characters

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	◦ 1 or 3 = Fault ◦ 2 or 4 = Warning • Bytes 2 and 3 = Fault or warning code When Byte 1 = 1 or 2, returns the exact length of the fault or warning string (up to 250 ASCII characters). This is the variable length version of the command. The response packet will not be null terminated. When Byte 1 = 3 or 4, returns exactly 80 ASCII characters. This is the fixed-length version of the command, and always returns exactly 80 characters. If the description string is fewer than 80 characters, the remainder of the response packet is padded with null characters. If the description string is more than 80 characters, the string is truncated to fit into the packet and will not be null terminated. If the description string is exactly 80 characters, the response packet will not be null terminated.		
204 **report CSR description** (subcommand 97)	Reports the description for the requested command status response (CSR) code. Send 3 data bytes: • Byte 0 = 97 (report CSR description) • Byte 1 = CSR code • Byte 2 = Reserved (set to 0) Returns a string of up to ASCII 250 characters that represent the description of the requested CSR. The string is the exact length of the description and is not null terminated.	3	Variable: up to 250 ASCII characters
204 **report number of TCP connections** (subcommand 101)	Reports the number of active connections for the selected TCP port. Send 4 data bytes: • Bytes 0 and 1 = 101 (report number of TCP connections)	4	2

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	• Bytes 2 and 3 = TCP port number Returns 2 data bytes: • Bytes 0 and 1 = Number of active TCP connections		
204 **report domain name (NV)** (subcommand 200)	Reports the network domain name. The domain name is stored in nonvolatile memory and is restored each time the unit is powered on. The length of the domain name is 0 to 64 ASCII characters. Valid characters for the domain name are letters, digits, hyphens, and dots. The factory default value is null. Send 1 data byte: • Byte 0 = 200 (report domain name) Returns a variable number of data bytes containing the domain name. Set this value with command **71**; B0 = 200.	1	Variable: up to 64 ASCII characters
204 **report DNS server IP address (NV)** (subcommand 202)	Reports the IP address for the DNS server. The DNS server IP address is stored in nonvolatile memory and is restored each time the unit is powered on. This value is reported LSB first; that is, data Byte 0 = the least significant octet of the DNS server IP address. Send 1 data byte: • Byte 0 = 202 (report DNS server IP address) Returns 4 data bytes: • Bytes 0 to 3 = DNS server IP address Set this value with command **71**; B0 = 202.	1	4
204 **report DNS configuration (NV)** (subcommand 203)	Reports the DNS configuration mode. • Mode 0 = The DHCP server will not be requested to perform DNS updates, nor will the client perform any DNS updates • Mode 1 = The DHCP server will be requested to perform the IP-address-to-FQDN (PTR RR) updates, and the FQDN-to-address (A RR) updates will be performed by the client	1	2

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	Send 1 data byte: • Byte 0 = 203 (report DNS configuration) Returns 2 data bytes: • Bytes 0 and 1 = DNS configuration mode: ◦ 0 = Mode 0 ◦ 1 = Mode 1 Set this value with command **71**; B0 = 203.		
205 **report unit run time**	Reports the unit run time in seconds. The unit increments the run time each second that RF power is turned on. The unit stores the unit run time in nonvolatile memory. Returns 4 data bytes (one 32-bit value): • Bytes 0 to 3 = Unit run time in seconds.	0	4
206 **report total energy output**	Reports the total energy output in kWh. The unit increments this number each time it delivers a full kWh of energy to the load. The unit also stores partial kWh internally in nonvolatile memory. Returns 4 data bytes (one 32-bit value): • Bytes 0 to 3 = Total energy output in kWh	0	4
212 **report serial port address and baud rate**	Reports the Serial address, baud rate, and RS-485 mode for system serial ports. To report one or more ports with this command, the unit configuration must include the ports as active. You can report the configuration of the port labeled **Serial** with this command, or you set the port configuration by using the DIP switches. You can issue this command only from the **Serial** port or the **ENET** port. ☞ **Important** The Serial broadcast mode is not supported. Therefore, if the Serial address is set to 0, the unit will report the default address of 1. Send 1 data byte: • Byte 0 = Serial port selection:	1	3

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	◦ 1= **Service** port ◦ 2 = **Serial** port Returns 3 data bytes: • Byte 0 = Serial address: 1 to 31 • Byte 1 = Baud rate: ◦ 0 = 2400 baud ◦ 1 = 4800 baud ◦ 2 = 9600 baud ◦ 3 = 19200 baud ◦ 4 = 38400 baud ◦ 5 = 57600 baud ◦ 6 = 115200 baud • Byte 2 = RS-485 mode: ◦ 0 = Off ◦ 1 = On Set this value with command **69**.		
215 **report real-time clock**	Reports the system real-time clock time and date. The data received is encoded in binary coded decimal (BCD) format (for example, if the value for seconds is 48, the data value received will be 0x48). The real-time clock features automatic leap year compensation for years up to 2100. The real-time clock only operates when the unit is on. To use the real-time clock, the values must be set each time the unit is powered up. Returns 7 data bytes: • Byte 0 = Seconds (valid values are 0 to 59) • Byte 1 = Minutes (valid values are 0 to 59) • Byte 2 = Hours (valid values are 0 to 23) • Byte 3 = Day of the week (valid values are 1 to 7): ◦ 1 = Sunday	0	7

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	◦ 2 = Monday ◦ 3 = Tuesday ◦ 4 = Wednesday ◦ 5 = Thursday ◦ 6 = Friday ◦ 7 = Saturday • Byte 4 = Date (valid values are 1 to 31) • Byte 5 = Month (valid values are 1 to 12) • Byte 6 = Year (valid values are 00 to 99) Set this value with command **70**.		
219 **report condensed generator snapshot data**	Reports a selected collection of data identical to the data reported by the individual commands. Sending 0 data bytes is optional. However, sending this command with 0 data bytes and sending it with 1 data byte = 0 return the same data. Bytes vary according to whether the unit has the HALO (high accuracy, low output) option. For these bytes, HALO units report in tenths of watts and standard units report in watts. Send 0 data bytes or 1 data byte = 0: • Byte 0 = 0 (optional) Returns 28 data bytes: • Bytes 0 and 1 = Forward power reported in watts. HALO units report in tenths of watts. See command **165**. • Bytes 2 and 3 = Reflected power reported in watts. HALO units report in tenths of watts. See command **166**. • Bytes 4 and 5 = Delivered power reported in watts. HALO units report in tenths of watts. See command **167**. • Bytes 6 and 7 = Setpoint (see command **164**) in:	0 or 1	28, 38, or 40

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	◦ Volts = Units operating in external regulation mode ◦ Watts = Standard units operating in power regulation modes ◦ Tenths of watts = HALO units operating in power regulation modes • Bytes 8 to 11 = Real impedance in hundredths of ohms (see command **225**) • Bytes 12 to 15 = Reactive impedance in hundredths of ohms (see command **225**) • Bytes 16 to 19 = Actual frequency in kHz (see command **147**) • Bytes 20 to 23 = Process status (see command **162**) • Byte 24 = Regulation mode (see command **154**) • Byte 25 = Control mode (see command **155**) • Bytes 26 and 27 = Coldplate temperature in °C (see command **228**) Send 1 data byte: • Byte 0 = 6 Returns 40 data bytes: • Bytes 0 and 1 = Snapshot revision • Bytes 2 and 3 = Reserved • Bytes 4 and 5 = Forward power reported in watts. HALO units report in tenths of watts (see command **165**) • Bytes 6 and 7 = Reflected power reported in watts. HALO units report in tenths of watts (see command **166**) • Bytes 8 and 9 = Delivered power reported in watts. HALO units report in tenths of watts (see command **167**) • Bytes 10 and 11 = Setpoint reported in watts or volts. HALO units report in tenths of watts (see command **164**) in:		

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	◦ Volts = Units operating in external regulation mode ◦ Watts = Standard units operating in power regulation modes ◦ Tenths of watts = HALO units operating in power regulation modes • Bytes 12 to 15 = Real impedance in hundredths of ohms (see command **225**) • Bytes 16 to 19 = Reactive impedance in hundredths of ohms (see command **225**) • Bytes 20 to 23 = Actual frequency in kHz (see command **147**) • Bytes 24 to 27 = Process status (see command **162**) • Byte 28 = Regulation mode (see command **154**) • Byte 29 = Control mode (see command **155**) • Bytes 30 and 31 = Coldplate temperature in °C (see command **228**) • Bytes 32 to 35 = Reflected power warning count (see command **248** [subcommand 66]) • Bytes 36 to 39 = Reflected power fault count (see command **248** ([subcommand 66]) Send 1 data byte: • Byte 0 = 8 Returns 38 data bytes: • Bytes 0 and 1 = Snapshot revision • Bytes 2 and 3 = Reserved • Bytes 4 and 5 = Forward power reported in watts. HALO units report in tenths of watts (see command **165**) • Bytes 6 and 7 = Reflected power reported in watts. HALO units report in tenths of watts (see command **166**)		

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	• Bytes 8 and 9 = Delivered power reported in watts. HALO units report in tenths of watts (see command **167**) • Bytes 10 and 11 = Setpoint reported in watts or volts. HALO units report in tenths of watts (see command **164**) in: ◦ Volts = Units operating in external regulation mode ◦ Watts = Standard units operating in power regulation modes ◦ Tenths of watts = HALO units operating in power regulation modes • Bytes 12 to 15 = Real impedance in hundredths of ohms (see command **225**) • Bytes 16 to 19 = Reactive impedance in hundredths of ohms (see command **225**) • Bytes 20 to 23 = Actual frequency in kHz (see command **147**) • Bytes 24 to 27 = Process status (see command **162**) • Byte 28 = Regulation mode (see command **154**) • Byte 29 = Control mode (see command **155**) • Bytes 30 and 31 = Coldplate temperature in °C (see command **228**) • Bytes 32 to 35 = Pulsing frequency in Hz (see command **248** [subcommand 65]) • Bytes 36 to 37 = Pulsing duty cycle in % (see command **248** [subcommand 65]) Send 1 data byte: • Byte 0 = 9 Returns 38 data bytes: • Bytes 0 and 1 = Snapshot revision • Bytes 2 and 3 = Reserved		

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	• Bytes 4 and 5 = Average forward power reported in watts. HALO units report in tenths of watts (see command **248** [subcommand 60]) • Bytes 6 and 7 = Average reflected power reported in watts. HALO units report in tenths of watts (see command **248** [subcommand 60]) • Bytes 8 and 9 = Average delivered power reported in watts. HALO units report in tenths of watts (see command **248** [subcommand 60]) • Bytes 10 and 11 = Setpoint reported in watts or volts. HALO units report in tenths of watts (see command **164**) in: ◦ Volts = Units operating in external regulation mode ◦ Watts = Standard units operating in power regulation modes ◦ Tenths of watts = HALO units operating in power regulation modes • Bytes 12 to 15 = Real impedance in hundredths of ohms (see command **225**) • Bytes 16 to 19 = Reactive impedance in hundredths of ohms (see command **225**) • Bytes 20 to 23 = Actual frequency in kHz (see command **147**) • Bytes 24 to 27 = Process status (see command **162**) • Byte 28 = Regulation mode (see command **154**) • Byte 29 = Control mode (see command **155**) • Bytes 30 and 31 = Coldplate temperature in °C (see command **228**) • Bytes 32 to 35 = Pulsing frequency in Hz (see command **248** [subcommand 65]) • Bytes 36 to 37 = Pulsing duty cycle in % (see command **248** [subcommand 65])		

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
221 **report PIN number**	Returns a null-terminated ASCII string that represents the AE product identification number (PIN). Returns 32 data bytes: • Bytes 0 to 32 = Null-terminated ASCII string that represents the AE product identification number (PIN)	0	32
223 **report fault or warning code list**	Reports up to 20 codes representing active or latched faults or warnings that exist within the unit. Send 1 data byte: • Byte 0 = 1 or 3 reports faults • Byte 0 = 2 or 4 reports warnings If no faults or warnings are active, the packet data length is 1, which is CSR code 0 (no faults). If the sent data byte value = 1 or 2, it returns a variable number of data bytes based on the number of active or latched faults or warnings. If faults are active or latched, the response packet reports 2 data bytes for each error code. For example, if a single fault is active, the packet contains 2 data bytes; if two faults are active, the packet data length is 4 data bytes, and so on, up to a maximum of 20 faults (40 data bytes). If the sent data byte value = 3 or 4, it returns a fixed-length packet of 40 bytes. If faults are active or latched, the response packet reports 2 data bytes for each error code. If fewer than 20 faults or warnings are active or latched, the remaining data bytes in the packet are set to 0. If no faults or warnings are active, the packet data length is still 40 but with all data bytes set to 0.	1	Variable or CSR code 0 (if no fault exists)
225 **report impedance**	Reports the real and reactive impedance in hundredths of ohms. Returns 8 data bytes (two 32-bit values): • Bytes 0 to 3 = Signed long integer value of the real impedance (LSB first)	0	8

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	• Bytes 4 to 7 = Signed long integer value of the reactive impedance (LSB first)		
228 **report coldplate temperature**	Reports the coldplate temperature. When the coldplate temperature is specified, the value returned is the greater of the DC coldplate and the RF coldplate temperature. You can send 0 data bytes or 1 data byte. Send 0 data bytes: Returns 2 data bytes = Coldplate temperature value in °C Send 1 data byte: • Byte 0 = 0 Returns 2 data bytes = Coldplate temperature value in tenths of °C • Bytes 0 and 1 = Coldplate temperature value	0 or 1	2
231 **report unit serial number**	Reports the unit serial number, final assembly part number, or final assembly revision. You can send 0 data bytes or 1 data byte. Send 0 data bytes: Returns 4 data bytes (32-bit value) representing the unit serial number (LSB first) Send 1 data byte: • Byte 0 = 0 Returns 4 data bytes (32-bit value) representing the unit serial number (LSB first) • Byte 0 = 1 Returns up to 12 ASCII characters representing the unit part number (for example, 315) • Byte 0 = 6 Returns 3 ASCII characters. The first is the revision letter representing the unit final assembly revision. The last two are null.	0 or 1	3 to 12

Table 4-14. AE Host Commands (Continued)

<table>
<tr><th>Command</th><th>Description</th><th>Data Bytes Sent</th><th>Data Bytes Returned</th></tr>
<tr><td>244
report diagnostic status</td><td>Reports the results of the diagnostic self-test.
Send 1 data byte:
Byte 0 = 0 (report diagnostic status)
Returns 5 data bytes:
Byte 0 = Status code:
0 = Diagnostics in progress
1 = Diagnostic test complete – passed
2 = Diagnostic test complete – failed
3 = Diagnostic test interrupted
4 = Diagnostic mode disabled
Bits 5 to 7 = Reserved
Byte 1 = Failure status (bit flags):
Bit 0 = Forward power
Bit 1 = DC rail voltage
Bit 2 = DC current
Bits 3 to 7 = Reserved
Bytes 2 to 4 = Reserved</td><td>1</td><td>5</td></tr>
<tr><td>248
report operational parameters</td><td>This command allows you to send subcommands to report several operational parameters. The name and function of a subcommand depend on the value of the first two bytes.<table><tr><th>Bytes 0 and 1</th><th>Subcommand</th></tr><tr><td>1</td><td>Report tuning frequency step size minimum</td></tr><tr><td>2</td><td>Report tuning frequency step size maximum</td></tr><tr><td>3</td><td>Report step up gain</td></tr><tr><td>4</td><td>Report step down gain</td></tr><tr><td>6</td><td>Report gamma threshold high</td></tr><tr><td>7</td><td>Report gamma threshold low</td></tr><tr><td>8</td><td>Report maximum tuning count</td></tr></table></td><td>variable</td><td>variable</td></tr>
</table>

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	<table><tr><th>Bytes 0 and 1</th><th>Subcommand</th></tr><tr><td>15</td><td>Report ignition mode</td></tr><tr><td>16</td><td>Report CEX lock mode</td></tr><tr><td>17</td><td>Report tuning scan step size</td></tr><tr><td>20</td><td>Report CEX output mode</td></tr><tr><td>21</td><td>Report gamma threshold mode</td></tr><tr><td>22</td><td>Report tuning step time</td></tr><tr><td>23</td><td>Report tuning gain delay</td></tr><tr><td>43</td><td>Report IMD filter frequency</td></tr><tr><td>44</td><td>Report CEX output phase offset</td></tr><tr><td>45</td><td>Report user power correction</td></tr><tr><td>47</td><td>Report auto stability configuration</td></tr><tr><td>52</td><td>Report frequency tuning mode</td></tr><tr><td>53</td><td>Report user readback filter configuration</td></tr><tr><td>60</td><td>Report statistics data</td></tr><tr><td>65</td><td>Report measured pulsing frequency and duty cycle</td></tr><tr><td>66</td><td>Report reflected power timer</td></tr><tr><td>67</td><td>Report sweep auto frequency mode</td></tr><tr><td>69</td><td>Report pulsing measurement warning threshold</td></tr><tr><td>70</td><td>Report pulsing measurement errors and warnings</td></tr><tr><td>72</td><td>Report user card low scale enable mode</td></tr><tr><td>73</td><td>Report statistics pulse mask time</td></tr><tr><td>74</td><td>Report statistics sample rate</td></tr><tr><td>75</td><td>Report statistics sample count</td></tr><tr><td>77</td><td>Report pulsing measurement delays</td></tr></table>		

Table 4-14. AE Host Commands (Continued)

<table>
<tr><th>Command</th><th>Description</th><th>Data Bytes Sent</th><th>Data Bytes Returned</th></tr>
<tr><td></td><td>
<table>
<tr><th>Bytes 0 and 1</th><th>Subcommand</th></tr>
<tr><td>78</td><td>Report sweep frequency step direction</td></tr>
<tr><td>79</td><td>Report control loop gain</td></tr>
<tr><td>81</td><td>Report sweep gamma average mask enable</td></tr>
<tr><td>83</td><td>Report sweep skip frequency range</td></tr>
<tr><td>86</td><td>Report statistics acquisition mode</td></tr>
<tr><td>93</td><td>Report fixed frequency control</td></tr>
<tr><td>94</td><td>Report frequency tuning mask time</td></tr>
<tr><td>300</td><td>Report RF bias DAC manual mode</td></tr>
<tr><td>301</td><td>Report RF bias DAC offset</td></tr>
</table>
</td><td></td><td></td></tr>
<tr><td>248
report frequency step minimum
(subcommand 1)</td><td>Reports the frequency step minimum used during the tuning process. This is the smallest step size used by the frequency tuning algorithm when making frequency step changes. Valid values for frequency step minimum are 10 Hz to 96,000 Hz. Frequency step minimum cannot be greater than frequency step maximum. This subcommand applies only when the Type III tuning algorithm is active.
Send 2 data bytes:
• Bytes 0 and 1 = 1 (report frequency step minimum)
Returns 4 data bytes:
• Bytes 0 to 3 = Frequency step minimum in Hz (unsigned long, LSB first)
Set this value with command 118; B0 = 1.</td><td>2</td><td>4</td></tr>
<tr><td>248
report frequency step maximum
(subcommand 2)</td><td>Reports the frequency step maximum used during the frequency tuning process. This is the largest step size used by the frequency tuning algorithm when making frequency step changes. Valid values for frequency step maximum must be greater than or equal to frequency step minimum, and less than or equal to</td><td>2</td><td>4</td></tr>
</table>

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	200,000 Hz. The actual frequency step maximum used by the frequency tuning algorithm is determined by the frequency step minimum multiplied by a power of 2. Therefore, the actual frequency step maximum is the value reported by this subcommand reduced to the next lower power of 2. This subcommand applies only when the Type III tuning algorithm is active. Send 2 data bytes: • Bytes 0 and 1 = 2 (report frequency step maximum) Returns 4 data bytes: • Bytes 0 to 3 = Frequency step maximum in Hz (unsigned long, LSB first) Set this value with command **118**; B0 = 2.		
248 **report step up gain** (subcommand 3)	Reports the step up gain used during the frequency tuning process. This parameter sets the magnitude of frequency step increase when the error is decreasing (frequency step size is increasing). A value of *n* sets the gain to 2^n. Valid values are 1 to 7. This subcommand applies only when the Type III tuning algorithm is active. Send 2 data bytes: • Bytes 0 and 1 = 3 (report step up gain) Returns 2 data bytes: • Bytes 0 and 1 = Step up gain (unsigned short, LSB first) Set this value with command **118**; B0 = 3.	2	2
248 **report step down gain** (subcommand 4)	Reports the step down gain used during the frequency tuning process. This parameter sets the magnitude of frequency step decrease when the error is increasing (frequency step size is decreasing). A value of *n* sets the gain to 2^{-n}. Valid values are 1 to 7. This subcommand applies only when the Type III tuning algorithm is active. Send 2 data bytes:	2	2

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	• Bytes 0 and 1 = 4 (report step down gain) Returns 2 data bytes: • Bytes 0 and 1 = Step down gain (unsigned short, LSB first) Set this value with command **118**; B0 = 4.		
248 **report gamma threshold high** (subcommand 6)	Reports the gamma threshold high used during the frequency tuning process. The generator uses the high threshold after first attempting (and failing) to achieve a tuning criteria less than the low threshold. Valid values for gamma threshold high must be greater than or equal to gamma threshold low and less than or equal to 3,000. This subcommand applies only when the Type III tuning algorithm is active. Send 2 data bytes: • Bytes 0 and 1 = 6 (report gamma threshold high) Returns 2 data bytes: • Bytes 0 and 1 = Gamma threshold high (unsigned short, LSB first) Set this value with command **118**; B0 = 6.	2	2
248 **report gamma threshold low** (subcommand 7)	Reports the gamma threshold low used during the frequency tuning process. The generator first attempts to achieve a tuning criteria less than the low threshold. If it cannot find a tuning criterion less than the low threshold, and if the maximum tuning counter expires, the generator gives up and tries the high threshold. Valid values for gamma threshold low must be less than or equal to gamma threshold high. This subcommand applies only when the Type III tuning algorithm is active. Send 2 data bytes: • Bytes 0 and 1 = 7 (report gamma threshold low) Returns 2 data bytes: • Bytes 0 and 1 = Gamma threshold low (unsigned short, LSB first) Set this value with command **118**; B0 = 7.	2	2

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
248 **report maximum tuning count** (subcommand 8)	Reports the maximum tuning count used during the frequency tuning process. This reports the number of attempts to first tune to the low threshold before then trying the high threshold. Valid values are 0 to 65,535. This subcommand applies only when the Type III tuning algorithm is active. Send 2 data bytes: • Bytes 0 and 1 = 8 (report maximum tuning count) Returns 2 data bytes: • Bytes 0 and 1 = Maximum tuning count (unsigned short, LSB first) Set this value with command **118**; B0 = 8.	2	2
248 **report ignition mode** (subcommand 15)	Reports the frequency tuning ignition mode: • Fixed frequency mode: The generator first turns on at the specified start frequency (see command **46**), and then begins tuning. • Variable frequency mode: The generator first turns on at the maximum frequency. It will then compute the gamma^2 value and compare it to the ignition threshold. If the gamma^2 value is less than the threshold, the unit declares ignition and begins tuning from that frequency. If the unit does not detect ignition, it steps the frequency down and repeats the process until it detects ignition, or until the tuning timeout has expired (see command **38**). • Frequency scan mode: The unit first scans the frequency band for the lowest gamma^2 value. The frequency tuning algorithm begins tuning from that frequency. This subcommand applies only when the Type III tuning algorithm is active. Send 2 data bytes: • Bytes 0 and 1 = 15 (report ignition mode, LSB first) Returns 2 data bytes:	2	2

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	• Bytes 0 and 1 = Ignition mode: ◦ 0 = Fixed frequency ignition mode ◦ 1 = Variable frequency ignition mode ◦ 2 = Scan frequency ignition mode Set this value with command **118**; B0 = 15.		
248 **report CEX lock mode** (subcommand 16)	Reports the CEX lock mode. This command is only available when the unit is factory configured to enable the CEX feature. When CEX is enabled, the CEX input is phase-locked to the RF output. Send 2 data bytes: • Bytes 0 and 1 = 16 (report CEX lock mode, LSB first) Returns 2 data bytes: • Bytes 0 and 1 = CEX lock mode: ◦ 0 = CEX disabled ◦ 1 = Lock to output ◦ 2 = Lock to output ◦ 3 = Lock to output Set this value with command **118**; B0 = 16.	2	2
248 **report tuning scan step size** (subcommand 17)	Reports the tuning scan step size used in scan frequency ignition mode. The valid range of values is 5,296 Hz to 193,353 Hz. This subcommand applies only when the Type III tuning algorithm is active. Send 2 data bytes: • Bytes 0 and 1 = 17 (report tuning scan step size) Returns 4 data bytes: • Bytes 0 to 3 = Tuning scan step size (unsigned long, LSB first) Set this value with command **118**; B0 = 17.	2	4

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
248 **report CEX output mode** (subcommand 20)	Reports the CEX output mode. You can control the signal that is output from the **CEX Out** connector using this subcommand. This subcommand is only available when the unit is factory configured to enable the CEX feature. ☞ **Important** If the CEX lock mode is changed from lock to output mode to CEX disabled, the CEX output will be turned off and this command will report mode 2: CEX output off. The previous CEX output mode is remembered, and if the CEX lock mode is subsequently changed to lock to output mode, the previously remembered CEX output mode is restored. Send 2 data bytes: • Bytes 0 and 1 = 20 (report CEX output mode) Returns 2 data bytes: • Bytes 0 and 1 = CEX output mode: ◦ 0 = CEX output on ◦ 1 = CEX output on ◦ 2 = CEX output off Set this value with command **118**; B0 = 20.	2	2
248 **report gamma threshold mode** (subcommand 21)	Reports gamma threshold mode. In mode 0, the frequency tuning algorithm uses the gamma threshold high value set by command **118** (subcommand 6). In mode 1, the frequency tuning algorithm uses the power profile to limit gamma threshold high to values that will not exceed the generator's ability to deliver the power requested by the setpoint command (see command **8**). This subcommand applies only when the Type III tuning algorithm is active. Send 2 data bytes: • Bytes 0 and 1 = 21 (gamma threshold mode) Returns 2 data bytes:	2	2

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	• Bytes 0 and 1 = Gamma threshold mode: ◦ 0 = User gamma threshold high ◦ 1 = Power profile gamma threshold high Set this value with command **118**; B0 = 21.		
248 **report tuning step time** (subcommand 22)	Reports the tuning step time. The range of valid values is 8 µs to 4,096 µs. The resolution for setting tuning step time is currently 1.016 µs. All values of tuning step time are rounded to the nearest multiple of 1.016 µs. The value reported by this subcommand is the same value that was sent by command **118** (subcommand 22), regardless of any internal limiting that might have occurred. This subcommand applies only when the Type III tuning algorithm is active. Send 2 data bytes: • Bytes 0 and 1 = 22 (report tuning step time) Returns 2 data bytes: • Bytes 0 and 1 = Tuning step time in µs Set this value with command **118**; B0 = 22.	2	2
248 **report tuning gain delay** (subcommand 23)	Reports tuning gain delay, which is the delay before increasing the step size after a change in direction. The range of valid values is 0 to 7. This subcommand applies only when the Type III tuning algorithm is active. Send 2 data bytes: • Bytes 0 and 1 = 23 (report tuning gain delay) Returns 2 data bytes: • Bytes 0 and 1 = Tuning gain delay Set this value with command **118**; B0 = 23.	2	2
248 **report IMD filter frequency** (subcommand 43)	Reports the frequency used by the IMD filter. The valid range of values is 325 kHz to 460 kHz. A value of 0 disables this feature. Send 2 data bytes: • Bytes 0 and 1 = 43 (report IMD filter frequency, LSB first)	2	2

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	Returns 2 data bytes: • Bytes 0 and 1= IMD filter frequency in kHz Set this value with command **118**; B0 = 43.		
248 **report CEX output phase offset** (subcommand 44)	Reports the CEX output phase offset value in tenths of degrees. Valid values for the CEX output phase offset are 0 to 3,600, representing 0 to 360 degrees in 0.1 degree increments. This subcommand is only available when the unit is factory configured to enable the CEX feature. Send 2 data bytes: • Bytes 0 and 1 = 44 (report CEX output phase offset), LSB first Returns 2 data bytes: • Bytes 0 and 1= CEX output phase offset value Set this value with command **118**; B0 = 44.	2	2
248 **report user power correction** (subcommand 45)	Reports the user power correction coefficient. This parameter specifies the amount of correction that is applied to the user setpoint to adjust RF output power. A value of 0 disables the user power correction feature. This subcommand is only available when the unit is factory configured to enable the user power correction feature. The range of valid values is also factory configured. ☞ **Important** The user power correction feature is not applicable while operating in external regulation mode. Send 2 data bytes: • Bytes 0 and 1 = 45 (report user power correction) Returns 2 data bytes: • Bytes 0 and 1 (signed short) = User power correction coefficient in hundredths of a percent Set this value with command **118**; B0 = 45.	2	2

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
248 **report auto stability configuration (NV)** (subcommand 47)	Reports the configuration parameters for the auto stability feature. The auto stability feature will be temporarily disabled when RF bias DAC manual mode is enabled. Send 4 data bytes: • Bytes 0 and 1 = 47 (report auto stability configuration), LSB first • Bytes 2 and 3 = Auto stability configuration subcommand number (LSB first): ◦ 1 = Report auto stability mode (NV) ◦ 2 = Report auto stability start delay (NV) ◦ 3 = Report auto stability enter threshold (NV) ◦ 4 = Report auto stability exit threshold (NV) ◦ 5 = Report auto stability ramp rate (NV) ◦ 6 = Report auto stability step size (NV) ◦ 7 = Report auto stability tuning threshold 1 (NV) ◦ 8 = Report auto stability tuning threshold 2 (NV) ◦ 9 = Report auto stability oscillation monitor Returns 2 data bytes: • Bytes 0 and 1 = Auto stability configuration value (LSB first) ◦ 1 = Report auto stability mode: ▪ 0 = Disabled ▪ 1 = Standard search ▪ 2 = Wide search ▪ 3 = Narrow search ▪ 4 = Reversing search ◦ 2 = Report auto stability start delay (values are 0 µs to 65,535 milliseconds	4	2

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	◦ 3 = Report auto stability enter threshold (values are 0 to 3000) ◦ 4 = Report auto stability exit threshold (values are 0 to 3000) ◦ 5 = Report auto stability ramp rate (values are 0 to 9929 in units of 0.1 microseconds) ◦ 6 = Report auto stability step size (values are 1 to 256 in units of DAC counts) ◦ 7 = Report auto stability tuning threshold 1 (values are 0 to 4096) ◦ 8 = Report auto stability tuning threshold 2 (values are 0 to 4096) ◦ 9 = Report auto stability oscillation monitor (values are 0 to 8192) Set this value with command **118**; B0 = 47.		
248 **report frequency tuning mode** (subcommand 52)	Reports various frequency tuning modes. This parameter specifies the behavior when switching between tuning modes while RF output is on. Send 2 data bytes: • Bytes 0 and 1 = 52 (report frequency tuning mode), LSB first ☞ **Important** Sending Byte 2 and Byte 3 is optional. If subcommand 52 is issued with 2 data bytes, the variable-to-fixed-frequency tuning mode is reported. Optional 4-byte subcommand transmit format. Send 4 data bytes: • Bytes 0 and 1 = 52 (report frequency tuning mode), LSB first • Bytes 2 and 3 = Frequency tuning mode command: ◦ 0 = Report variable-to-fixed-frequency tuning mode	2 or 4	2

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	◦ 1 = Report fixed-to-variable-frequency tuning mode Returns two data bytes: • Bytes 0 and 1 = Tuning mode: ◦ When tuning mode command is 0 = Report variable-to-fixed-frequency tuning mode: ▪ Mode 0 = Remain at tuned frequency ▪ Mode 1 = Jump to fixed frequency value ▪ Mode 1 = Ramp to fixed frequency value ◦ When tuning mode command is 1 = Report fixed-to-variable-frequency tuning mode: ▪ Mode 0 = Start tuning from current fixed frequency ▪ Mode 1 = Start tuning from start frequency		
248 **report user readback filter configuration (NV)** (subcommand 53)	Reports the user readback filter configuration. When Byte 0 is set to 1, the fast readback update feature is enabled, which also enables the filtering of forward power, reflected power, and impedance from both the **User** analog port and all digital interfaces. The filter time constant is adjustable from 7 µs to 432,537 µs. Send 2 data bytes: • Bytes 0 and 1 = 53 (report user readback filter configuration), LSB first Returns 5 data bytes: • Byte 0 = Enable for user readback filter: ◦ 0 = Disable ◦ 1 = Enable • Bytes 1 to 4 = User readback filter time constant in µs (long) Set this value with command **118**; B0 = 53.	2	5

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
248 **report statistics data** (subcommand 60)	Reports the statistics data. Send 4 data bytes: • Bytes 0 and 1 = 60 (report statistics data), LSB first • Bytes 2 and 3 = statistics data selection (set to 1) Returns 64 data bytes: • 0 to 3 = Minimum sample for forward power (watts or tenths of watts) • 4 to 7 = Maximum sample for forward power (watts or tenths of watts) • 8 to 11 = Average for forward power (watts or tenths of watts) • 12 to 15 = Standard deviation for forward power • 16 to 19 = Minimum sample for reflected power (watts or tenths of watts) • 20 to 23 = Maximum sample for reflected power (watts or tenths of watts) • 24 to 27 = Average for reflected power (watts or tenths of watts) • 28 to 31 = Standard deviation for reflected power • 32 to 35 = Minimum sample for delivered power (watts or tenths of watts) • 36 to 39 = Maximum sample for delivered power (watts or tenths of watts) • 40 to 43 = Average for delivered power (watts or tenths of watts) • 44 to 47 = Standard deviation for delivered power • 48 to 51 = Minimum sample for frequency (kHz) • 52 to 55 = Maximum sample for frequency (kHz)	4	64

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	• 56 to 59 = Average for frequency (kHz) • 60 to 63 = Standard deviation for frequency		
248 **report measured pulsing frequency and duty cycle** (subcommand 65)	Returns the actual measured pulsing frequency and duty cycle for either the pulse sync input signal or the RF output of the generator. Send 4 data bytes: • Bytes 0 and 1 = 65 (report measured pulsing frequency and duty cycle), LSB first • Bytes 2 and 3 = Select in/out: ◦ 0 = PSYNC-IN ◦ 1 = RF output Returns 6 data bytes: • Bytes 0 to 3 = Measured pulsing frequency in Hz • Bytes 4 and 5 = Measured pulsing duty cycle in % Set this value with command **118**; B0 = 65.	4	6
248 **report reflected power timer** (subcommand 66)	Reports the configuration parameters for the reflected power timer feature. The reflected power timer feature sets the maximum amount of time that can elapse before the unit will assert the appropriate reflected power timer fault or warning. There are independent timers for the reflected power timer fault and warning. Each timer has an associated reflected power threshold and timeout value. The reflected power threshold and timeout value set the amount of time that can elapse before the unit will assert a fault or warning when the measured reflected power is greater than the corresponding threshold. The reflected power timer parameters are retained as long as AC power is applied. Refer to command **118** (subcommand 66) for more detailed information. Send 4 data bytes:	4	2 or 4

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	• Bytes 0 and 1 = 66 (report reflected power timer), LSB first • Bytes 2 and 3 = Reflected power timer subcommand number (LSB first): ◦ 1 = Report reflected power fault timeout ◦ 2 = Report reflected power fault threshold ◦ 3 = Report reflected power fault timeout ◦ 4 = Report reflected power warning timeout ◦ 5 = Report reflected power warning threshold ◦ 6 = Report reflected power warning count ◦ 7 = Report reflected power fault count Returns 2 data bytes for subcommands 1, 2, and 5: • Bytes 0 and 1 = Reflected power timer configuration value (LSB first): ◦ 1 = Report reflected power fault timeout. Valid values are 0 seconds to 3,600 seconds. ◦ 2 = Report reflected power fault threshold. Valid values are 10 W up to the user reflected power limit (see command **170**). ◦ 5 = Report reflected power warning threshold. Valid values are 10 W up to the user reflected power limit (see command **170**). Returns 4 data bytes for subcommands 3, 4, 6, or 7: • Bytes 0 to 3 = Reflected power timer configuration value (LSB first): ◦ 3 = Report reflected power fault timeout. Valid values are 0 milliseconds to 3,600,000 milliseconds. ◦ 4 = Report reflected power warning timeout. Valid values are 0 milliseconds to 3,600,000 milliseconds. ◦ 6 = Report reflected power warning count. Valid values are 0 to 4,294,967,295. ◦ 7 = Report reflected power fault count. Valid values are 0 to 4,294,967,295.		

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	Set this value with command **118**; B0 = 66.		
248 **report sweep auto frequency mode** (subcommand 67)	Reports the sweep auto frequency mode. The sweep auto frequency mode determines the RF output frequency that the generator will first output on the rising edge of each pulse while pulsing. When disabled, the frequency will be the same frequency as at the end of the previous pulse. When enabled, the RF output frequency that is present when sweep is first enabled is stored internally. The RF output is controlled to that stored frequency on the rising edge of each pulse. Once the RF output is back on, the tuning algorithm controls the frequency according to the sweep configuration. The unit will also make the direction of the first frequency tuning step according to the sweep frequency step direction (see command **118** [subcommand 78]) and the frequency step size will be the frequency step maximum size. This subcommand applies only when the Type III tuning algorithm is active. Send 2 data bytes: • Bytes 0 and 1 = 67 (report sweep auto frequency mode), LSB first Returns 2 data bytes: • Bytes 0 and 1 = Sweep auto frequency mode (unsigned short): ◦ 0 = Disabled ◦ 1 = Enabled Set this value with command **118**; B0 = 67.	2	2
248 **report pulsing measurement warning threshold** (subcommand 69)	Reports the warning thresholds for pulsing frequency and duty cycle. When the actual measured error percentage exceeds this threshold, a warning is activated which alerts the user that the actual pulsing frequency or duty cycle does not match the requested value. The range of valid values is 0% to 100%. Any value from 0% to 3% disables the corresponding warning. Send 4 data bytes:	4	2

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	• Bytes 0 and 1 = 69 (report pulsing measurement warning threshold), LSB first • Bytes 2 and 3 = Pulsing measurement warning threshold selection: ◦ 1 = Report pulse frequency warning threshold ◦ 2 = Report pulse duty cycle warning threshold Returns 2 data bytes: • Bytes 0 and 1 = Pulse warning threshold in % (LSB first). Valid values are 0% to 100%. Set this value with command **118**; B0 = 69.		
248 **report pulsing measurement errors and warnings** (subcommand 70)	Reports the actual pulse frequency and duty cycle measurement errors in %. When the actual measured error percentage exceeds the corresponding threshold, a warning or fault is activated which alerts the user that the actual pulsing frequency or duty cycle does not match the requested value. The range of valid values for measurement errors is 0% to 100%. The warnings and faults are also included in the response packet. A value of 0 indicates that the warning or fault is inactive, while a value of 1 indicates that the warning or fault is active. Any warning threshold value from 0% to 3% disables the corresponding warning and fault, so there will be no warning or fault indicated in the response packet. The thresholds for pulse frequency fault and pulse duty cycle fault are configured by the factory. The pulse high power fault indicates there is forward power generated during the pulse off time in excess of a factory configured threshold. Send 4 data bytes: • Bytes 0 and 1 = 70 (report pulsing measurement errors and warnings), LSB first • Bytes 2 and 3 = Pulsing measurement selection: ◦ 1 = Report all pulse measurement errors Returns 10 data bytes:	4	10

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	• Bytes 0 and 1 = Pulse frequency measurement error in % (LSB first) • Bytes 2 and 3 = Pulse duty cycle measurement error in % (LSB first) • Byte 4 = Pulse frequency warning • Byte 5 = Pulse duty cycle warning • Byte 6 = Pulse frequency fault • Byte 7 = Pulse duty cycle fault • Byte 8 = Pulse high power fault • Byte 9 = Reserved		
248 **report user card low scale enable mode** (subcommand 72)	Reports the user card low scale enable mode. The user card low scale enable mode determines the scaling of the user card analog setpoint input and analog power monitor outputs. The user card low scale enable mode is only active while operating in user control mode, and has no effect in any other control mode. When disabled, the standard scale factor is in effect and no analog inputs or outputs are modified. When enabled, the setpoint generated by the user card analog setpoint input is divided by 10, such that a 10 V setpoint input will generate a setpoint equal to 10% of full scale. The power monitor values are multiplied by 10 such that a power value equal to 10% of full scale generates a 10 V analog power monitor output. This parameter is volatile and defaults to disabled each time the generator is power cycled. This subcommand is accepted in all control modes. Send 2 data bytes: • Bytes 0 and 1 = 72 (report user card low scale enable mode), LSB first Returns 2 data bytes: • Bytes 0 and 1 = User card low scale enable mode (unsigned short): ◦ 0 = Disabled	2	2

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	◦ 1 = Enabled Set this value with command **118**; B0 = 72.		
248 **report statistics pulse mask time** (subcommand 73)	Reports the statistics pulse mask time in either time or % mode. The statistics pulse mask time determines the time that is masked off and excluded for statistics measurements. In statistics pulse mask time mode, the mask time begins when the measurement mask time has expired. In statistics pulse mask % mode, the mask time begins at the beginning of the pulse. The range of valid values for statistics pulse mask time in time mode is 0 to 10,000, representing 0 µs to 1,000.0 µs. The range of valid values for statistics pulse mask time in % mode is from 0% to 99%. The actual mask time in % mode cannot exceed approximately 4.16 milliseconds. The requested mask time is the time set by command **118** (subcommand 73). The actual mask time can be shorter than the requested mask time when pulsing is configured for pulses with shorter on-times. ☞ **Important** The pulse mask mode must match the parameter type requested in order for the command to be successful. Send 4 data bytes: • Bytes 0 and 1 = 73 (report statistics pulse mask time), LSB first • Bytes 2 and 3 = Statistics pulse mask time selection (LSB first): ◦ 0 = Report statistics pulse mask mode: ▪ 0 = Time mode ▪ 1 = % mode ◦ 1 = Report requested statistics pulse mask time in tenths of µs ◦ 2 = Report actual statistics pulse mask time in tenths of µs	4	2

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	◦ 5 = Report requested statistics pulse mask time in % ◦ 6 = Report actual statistics pulse mask time in % Returns 2 data bytes: • Bytes 0 and 1 = Statistics pulse mask time value (unsigned short) Set this value with command **118**; B0 = 73.		
248 **report statistics sample rate (NV)** (subcommand 74)	Reports the statistics sample rate. The statistics sample rate is only applicable while in statistics sample mode, and determines the rate at which data samples are obtained and used to calculate the statistical data. The range of valid values is 1 µs to 125 µs. Send 4 data bytes: • Bytes 0 and 1 = 74 (report statistics sample rate), LSB first • Bytes 2 and 3 = Statistics sample rate selection (LSB first): ◦ 1 = Report statistics sample rate for power measurements Returns 2 data bytes: • Bytes 0 and 1 = Statistics sample rate (LSB first): ◦ Valid values are 1 µs to 125 µs Set this value with command **118**; B0 = 74.	4	2
248 **report statistics sample count** (subcommand 75)	Reports the statistics sample count or statistics pulse count. The statistics sample count is applicable in statistics sample mode and determines the number of data samples obtained and used to calculate the statistical data. The statistics pulse count is applicable in statistics pulse mode and determines the number of pulses used to calculate the statistical data. The range of valid values is defined in the following for each command. Send 4 data bytes:	4	2

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	• Bytes 0 and 1 = 75 (report statistics sample count), LSB first • Bytes 2 and 3 = Statistics count selection (LSB first): ◦ 1 = Report statistics sample count for statistics sample mode (valid values are 1 to 4,096) ◦ 2 = Report statistics pulse count for statistics pulse mode (valid values are 1 to 4,096) Returns 2 data bytes: • Bytes 0 and 1 = Statistics sample count value (LSB first) Set this value with command **118**; B0 = 75.		
248 **report pulsing measurement delays (NV)** (subcommand 77)	Reports the delay times and inflection point for control loop/measurement updates during pulsing. The maximum measurement delay must be greater than or equal to the minimum measurement delay. The inflection point must be greater than or equal to twice the maximum measurement delay. If the inflection point is set to minimum, then the maximum measurement delay can be increased to inflection point –5 µs). Send 2 data bytes: • Bytes 0 and 1 = 77 (report pulsing measurement delays), LSB first Returns 6 data bytes: • Bytes 0 and 1 = Minimum measurement delay (valid range is 1 µs to 4 µs) • Bytes 2 and 3 = Maximum measurement delay (valid range is 1 µs to 496 µs) • Bytes 4 and 5 = Inflection point (valid range is 25 µs to 1,000 µs) Set this value with command **118**; B0 = 77.	2	6

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
248 **report sweep frequency step direction** (subcommand 78)	Reports the sweep frequency step direction. The specified direction is only used for the first frequency step after RF is turned when the unit has sweep auto frequency mode disabled. If sweep auto frequency mode is enabled, then the step direction applies to the first frequency step after the rising edge of each pulse while pulsing. This subcommand applies only when the Type III tuning algorithm is active. Send 2 data bytes: • Bytes 0 and 1 = 78 (report sweep frequency step direction), LSB first Returns 2 data bytes: • Bytes 0 and 1 = Sweep frequency step direction (unsigned short): ◦ 0 = Step up (increase frequency) ◦ 1 = Step down (decrease frequency) Set this value with command **118**; B0 = 78.	2	2
248 **report control loop gain** (subcommand 79)	Reports the control loop gain used by the power control loop. Valid values for control loop gain are 49 to 500. This parameter is volatile and is not retained after an AC power cycle. Send 2 data bytes: • Bytes 0 and 1 = 79 (report control loop gain), LSB first Returns 2 data bytes: • Bytes 0 and 1 = Control loop gain (unsigned short, LSB first) Set this value with command **118**; B0 = 79.	2	2
248 **report sweep gamma average mask enable** (subcommand 81)	Reports the sweep gamma average mask enable. When enabled, the sweep gamma average mask causes all gamma^2 samples to be discarded except for the last one immediately prior to the tuning frequency step. When disabled, the unit accumulates all the gamma^2 average data and uses it to determine the next frequency step. This subcommand applies only when the Type III tuning algorithm is active.	2	2

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	Send 2 data bytes: • Bytes 0 and 1 = 81 (report sweep gamma average mask enable), LSB first Returns 2 data bytes: • Bytes 0 and 1 = Sweep gamma average mask enable (unsigned short): ◦ 0 = Disabled ◦ 1 = Enabled Set this value with command **118**; B0 = 81.		
248 **report sweep skip frequency range** (subcommand 83)	Reports the sweep skip frequency range in kHz. The minimum and maximum frequency range must be within the frequency range specified by the unit configuration, and the maximum must be greater than or equal to the minimum. Additionally, the range specified must not be greater than 200 kHz. ☞ **Important** Setting both minimum and maximum frequencies to 0 disables this feature. When this feature is enabled, the tuning algorithm will exclude or skip frequencies within the specified range when automatically tuning the generator. If the tuning algorithm attempts to go to a frequency that is within the skip frequency range, the frequency will jump to either the minimum or maximum skip frequency, depending on the sweep direction. The factory default values for minimum and maximum skip frequency are both 0, causing this feature to be disabled by default. Send 4 data bytes: • Bytes 0 and 1 = 83 (report sweep skip frequency range), LSB first • Bytes 2 and 3 = 1 (report sweep skip frequency range) Returns 8 data bytes: • Bytes 0 to 3 = Skip frequency range minimum in kHz	4	8

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	• Bytes 4 to 7 = Skip frequency range maximum in kHz Set this value with command **118**; B0 = 83.		
248 **report statistics acquisition mode** (subcommand 86)	Reports the statistics acquisition mode. In statistics sample mode, the data samples are obtained using the statistics sample rate and statistics sample count parameters. This mode does not perform averaging over each pulse while pulsing to calculate the statistics data. In statistics pulse mode, the data samples are obtained using the statistics pulse count parameter. This mode performs averaging over each pulse and then uses those averages to calculate the statistics data. This mode also performs averaging over the pulse period when configured to run in CW mode. In pulsing master mode, averaging is based on the master pulsing frequency. In pulsing slave mode, averaging is based on the frequency present on the *PSYNC* input connector. If the master pulsing frequency is 0 or the *PSYNC* input signal is not present, the averaging is configured to average over the pulse period of a 1 kHz pulsing frequency. The factory default value is statistics sample mode. If the unit is configured to run in CW mode, it will automatically switch over to statistics sample mode. The factory default value is statistics sample mode. Send 2 data bytes: • Bytes 0 and 1 = 86 (report statistics acquisition mode), LSB first Returns 2 data bytes: • Bytes 0 and 1 = Statistics acquisition mode (unsigned short LSB first): ◦ 1 = Statistics sample mode ◦ 2 = Statistics pulse mode Set this value with command **118**; B0 = 86.	2	2

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
248 **report fixed frequency control (NV)** (subcommand 93)	Reports the ramp time for fixed frequency ramping in milliseconds. This ramp time is used while operating in fixed frequency mode when changing the fixed frequency from one value to another. Ramp time is also used when changing the frequency mode from frequency tuning mode to fixed frequency mode, while in the mode to ramp to the fixed frequency (see command **118** [subcommand 52]). Valid values for fixed frequency ramp time are 100 milliseconds to 60,000 milliseconds. A value of 0 disables fixed frequency ramping. Send 4 data bytes: • Bytes 0 and 1 = 93 (report fixed frequency control), LSB first • Bytes 2 and 3 = Fixed frequency control command: ◦ 1 = Report fixed frequency ramp time Returns 2 data bytes: • Bytes 0 and 1 = Fixed frequency control command data value: ◦ 1 = Report fixed frequency ramp time in milliseconds	4	2
248 **report frequency tuning mask time** (subcommand 94)	Reports the frequency tuning mask time in %. The frequency tuning mask time determines the portion of the pulse that is masked off and excluded for measurements related to frequency tuning. The frequency tuning mask time begins at the start of the pulse on-time. The range of valid values for frequency tuning mask time is 0% to 99%. The actual mask time cannot exceed 125 milliseconds. The requested mask time is the time set by command **118** (subcommand 94). The actual mask time can be shorter or longer than the requested mask time. Send 4 data bytes: • Bytes 0 and 1 = 94 (report frequency tuning mask time), LSB first	4	2

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	• Bytes 2 and 3 = Frequency tuning mask time selection: ◦ 2 = Report requested frequency tuning mask time ◦ 3 = Report actual frequency tuning mask time Returns 2 data bytes: • Bytes 0 and 1 = Frequency tuning mask time value in %		
248 **report RF bias DAC manual mode** (subcommand 300)	Reports the RF bias DAC manual mode. In lookup table mode, the RF bias DAC value is determined by the frequency lookup table. In manual mode, the RF bias DAC value is determined by subtracting the RF bias DAC offset from the RF bias DAC calibration value. This parameter is volatile and is not retained after an AC power cycle. Send 2 data bytes: • Bytes 0 and 1 = 300 (report RF bias DAC manual mode), LSB first Returns 2 data bytes: • Bytes 0 and 1 = RF bias DAC manual mode (unsigned short): ◦ 0 = Lookup table mode ◦ 1 = Manual mode Set this value with command **118**; B0 = 300.	2	2
248 **report RF bias DAC offset** (subcommand 301)	Reports the RF bias DAC offset in DAC counts. The RF bias DAC offset is subtracted from the RF bias DAC calibration value and the result is written to the manual data register. This parameter is volatile and is not retained after an AC power cycle. Send 2 data bytes: • Bytes 0 and 1 = 301 (report RF bias DAC offset), LSB first Returns 2 data bytes:	2	2

Table 4-14. AE Host Commands (Continued)

Command	Description	Data Bytes Sent	Data Bytes Returned
	• Bytes 0 and 1 = RF bias DAC offset (unsigned short) Set this value with command **118**; B0 = 301.		

ETHERNET INTERFACE

The Paramount unit provides an Ethernet communications interface that allows the unit to communicate with a host computer. The interface consists of a shielded RJ-45 port (labeled **Enet** on your unit) and the AE TCP protocol, which uses function code (FC) 100.

Use only a shielded Ethernet cable when connecting to this port.

Enet Connector and Indicators

☞ **Important**

The Paramount unit supports a Modbus®/TCP connection to port 502. For more information about the Modbus/TCP protocol, visit the Modbus Users website at: http://www.modbus.org.

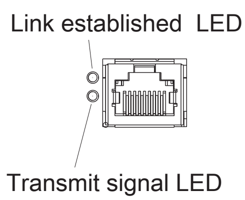


Figure 4-60. Ethernet connector and indicators

The two LEDs next to the Ethernet connector communicate when the unit is transmitting data and if the Ethernet link has been established.

- The Transmit Signal (yellow) LED lights and flashes when the unit is actively transmitting. The LED is off (not lit) when no data is being transmitted.
- The Link Established (green) LED is on (is lit and steady) when the Ethernet link has been established with the unit. The LED is off when no link has been established with the unit.

Enet Port Pin and Signal Descriptions

*Table 4-15. **Enet** port pin and signal descriptions*

Signal Pin	Pin Name	Description
1	*TX+*	Transmit data +
2	*TX–*	Transmit data –
3	*RX+*	Receive data +
4	Unassigned	Not connected
5	Unassigned	Not connected
6	*RX–*	Receive data –
7	Unassigned	Not connected
8	Unassigned	Not connected

AE TCP Protocol (FC100)

The AE TCP protocol is a method for communicating with an AE product using a network connection. It uses Modbus/TCP as a transport for AE Host commands. The Paramount unit acts as a server while the host or tool program communicating with the unit acts as a client. The unit listens for requests for TCP connections on registered port 502. Port 502 is assigned to Modbus/TCP protocol. The unit can support up to six simultaneous TCP connections.

Modbus user-defined function code FC100 encapsulates AE Host commands and data into Modbus/TCP packets. FC100 functions according to the Modbus/TCP standard (visit http://www.modbus.org for more information). You can use FC100 to run all common commands.

ESTABLISHING A CONNECTION

To establish a TCP connection, the host or tool program (client) connects to TCP port 502. If the number of already established connections exceeds the predefined limit for the given equipment, the connection is rejected.

Once the connection is established, the client may perform multiple transactions consisting of the following two steps:

1. The client sends a request containing an AE Host command to be executed by the Paramount unit (server).
2. The server executes the AE Host command and returns a packet containing the unit's reply to the command (CSR and data).

☞ **Important**

For optimum performance, keep the TCP connection open during continuous operation. Opening and closing a connection for each command transaction will result in poor communication performance.

DATA ENCODING

Each Modbus/TCP message packet consists of two sections: A Modbus Application Protocol (MBAP) header and a protocol data unit (PDU).

The MBAP header contains the following information:

- Transaction ID (2 bytes)
- Protocol ID (2 bytes)
- Length (2 bytes)
- Unit ID (1 byte)

Following the MBAP header, the PDU consists of the following information:

- Function code (1 byte)
- Command number (1 byte)
- Command status response (CSR; 1 byte)

  All commands and responses include a CSR byte.
- Data length (2 bytes)
- Data bytes (as many as 248)

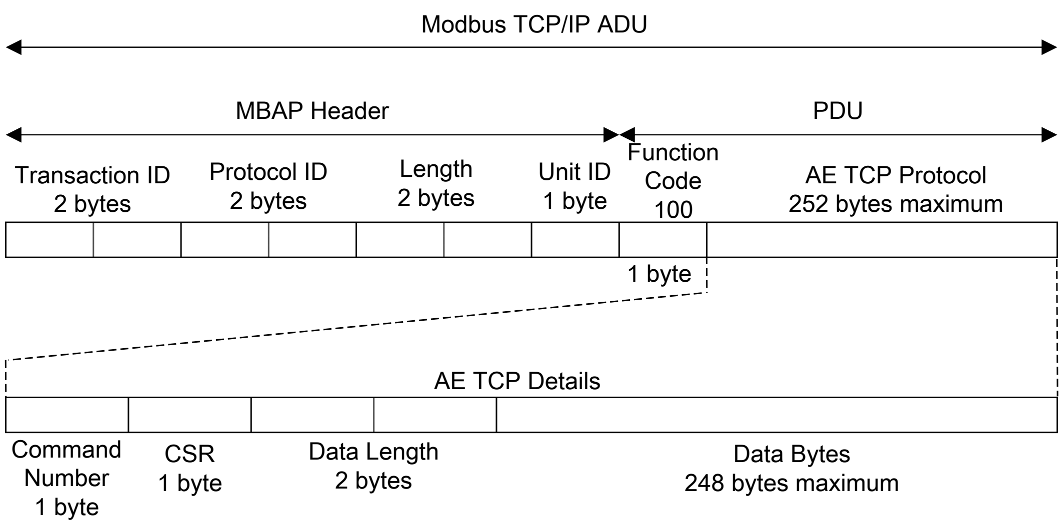


Figure 4-61. Data encoding for AE TCP using FC100

The Modbus/TCP protocol uses big endian (most significant byte first) architecture. The AE TCP portion of each packet uses little endian (least significant byte first) architecture.

To remain compliant with Modbus/TCP protocol, the PDU size must be no larger than 253 bytes.

Using AE FC100

FC100 allows you to send any AE Host command through the Ethernet interface, providing complete control of the system.

FC100 SEND PACKET FORMAT

Table 4-16. Format for FC100 send packet

Byte Numbers	Purpose	Value To Send
MBAP		
0 and 1	Transaction ID	Not used (value is copied into reply)
2 and 3	Protocol ID	0
4 and 5	Number of bytes following	Count of bytes in packet (starting with byte 6)
6	Unit ID	Address of unit. • Unit ID ◦ 1 = Normal operation ◦ 2 to 255 = Reserved
PDU		
7	Function code	100 = 0x64
8	AE command number	AE Host command number
9	CSR	Send packets do not use the CSR byte; it may be set to 0.
10 and 11	Data length	Number of AE TCP data bytes in the packet
12 and up	Data bytes	Data bytes contained in the command packet. ☞ **Important** All bytes in the PDU (byte 8 to end of packet) are in little endian order (least significant bytes first).

FC100 RESPONSE PACKET

Table 4-17. Format for FC100 response packet

Byte Numbers	Purpose	Value To Send
MBAP		
0 and 1	Transaction ID	Not used (value is copied from send packet)
2 and 3	Protocol ID	0
4 and 5	Number of bytes following	Count of bytes in packet (starting with byte 6)
6	Unit ID	Identity of unit: • Unit ID ◦ 1 = Normal operation ◦ 2 to 255 = Reserved
PDU		
7	Function code (100)	0x64
8	AE command number	AE Host command number
9	CSR	CSR byte (always returned)
10 and 11	Data length	Total number of data bytes in the packet
12 and up	Data bytes	Data bytes contained in the command packet ☞ **Important** All bytes in the PDU (byte 8 to end of packet) are in little endian order (least significant bytes first).

FC100 ERROR PACKETS

If the communication from the host to the Paramount unit encounters no problems, the unit sends CSR 0 (command accepted). If something goes wrong in the communication to the unit, you receive one of these two notifications:

- Modbus/TCP error packet: The Modbus/TCP protocol issues an exception error packet
- CSR packet: The Paramount unit replies to commands with a CSR packet.

Table 4-18. Format for FC100 Modbus/TCP exception error packet

Byte Numbers	Purpose	Response Value
0 and 1	Transaction ID	Not used (value is copied from send packet)
2 and 3	Protocol ID	0
4 and 5	Number of bytes following	Count of bytes in packet (starting with byte 6)
6	Unit ID	Unit identifier
7	Function code	228 = 0xE4
8	Exception code	One of many available exception codes

Table 4-19. Format for FC100 CSR packet

Byte Numbers	Purpose	Response Value
0 and 1	Transaction ID	Not used (value is copied from send packet)
2 and 3	Protocol ID	0
4 and 5	Number of bytes following	Count of bytes in packet (starting with byte 6)
6	Unit ID	Unit identifier
7	Function code	100 = 0x64
8	Command	AE Host command number
9	CSR	One of many CSR codes
10 and 11	Data length	0

FC100 EXAMPLE

Refer to the following information for an example that illustrates using AE Host command 14 to set the active control mode for the power supply using the AE TCP connection with FC100.

Table 4-20. Packet format for command 14 send

Byte Numbers	Send Value	Purpose
0 and 1	0x00, 0x00	Transaction ID (any value)
2 and 3	0x00, 0x00	Protocol ID
4 and 5	0x00, 0x07	Number of bytes following (count of bytes in packet starting with byte 6)

6	0x01	Unit ID
7	0x64	Function code (100 = 0x64)
8	0x0E	AE Host command number = 14
9	0x00	CSR = Reserved
10 and 11	0x01, 0x00	Data length = 1 End of packet—no data bytes exist in this command.
12	0x04	Data byte: 4 = User port (analog)

This table illustrates the response packet for command 14.

Table 4-21. Packet format for command 14 response

Byte Numbers	Send Value	Purpose
0 and 1	0x00, 0x00	Transaction ID (any value)
2 and 3	0x00, 0x00	Protocol ID
4 and 5	0x00, 0x06	Number of bytes following (count of bytes in packet starting with byte 6)
6	0x01	Unit ID
7	0x64	Function code (100 = 0x64)
8	0x0E	AE Host command number = 14
9	0x00	AE command status response = CSR value
10 and 11	0x00, 0x00	Number of data bytes in response

ETHERCAT INTERFACE

AE provides an EtherCAT communications interface that incorporates an EtherCAT slave module, allowing for instant connectivity to an EtherCAT network. The interface consists of two EtherCAT RJ-45 ports (labeled **In** and **Out**), the CANopen® protocol, and operational commands for your unit.

- For questions specific to the EtherCAT protocol, visit the EtherCAT Technology Group (ETG) at: http://www.ethercat.org.
- For questions specific to the CANopen protocol, visit CAN in Automation at: http://www.canopen.org.
- You will need an EtherCAT Slave Information (ESI) file to communicate with the unit using the EtherCAT interface. The unit-specific ESI file contains EtherCAT data types, Process Data Objects (PDOs), Service Data Objects (SDOs), and data definitions.

To obtain the most up-to-date ESI file that is specific to the EtherCAT implementation for your unit and a PDF that contains a readable summary of the object dictionary, please contact AE Global Services.

EtherCAT Ports, Device ID, and Status LEDs

PORT CONNECTORS

The EtherCAT interface consists of two RJ-45 ports (labeled **In** and **Out**), device ID switches, and status LEDs. The interface panel on your unit will look similar to one of the panels in Figure 4-62.

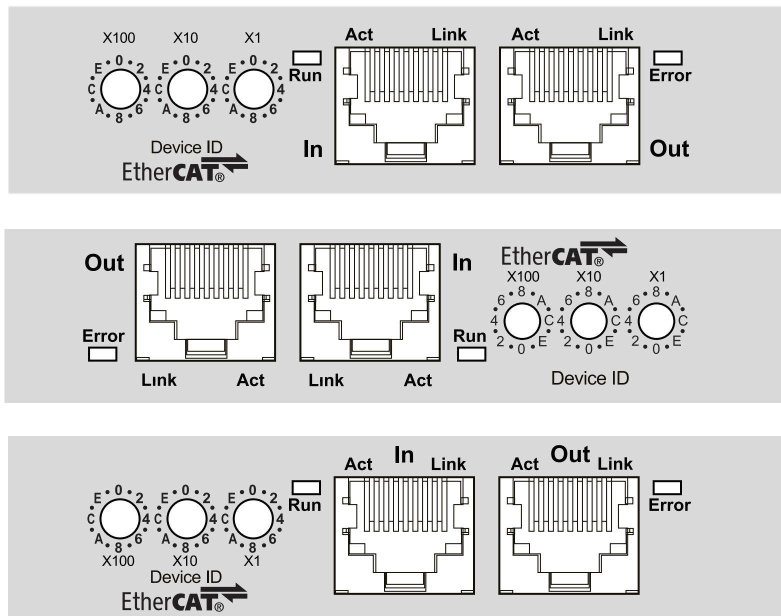


Figure 4-62. EtherCAT ports, device ID, and status LEDs

DEVICE ID

The EtherCAT device ID may be set to a 12-digit device ID. The switches form a three-digit hexadecimal identifier, from 000 to FFF, that is reported to the EtherCAT master. Three external rotary switches next to the EtherCAT port input connector show the switch numbers and letters (0 to F). To set the EtherCAT device ID, change each of the rotary switch positions to the hexadecimal representation of the device ID, with the rotary switch furthest away from the input connector as the most significant digit.

STATUS LEDS

The EtherCAT interface is equipped with status LEDs that have the following functions:

- The green **Run** indicator LED uses different patterns to show the communication state, per the EtherCAT protocol.

Table 4-22. Description of the ***Run*** *indicator (green LED)*

Run LED State	Description
Off	INIT: The unit is in initialization state.
On	Operational: The unit is operational.
Blinking	Pre-Operational: The unit is in pre-operational state.
Single flash	Safe-Operational: The unit is in safe-operational state.

- The red **Error** indicator LED uses different patterns to show various error states.

Table 4-23. Description of the ***Error*** *indicator (red LED)*

Error LED State	Error Name	Description	Example
Off	No error	The EtherCAT connection is operational.	
On	Application controller failure	A critical communication or application controller error has occurred.	The application controller is no longer responding.
Flickering	Booting error	The unit reached the INIT stage, but a boot error was detected.	There is a checksum error in flash memory.
Blinking	Invalid configuration	A general configuration error was detected.	A command received from the master unit cannot be performed due to register or object settings.
Single flash	Local error	The slave unit has changed the EtherCAT state autonomously.	A synchronization error has been detected and the unit has entered a safe-operational state.
Double flash	Process data watchdog timeout/ EtherCAT watchdog timeout	An application watchdog timeout has occurred.	A sync manager watchdog timeout was detected.

LED INDICATOR STATES

Table 4-24. Definition of LED indicator states and flash rates

LED State	LED Flash Rate Behavior
Off	Constantly off.
On	Constantly on.
Flickering	Turns on and off with a frequency of 10 Hz: 50 ms on, 50 ms off.
Blinking	Turns on and off with a frequency of 2.5 Hz: 200 ms on, 200 ms off.
Single flash	One short 200 ms flash, followed by a longer 1000 ms off phase.
Double flash	A sequence of two short 200 ms flashes, separated by a 200 ms off phase, followed by a longer 1000 ms off phase.

DEVICENET INTERFACE

The DeviceNet system enables basic control of the Paramount unit through a 5-pin **DeviceNet** port. The Paramount unit operates as a GROUP 2 slave device on an established DeviceNet network in accordance with the Open DeviceNet Vendor Association (ODVA) DeviceNet specification (revision 2.0 or later). For questions specific to the DeviceNet system or for a copy of the DeviceNet specification, consult either a DeviceNet network administrator or visit the ODVA website at http://www.odva.org, where members can download the specification.

For additional information on the DeviceNet interface for your unit, you can request the AE DeviceNet interface specification from AE Global Services.

DeviceNet Port

The **DeviceNet** port is a round, five-pin, male micro connector that is electrically isolated from the power supply.

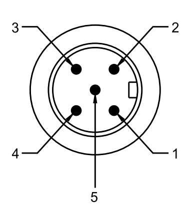


Figure 4-63. DeviceNet port

DeviceNet Port Pin Descriptions

Table 4-25. DeviceNet port pin descriptions

Pin Number	Pin Name
1	Drain
2	V+
3	V-
4	CAN_H
5	CAN_L

DeviceNet Control Panel

The DeviceNet control panel includes two LEDs that allow you to monitor DeviceNet communications and three rotary switches that allow you to set communication parameters.

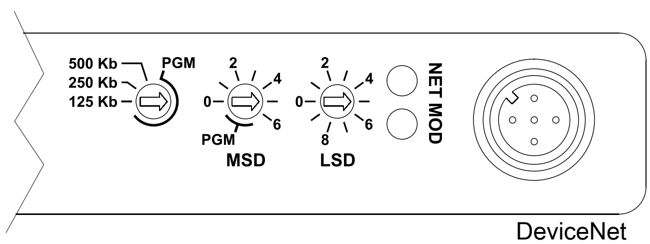


Figure 4-64. DeviceNet control panel

DEVICENET CONTROL PANEL LEDS

The DeviceNet control panel features two bicolor LEDs (light-emitting diodes). One LED is labeled **MOD** and indicates module status. The other LED is labeled **NET** and indicates network status.

DeviceNet Module Status (MOD) LED

The **MOD** bicolor (amber/green) LED provides device status, such as whether the device has power and is operating properly.

Table 4-26. DeviceNet module status (MOD) LED

LED Status	Indication	Unit Status
Off	No power	Unit is not receiving power.
Green (steady)	Operational	Unit is operating normally.

Table 4-26. DeviceNet module status (MOD) LED (Continued)

LED Status	Indication	Unit Status
Green (flashing)	Standby	Unit requires maintenance because the configuration is missing, incomplete, or incorrect.
Amber (steady)	Unrecoverable fault	Unit has experienced a fault from which it cannot recover; you may need to cycle power.
Amber/Green (flashing)	Device self testing	Unit is running self diagnostics.

☞ **Important**
For further information on indicator flash rates, refer to the current DeviceNet specification (available to ODVA members from the ODVA website at: http://www.odva.org).

☞ **Important**
For further information about module status indications during power-up, refer to the current DeviceNet specification.

Network Status (NET) LED

The **NET** bicolor (amber/green) LED is the network status LED and indicates the status of the communication link.

Table 4-27. Network status (NET) LED

LED Status	Indication	Unit Status
Off	No power	Unit is not online because: • Unit has not completed the Dup_MAC_ID test • Unit is not receiving power (check the **MOD** LED)
Green (steady)	Link okay	Unit is online and allocated to the master.
Green (flashing)	Online, not connected	Unit is online but has no connections in its existing state because: • Unit has not established connections to other nodes • Unit is not allocated to the master
Amber (flashing)	Connection timeout, critical link failure	One or more I/O connections are in the timed-out state.
Amber (steady)	Critical link failure	Communication has failed (that is, the unit has detected an error that has made it incapable of communicating on the network).

Table 4-27. Network status (NET) LED (Continued)

LED Status	Indication	Unit Status
		If you have a unit configured with two DeviceNet cards, the cause of this failure may be: • The two DeviceNet cards are not set to the same data rate as the network • The two DeviceNet cards have the same node address

☞ **Important**
For further information on indicator flash rates, refer to the current DeviceNet specification (available to ODVA members from the ODVA website at: http://www.odva.org).

CONTROL PANEL ROTARY SWITCHES

The DeviceNet control panel features three rotary switches to set the network address and communication data rate. Each time the DeviceNet interface is energized, the DeviceNet master reads the switch settings.

Data Rate Rotary Switch

Use the **DATA RATE** switch to select a communication baud rate:

- 0 = 125 kbits per second
- 1 = 250 kbits per second
- 2 = 500 kbits per second

The default is 500 kbits per second. A switch setting in the **P** or **PGM** region allows the DeviceNet master to set the baud rate for the unit.

Node Address Rotary Switches

Use the **NODE ADDRESS** rotary switches, **MSD** (most significant digit) and **LSD** (least significant digit), to select the DeviceNet network address (MAC ID). MAC IDs 0 through 63 are valid. Use the **MSD** switch to select the MAC ID's most significant digit; use the **LSD** switch to select the MAC ID's least significant digit. Switch settings greater than 63 (or in the **P** or **PGM** region of the **MSD** switch) allow you to set the MAC ID through the DeviceNet master.

DeviceNet Message Types

As a GROUP 2 slave device, the Advanced Energy DeviceNet interface supports the message types listed in this table. In the table, xxxxxx = Node address.

Table 4-28. DeviceNet supported message types

CAN Identifier	Group 2 Message Type
10xxxxxx111	Duplicate MACID Check Message
10xxxxxx110	Unconnected Explicit Request Message
10xxxxxx101	Master I/O Poll Command Message
10xxxxxx100	Master Explicit Request Message

DeviceNet Class Services

As a GROUP 2 slave device, the Advanced Energy DeviceNet interface supports the class services and instance services listed in the following table.

Table 4-29. DeviceNet supported class services

Service Code	Service Name
05 (0x05)	Reset
14 (0x0E)	Get Attribute Single
16 (0x10)	Set Attribute Single
75 (0x4B)	Allocate GROUP 2 Identifier Set
76 (0x4C)	Release GROUP 2 Identifier Set

DeviceNet Data Types

The Advanced Energy DeviceNet interface supports the DeviceNet data types shown in this table.

Table 4-30. DeviceNet data types

Key Word	Description
BOOL	Boolean (0 = False; 1 = True)
INT	Integer (-32768 to 32767)
UINT	Unsigned integer (0 to 65535)
BYTE	Bit string (8 bits)
USINT	Unsigned short integer (0 to 255)
SHORT STRING	Character string (1 byte per character, 1 byte length indicator)
UDINT	Unsigned double integer (0 to $2^{32} - 1$)

Installation, Setup, and Operation

PREPARING TO INSTALL THE UNIT

Spacing Requirements

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

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.

Dimensional Drawings

The following figures show Paramount generator dimensions, front, side, and top views.

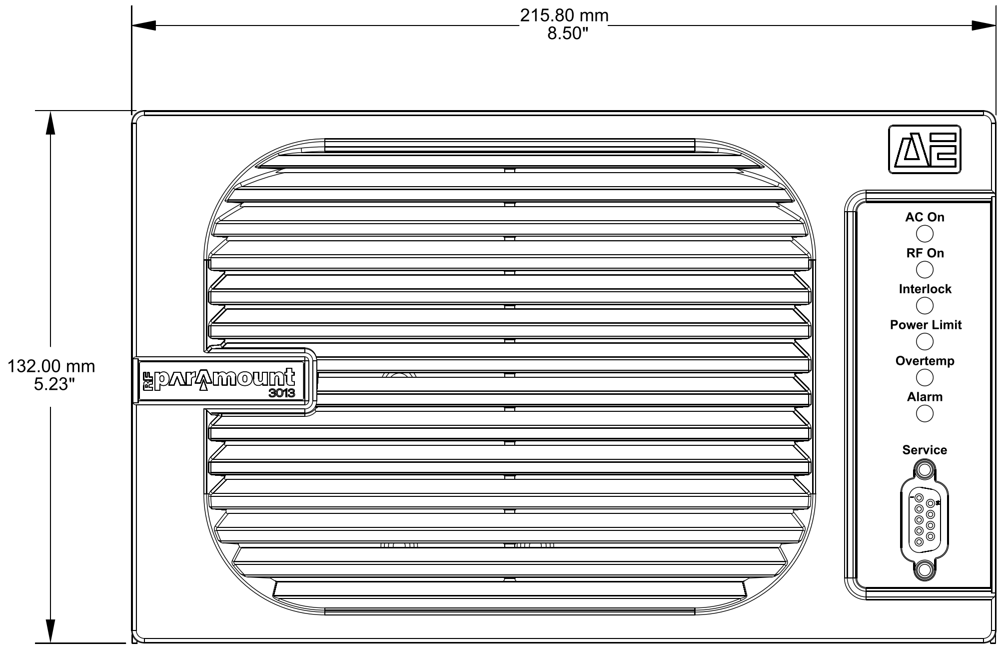


Figure 5-1. Paramount generator dimensions, front view

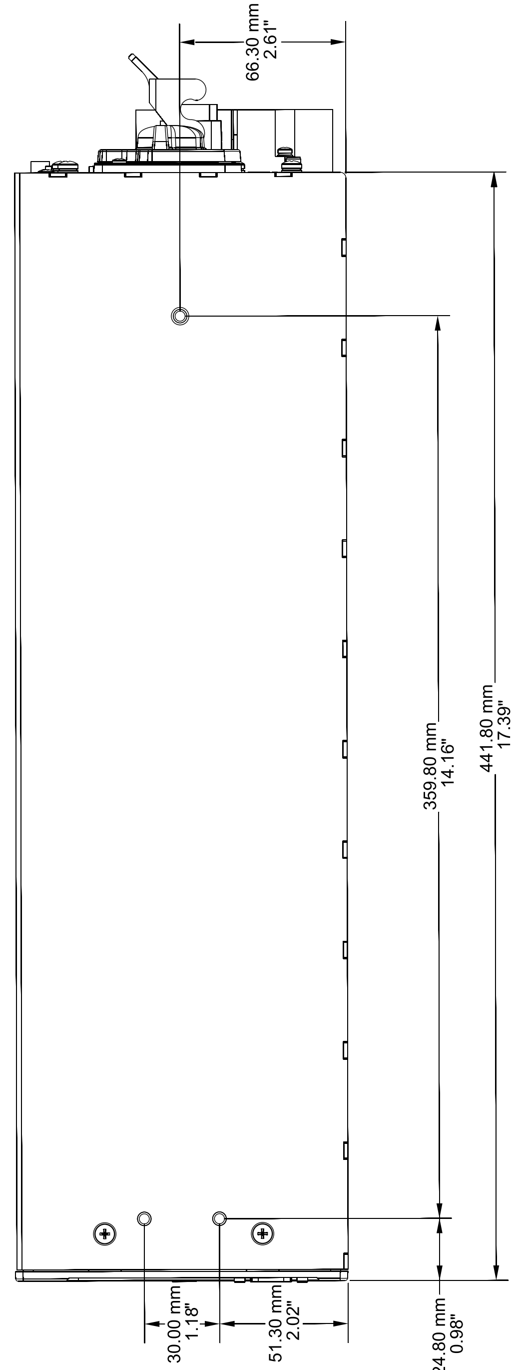


Figure 5-2. Paramount generator dimensions, side view

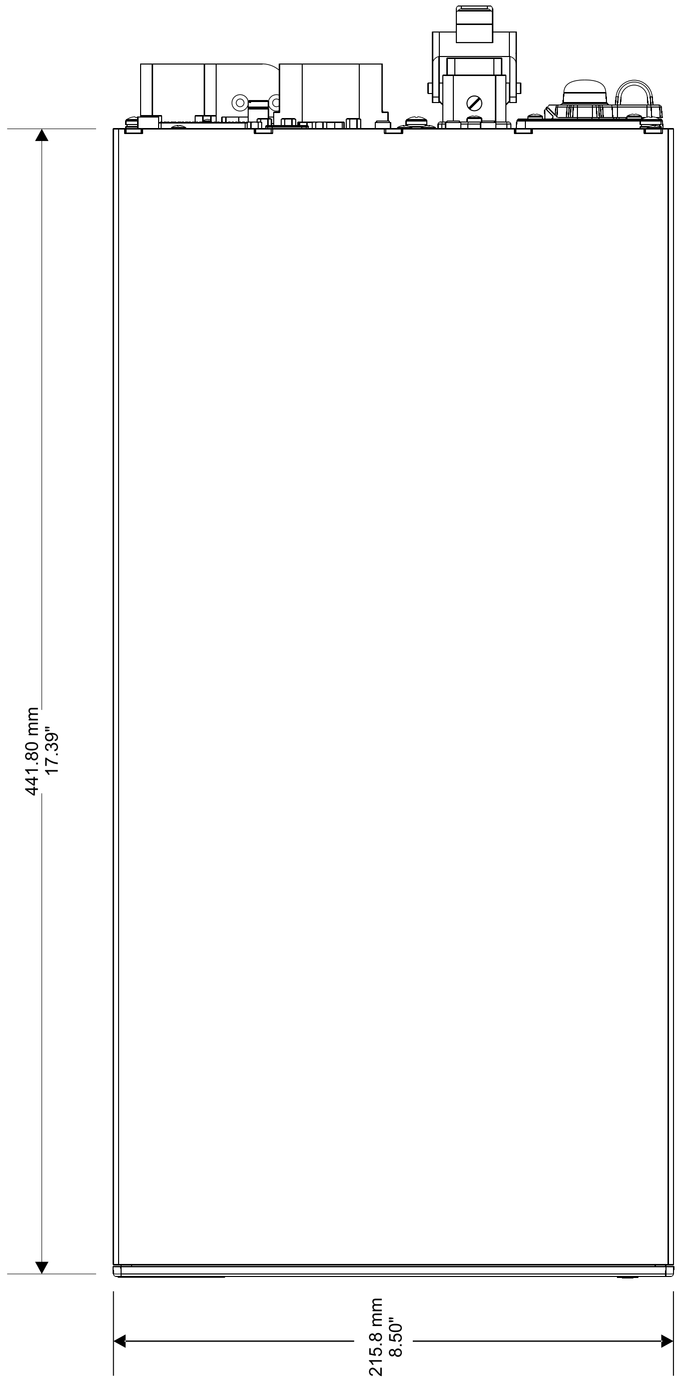


Figure 5-3. *Paramount generator dimensions, top view*

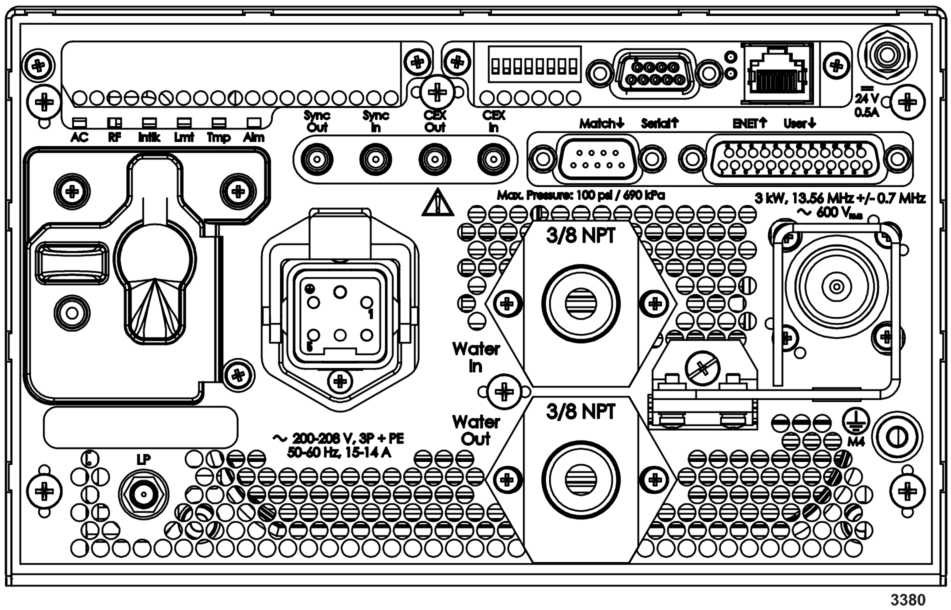


Figure 5-4. Paramount generator rear panel

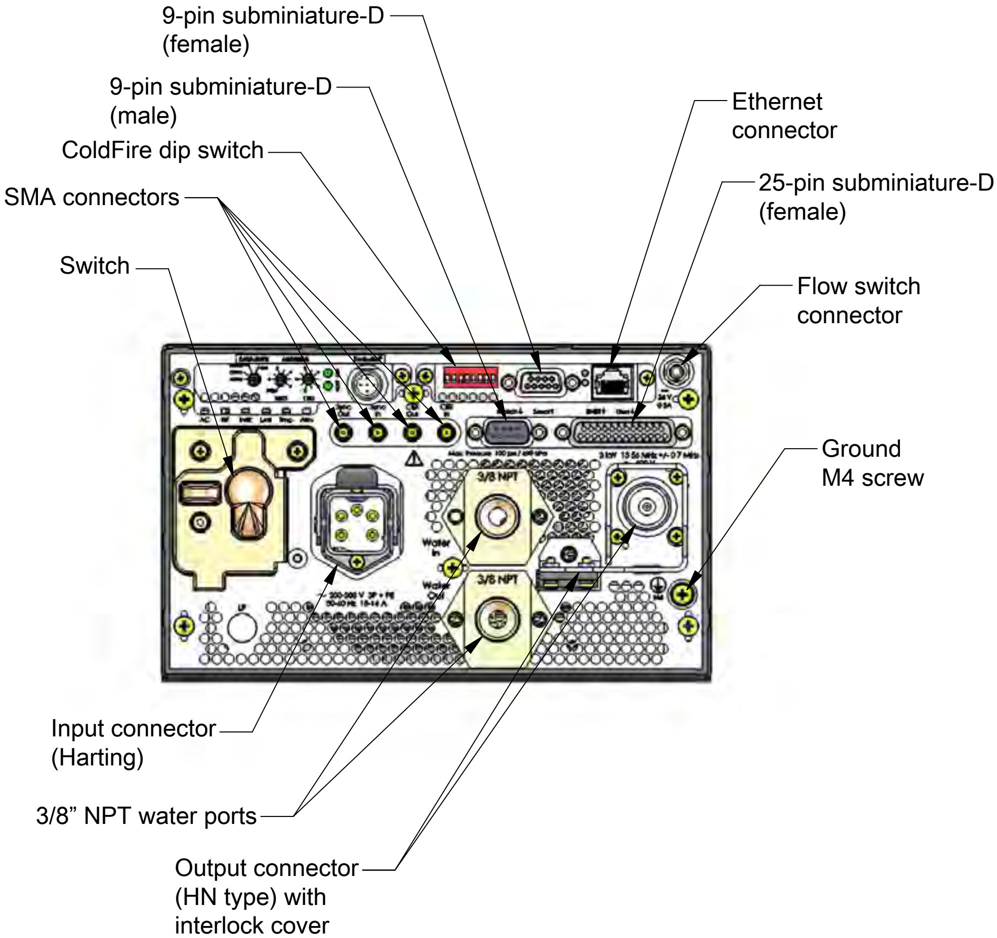


Figure 5-5. Paramount generator rear panel with connectors

Installation Requirements

Install this unit according to the following requirements.

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.

DANGER:

Personnel must receive proper training before installing or troubleshooting 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.

CAUTION:
This equipment is intended for use with a single source of three-phase power with all phases vectored at 120º angles ± 5º. 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

☞ **Important**
Some Paramount units are double-bagged to prevent contamination. The labels on the packaging provide important handling information. In many cases, the inner bag should not be removed until the unit is in the cleanroom.

1. Unpack and inspect the unit carefully, looking for obvious physical damage.
2. If no damage is apparent, proceed with the unit installation and setup.
3. If you do see signs of shipping damage, contact Advanced Energy and the carrier immediately.

   Save the shipping container for submitting necessary claims to the carrier.

INSTALLING THE UNIT

Grounding

WARNING:
Do not attempt to turn on power until the Paramount unit is grounded.

WARNING:
For a corner-grounded delta configuration, connect the secondary Protective Earth (ground) stud to the system ground terminal before making any other connection. This connection is mandatory.

You must make all ground connections before operating the Paramount generator. The unit provides one threaded grounding hole (metric M4). A suitable chassis ground connection made to this hole prevents or minimizes radio frequency interference.

Appropriate gage cable for current rating must be used during installation by qualified personnel.

Connecting Cooling Water

This generator is water cooled. Do not operate the unit until you have connected cooling water and met the cooling requirements.

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

> **CAUTION:**
> Do not use deionized water for cooling purposes. Deionized water causes both corrosion and erosion of cooling manifolds.

> **CAUTION:**
> Do not apply more than 54.2 N-m (40 ft-lb) to water fittings. Water leakage and damage to the unit could result.

The water fittings used on the Paramount generator are 3/8″ NPT female or 1/2″ SST male/female quick release.

TO CONNECT COOLING WATER

1. Make input and output water connections and tighten securely.
2. Turn on the water and ensure that there are no leaks.
3. Be sure that the flow rate, pressure, and temperature are within the minimum specifications required to operate the generator.

Water Control Connector

The water control connector can be used with a user-provided externally mounted water control valve. The Paramount generator provides 24 VDC for the water valve. The water control valve inhibits the flow of water to the generator when additional cooling is not required. Inhibiting the water flow minimizes condensation in the generator.

Water control is on (water control valve is open) if one or both of these conditions exist:

- RF output is on
- Water temperature exceeds the warning threshold

Water control is off (water control valve is closed) when both of these conditions exist for five minutes:

- RF is off
- Water temperature is below the warning threshold

WATER CONTROL CONNECTOR AND PIN DESCRIPTIONS

The Paramount generator water control connector is a 2-pin miniature power jack, Switchcraft p/n L712A.

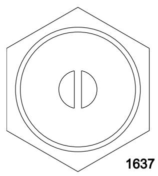


Figure 5-6. Water control connector

Table 5-1. Water control connector pins

Pin	Description
1 (center pin)	+24 V/1A (switched source to enable control)
2 (outer pin)	+24 V return

Connecting Output Power

> ⚠ **WARNING:**
> **This device must be installed so that the output power connection is inaccessible to the user.**

The Paramount generator uses an HN female output connector.

The following figure provides a basic example drawing of an RF output connector. The center pin provides the RF output connection, while the outer cable provides a ground connection.

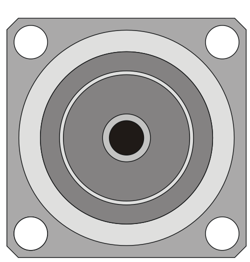


Figure 5-7. RF output connector

Your unit might be shipped with an RF interlock shroud that fits around the RF connector. The shroud prevents disconnecting the RF connector. If your unit is shipped with a shroud, install the shroud at the same time you connect the output power.

TO CONNECT OUTPUT POWER AND INSTALL THE RF INTERLOCK SHROUD

1. Slide the RF interlock shroud onto the RF cable.
2. Push the cable connector into the RF connector on the generator, and then turn the cable connector until you have secured the cable.
3. Position the shroud on the generator back panel and secure it with the Phillips M4 screw.

When the shroud is secure, its magnetic switch closes the interlock switch on the generator back panel. If the interlock switch does not close, the generator cannot turn on RF output.

TO DISCONNECT OUTPUT POWER ON UNITS WITH AN RF INTERLOCK SHROUD

1. Remove the RF interlock shroud by removing the Phillips M4 screw that secures the shroud to the generator back panel.
2. Slide the shroud out of the way and then disconnect the RF cable.

TO CONNECT OUTPUT POWER ON UNITS WITH A USER CARD DRY INTERLOCK

1. Push the cable connector into the HN RF connector on the generator, and then turn the cable connector until you have secured the cable.

   If the cable is firmly connected, an internal engagement switch will sense the presence of the cable. Pins 1 and 14 on the custom 1 **User** port will be closed if this dry interlock is met.
2. If pins 1 and 14 on the custom 1 **User** port are open, resecure the RF output cable and check again to ensure that interlock has been met.

Connecting AC Input Power

HARTING AC POWER CONNECTOR

The Paramount generator provides a HARTING Han 16 A input power connector that should be used with a four-conductor input cable.

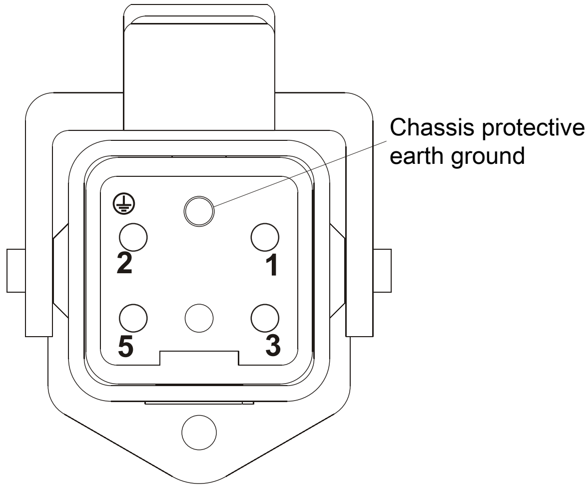


Figure 5-8. *HARTING AC 16 A power input connector*

Table 5-2. HARTING 16 A connector pin descriptions on rear of unit

Pin	Description
1	Phase A
2	Phase B
3	Phase C
Gnd	Ground
5	Shield connected to chassis

The parts listed in the following table are those used on the Paramount generator HARTING AC connector. Do not order these parts. Contact HARTING to find mating connector parts for the customer side of the AC connection.

Table 5-3. HARTING 16 A connector part numbers

HARTING Part Number	Quantity	Description
09 12 005 3001	1	HARTING Han Q 5/0 insert
09 20 003 0301	1	HARTING Q bulkhead housing mounting
09 33 000 6102	4	HARTING connector pin

TO CONNECT AC INPUT POWER WITH THE HARTING CONNECTOR

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:
This device must be installed so that the input power connection is inaccessible to the user.

CAUTION:
To provide the required overcurrent protection, install and operate this device with a 20 A (maximum) circuit breaker switch on the AC input. The circuit breaker switch must be easily accessible and near the device.

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.

1. Ensure that the AC line to which you are connecting the unit is a balanced, three-phase AC line that complies with the input specifications.

   All phases must be vectored at 120° angles ± 5°.

   ☞ **Important**
   Connection to an unbalanced line could negatively impact the dynamic performance of this device and its viable range of operation.

2. Ensure that the AC power circuit breaker to the connector is switched off.

   Lockout/tagout procedures are strongly advised.

3. Connect a properly wired Harting female connector and lock it in place by closing the latch or by using the two pressure-loaded side tabs.

Connecting I/O and Auxiliary Connectors

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

Depending on your process and the Paramount generator configuration, connect one or more of the I/O or auxiliary ports.

You must install either cable connectors or interlock covers to allow the generator to operate.

Table 5-4. I/O and auxiliary ports

Port	Description	For More Information, See ...
User	Allows analog/digital communication through voltage signals	25-Pin **User** Port
Serial (back panel)	Allows serial communications with a host computer using AE Bus communications protocol	AE Bus (Host) Interface
Service (front panel)	Allows serial communications with a host computer using Virtual Front Panel (VFP)	**Service** Interface
Enet	Allows digital communication with a host computer using the Ethernet protocol	Ethernet Host Port (AE TCP)
DeviceNet	Allows digital communication with a DeviceNet Master using DeviceNet protocol	**DeviceNet** Interface

FIRST TIME OPERATION

To Operate the Unit for the First Time

1. Install the generator according to the installation procedures in this user manual.
2. Turn on the system circuit breakers and apply AC input to the unit.

   When the generator receives AC input, it performs self-diagnostics. If the unit detects an error, the unit latches the error code and illuminates the **FAULT**

LED. You will not be able to turn RF output on until you clear the fault and send an RF off signal.

3. Verify that the **AC On** LED is lit.
4. Verify that the **Interlock** LED is lit..
5. Send the RF On command and verify that the **RF On** LED is on.
6. Request a set point and verify that the **Power Limit** LED is not lit. Make sure the generator is connected to a 50 Ω load, otherwise the **Power Limit** LED may correctly indicate a power limit condition.

If the Paramount generator is delivering power and the **Power Limit** LED is not lit, the unit is functioning properly.

NORMAL OPERATION

Each time you turn generator power on, the unit runs a self-diagnostics procedure to ensure that it is performing correctly. Follow the procedures in the user manual for first time operation the first time you operate your unit, and consult the troubleshooting section if you have issues or problems operating your generator after you have followed first time operation guidelines.

After you turn the unit on, the fan operates continuously, producing the following noise levels at one meter distance: 72.6 dBA at the back panel, and 76.1 dBA at the front panel.

Specific operating techniques vary depending on the control and monitoring interface. If you are using Virtual Front Panel to operate the generator, see the user manual and help system that came with the software for further operational instructions.

UNIT FEATURES

The Paramount generator offers several features for improved handling and operation. Your unit may have some or all of the following features:

- Frequency tuning
- Common exciter (CEX)
- Pulsing output (single level pulsing)
- Arc Management System (AMS) technology
- High accuracy, low output (HALO)
- Recipe mode

- IMD suppression

FREQUENCY TUNING

Understanding Frequency Tuning

Your Paramount generator may have a frequency tuning feature, which allows a generator to sweep through its frequencies until it optimizes power delivery and minimizes reflected power.

To determine if your unit has this feature, use the following configuration note.

ATTENTION:

CONFIGURATION NOTE

To determine if your generator has frequency tuning, you can access the product identification number (PIN) that the unit returns when it receives command 221. The 31 characters (0 through 30) in this PIN provide information about the configuration of the unit. You can also retrieve the PIN using Virtual Front Panel (VFP). Character 2 indicates whether frequency tuning is installed in the unit.

Example PIN: 2 2 3 2 1 0 0 1 2 2 2 1 1 0 1 1 2 7 1 1 1 0 0 0 0 0 0 0 0 0

Possible values for character 2:

- 0 = No frequency tuning
- 3 = Frequency tuning installed

TUNING THE FREQUENCY

Different processes and chambers run with varying operating parameters, including the quantity and frequency of power applied to the system. The Paramount generator delivers up to its full rated output power from 12.882 MHz to 14.238 MHz (13.56 MHz ± 5%). To optimize the power being delivered, the Paramount generator uses a frequency tuning algorithm.

RF ON TUNING

☞ **Important**
This description gives only basic information about frequency tuning. For detailed information about frequency tuning, contact AE Global Services.

If frequency tuning is enabled, the generator automatically tries to find the best operating frequency. The best operating frequency is the frequency at which the load reflection coefficient magnitude is at its lowest possible value. A small load reflection coefficient magnitude corresponds to a load impedance that is close to 50 Ω, and to low reflected power.

At RF on the generator first goes through an ignition sequence before running the normal frequency tuning algorithm. You can select one of three ignition modes:

- Fixed frequency ignition mode (the simplest ignition sequence) maintains unit frequency at the start frequency for a given amount of time (tune delay time).
- Variable frequency ignition mode adjusts the frequency until the reflection coefficient magnitude is below some limit and then remains at that frequency for the remainder of the tune delay time.
- Scan ignition mode scans for the frequency that minimizes the load reflection coefficient magnitude and then maintains that frequency for the remainder of the tune delay time.

Once the ignition sequence is complete, the generator adjusts the frequency to minimize load reflection coefficient magnitude for normal operation. The generator continues adjusting the frequency until either it exceeds a maximum number of iterations (tune count) or the load reflection coefficient magnitude is below the low tuning threshold (gamma low threshold). If the generator cannot reach the low tuning threshold, the generator continues to adjust the frequency until either the load reflection coefficient magnitude is below the high tuning threshold (gamma high threshold) or the tune time exceeds the tuning time-out, in which case the generator turns RF off and issues an error.

The tuning thresholds are expressed as numbers equal to 3000 times the square of the load reflection coefficient magnitude. The square of the load reflection coefficient magnitude is equal to the ratio of reflected power to forward power. To simplify the description of the algorithm, we refer to 3000 times the ratio of reflected power to forward power as D.

RETUNING

As a process continues with RF on, conditions can change, and the changing conditions can affect the load reflection coefficient magnitude. If D goes higher than the retuning threshold, the frequency tuning algorithm begins retuning. The algorithm begins by attempting to tune the generator to the low tuning threshold. If the algorithm cannot reach the low tuning threshold within a predetermined number of tries (tune count), it tries to reach a value that is less than high tuning threshold. If the algorithm cannot find a value less than the high tuning threshold within a predetermined time (tune time-out), it stops tuning, turns RF off, and issues a fault.

Frequency Tuning Parameters

You can allow the frequency tuning algorithm to sweep the entire range of generator frequencies, or you can optimize frequency tuning by setting tuning parameters. For additional information on these parameters and how to use them, or for information regarding default values, contact AE Global Services.

Table 5-5. Frequency tuning parameters

Parameter	Description	Command
Frequency mode	Toggles between frequency tuning and manual frequency adjustment: Variable: Turns frequency tuning on. Fixed: Turns frequency tuning off, allowing you to set or change generator frequency.	Set: **48** Report: **148**
Ignition mode	Sets one of three modes: • 0 = Fixed frequency • 1 = Variable frequency • 2 = Scan	Set: **118**:15 Report: **248**:15
Start frequency (kHz)	Sets the frequency at which frequency tuning starts its operation. Start frequency is a value within a range. The lower value in the range is the greater of these two values: 12.882 MHz or the minimum tuning frequency. The higher value in the range is the lesser of these two values: 14.238 MHz or the maximum tuning frequency.	Set: **46** Report: **146**
Minimum tuning frequency (kHz)	Sets the lowest frequency at which frequency tuning operates. Minimum tuning frequency is a value in a range. The lowest value in the range is 12.882 MHz. The highest value in the range is the least of these values: 14.238 MHz, start frequency, or the maximum tuning frequency. The minimum tuning frequency value must be within the specified frequency range for the generator. The value must also be less than or equal to both the start frequency and the maximum tuning frequency values.	Set: **44** Report: **144**
Maximum tuning frequency (kHz)	Sets the highest frequency at which frequency tuning operates. Minimum tuning frequency is a value in a range. The lowest value in the range is the greatest of these values: 12.882 MHz, start frequency, or the minimum tuning frequency. The highest value in the range is 14.238 MHz	Set: **45** Report: **145**
Frequency step minimum	Sets the minimum single frequency step the generator uses as frequency is changing. This step should be large enough to make the resulting change in load reflection coefficient	Set: **118**:1 Report: **248**:1

Table 5-5. Frequency tuning parameters (Continued)

Parameter	Description	Command
	significant when compared to system and measurement fluctuations and noise, while being small enough to allow the unit frequency to tune close to an optimum value. Data range: 10 to 2883 Hz	
Frequency step maximum	Sets the maximum single frequency step the generator uses as frequency is changing. This is also the starting step size. This step should be large enough to allow the frequency tuning algorithm to keep up with a dynamic load. A typical value is 2000. Data range: Frequency step minimum to 100,000 Hz	Set: **118**:2 Report: **248**:2
Retuning threshold	If the load reflection coefficient (D) increases beyond its current value plus the retuning threshold value (D + retuning value), the frequency tuning algorithm begins retuning unit frequency.	Set: **58**
Gamma threshold high (high tuning threshold)	Sets an upper threshold for the error value (calculated as load reflection coefficient magnitude squared and then multiplied by 3000). Data range: Low tuning threshold to 3000.	Set: **118**:6 Report: **248**:6
Gamma threshold low (low tuning threshold)	Sets a lower threshold for the error value. Data range: 0 to the high tuning threshold.	Set: **118**:7 Report: **248**:7
Fixed frequency	Sets the unit frequency in kHz when the unit is in fixed frequency mode.	Set: **61**
Tuning time-out	Sets the amount of time in ms that the generator sweeps before turning RF off and triggering a fault. The generator can time-out at RF on or during a retune. You can disable this time-out by entering a value of 0. With the time-out disabled, the generator continues to try to tune below gamma high threshold. Data range: 0 to 60,000	Set: **38**
Tune delay	Sets the time in ms the generator waits after RF is turned on before sweeping begins. RF remains fixed at start frequency until this time expires. Data range: 0 to 60,000	Set: **60**
Tuning gain delay	Prevents the frequency tuning algorithm from increasing the frequency step size immediately after	Set: **118**:23 Report: **248**:23

Table 5-5. Frequency tuning parameters (Continued)

Parameter	Description	Command
	changing the sign of the frequency step. Increasing this number increases the delay. Data range: 0 to 7	
Maximum tuning count	Sets the number of steps that the generator uses when attempting to reach the low tuning threshold. If the generator does not reach low tuning threshold in the specified number of counts, and if the generator is less than the high tuning threshold, tuning stops and RF remains on at that frequency. If the load reflection coefficient value is still higher than the high tuning threshold, tuning continues until the tuning time-out time has expired. RF on and re-tuning both follow this logic. Data range: 0 to 65535	Set: **118**:8 Report: **248**:8
Step up gain	Sets the magnitude of frequency step increase when the error is decreasing. A value of n sets the gain to 2^n. The default value is 2 (gain = $2^n = 2^2 = 4$). Data range: 1 to 7	Set: **118**:3 Report: **248**:3
Step down gain	Sets the magnitude of frequency step decrease when the error is increasing. A value of 3 sets the gain to $2^{-3} = 0.125$. Data range: 1 to 7	Set: **118**:4 Report: **248**:4
Scan step size	Sets the step size in Hz when in scan ignition mode. Data range: 5296 to 92282	Set: **118**:17 Report: **248**:17
Tuning step time	Sets the tuning step time. You cannot change this parameter while the RF output is on. The range of valid values is from 8 µs to 4096 µs. The resolution for setting tuning step time is currently 16 µs. The unit rounds all values of tuning step time to the nearest multiple of 16 µs; for example, the unit rounds the minimum value of 8 to 16.	Set: **118**:22 Report: **248**:22

COMMON EXCITER

Understanding CEX Operation

Your Paramount generator may have a common exciter (CEX) feature, which allows a generator to phase lock to an external oscillator. If the generator senses a valid input (between 12.882 MHz and 14.238 MHz and with a level of at least 2 dBm), it will phase lock to the input signal. To determine if your unit has this feature, use the following configuration note.

ATTENTION:

CONFIGURATION NOTE

To determine if your generator has the CEX feature, you can access the product identification number (PIN) that the unit returns when it receives command 221. The 31 characters (0 through 30) in this PIN provide information about the configuration of the unit. You can also retrieve the PIN using Virtual Front Panel (VFP). Character 15 indicates whether the unit has the CEX feature.

Example PIN: 2 2 3 2 1 0 0 1 2 2 2 1 1 0 1 1 2 7 1 1 1 0 0 0 0 0 0 0 0 0 0

Possible values for character 15 are:

- 0 = No CEX
- 1 = CEX installed

PHASE LOCKING GENERATORS

Users often phase lock one generator to another to prevent beat frequencies between two generators operating into the same plasma. To facilitate locking one generator to another, the Paramount generator provides a CEX output that can serve as the oscillator input to another generator.

It is possible to phase lock generators in one of two arrangements:

- You can lock multiple generators to a single master generator (or other reference oscillator) by connecting all the CEX inputs to the same reference. In such an arrangement, the following considerations are important:
  - Split the signals properly (for example, using -6 dB splitters).
  - Maintain the proper input signal levels at the CEX inputs.
  - Maintain the proper loading of the oscillator (or other generator).
- You can daisy chain multiple generators by connecting the CEX output of one generator to the CEX input of the next generator in the chain. The generator at the start of the chain becomes the master since it acts as the master oscillator. You can connect the CEX input of the generator at the start of the chain to an external oscillator, in which case the external oscillator is the master oscillator.

In some applications, it is important to keep the generators at exactly the same frequency and to maintain an exact phase relationship between the generators. The generator allows full 360º control of the phase relationship between the generator output and the CEX input. Be sure to control the cable length from the oscillator (which can be another generator) to the CEX input since roughly 15 m (50′) of typical RF cable corresponds to a full 360º phase shift.

PHASE LOCKING MODES

When a generator is receiving CEX input, you can lock the CEX input in one of four modes:

- CEX disabled. The CEX input does not lock to anything.
- Generator forward power. The CEX input phase-locks to the generator forward power. This is the default setting.
- DDS. The CEX input phase locks to the generator DDS.
- Auto mode. Generator output locks to either forward power or the internal DDS.

In auto mode, the output of the generator locks to either forward power or the internal DDS depending on the forward power level. The forward power level at which the lock source changes depends on two thresholds that provide hysteresis to prevent constant switching between modes when operating near the threshold level(s). When the forward power rises above the rising threshold, the lock source is forward power. When the forward power falls below the falling threshold, the lock source is DDS. The factory sets the current falling and rising threshold values:

- Falling threshold = 50 watts
- Rising threshold = 100 watts

You can also control the generator CEX output.

CEX Parameters

Table 5-6 summarizes the CEX system parameters.

Table 5-6. CEX parameters

Parameter	Range/Settings	Command
Capture range CEX bandwidth	13.56 MHz ± 5%	Not applicable
Locked CEX bandwidth	± 0.5 kHz	Not applicable
CEX In	2 dBm to 10 dBm, 13.56 MHz ± 5% 50 Ω nominal input impedance (≤ 1.5:1 VSWR), tolerant to 2.5 V_{pp} input (V_{pp} means peak to peak voltage or twice the amplitude), AC coupled	Not applicable
CEX Out	1.2 V_{pp} sine wave, 13.56 MHz ± 5% 50 Ω nominal source impedance (≤ 1.5:1 VSWR) Minimum 1.5 V_{pp} when loaded by 50 Ω, nominal 5 V_{pp} when unloaded, AC coupled	Not applicable

Table 5-6. CEX parameters (Continued)

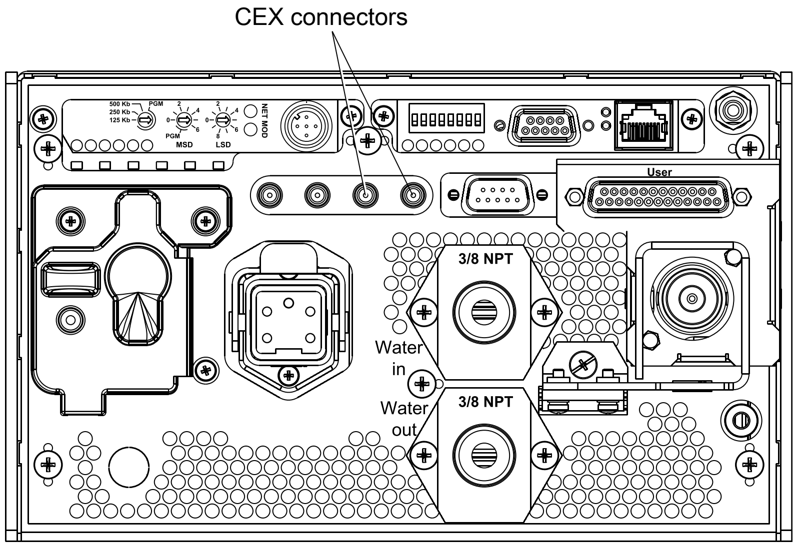
Parameter	Range/Settings	Command
CEX phase offset	This value sets the phase offset for the unit. The range of values is 0.0° to 360.0° The unit adds this value to the factory preset phase offset calibration value, which is selected based on the current CEX lock mode. This value is the only user-set CEX phase offset value. It applies in both RF output and in DDS lock mode. The factory default value is 0.	Set: **32** Report: **132**
CEX lock mode	You can lock the CEX input in the following ways: • CEX disabled • DDS mode: the CEX input phase locks to the generator DDS • Generator lock on output mode: the CEX input phase-locks to the generator output • Auto mode: the generator locks to either the generator output or the internal DDS depending on the forward power level	Set: **118**: 16 Report: **248**: 16
CEX output mode	This value sets the CEX output mode to one of the following: • CEX output locks to the generator DDS • CEX output locks to the generator RF output • CEX output is off	Set: **118**: 20 Report: **248**: 20

Setting Up CEX Mode Operation

The factory enables CEX mode in your generator. You need 50 Ω coaxial cable for the **CEX In** and **CEX Out** connections. The CEX coaxial cable must be ≤ 30 m (98′) in length.

TO SET UP CEX MODE OPERATION

1. Remove all AC input power from the master and all slave generators.
2. Plug one end of the CEX cable into the **CEX Out** port on the master generator.



3. Plug the other end of the CEX cable into the **CEX In** port on the next generator in the chain.
4. If the system includes more than one slave unit, connect the **CEX Out** port of the second unit to the **CEX In** port on the next unit.

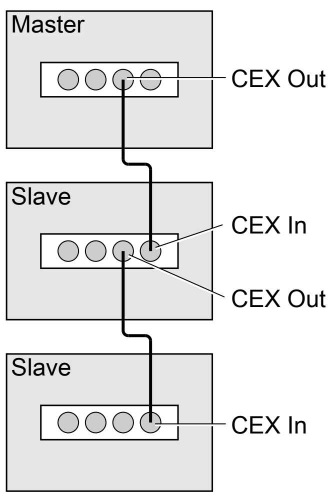


Figure 5-9. CEX mode connections

5. Using AE Host command **32**, set the phase offset (in degrees). You can use command **132** to report the phase offset.
6. Using AE Host command **118**, Byte 0 = 1, set the CEX lock mode. You can use command **248**, Byte 0 = 16, to report the CEX lock mode.
7. Using AE Host command **118**, Byte 0 = 20, set the CEX output mode. You can use command **248**, Byte 0 = 20 to report the CEX output mode.

PULSING OUTPUT

Understanding Pulsing

Your Paramount generator may have a pulsing feature, which allows a generator to pulse the RF output based on frequency and duty cycle settings. To determine if your unit has this feature, use the PIN for your unit and the following configuration note.

ATTENTION:

CONFIGURATION NOTE

To determine if your generator has the pulsing feature, you can access the product identification number (PIN) that the unit returns when it receives command 221. The 31 characters (0 through 30) in this PIN provide information about the configuration of the unit. You can also retrieve the PIN using Virtual Front Panel (VFP). Character 14 indicates whether the unit has the pulsing feature.

Example PIN: 2 2 3 2 1 0 0 1 2 2 2 1 1 1 1 1 2 7 1 1 1 0 0 0 0 0 0 0 0 0

Possible values for character 14 are:

- 0 = No pulsing
- 1 = Pulsing installed

PULSING

When pulsing is enabled, the Paramount generator pulses RF output based on frequency and duty-cycle settings:

- The frequency defines the length of pulsing cycles. A pulsing cycle is the time from the beginning of one RF on event to the beginning of the next RF on event.
- The duty cycle sets the percentage of each pulsing cycle for which output is on.

☞ **Important**

You cannot change pulsing configuration settings when RF output is on. You must turn output off before changing pulsing configuration settings. You can change pulsing frequency and duty cycle settings while RF is on.

Pulsing includes a master/slave mode. You can use Virtual Front Panel (VFP) or AE Host command **26** to enable and set up master/slave pulsing. A coaxial cable connects the **Sync Out** connector on a master unit to the **Sync In** connector on a slave unit. The slave unit receives a signal (*PSYNC*) from the master, and then matches its pulsing to the signal from the master. If you set it, a slave input delay parameter allows the slave generator to delay its response to the *PSYNC* signal.

Pulsing Parameters

Pulsing and its master/slave mode operate on five parameters. Table 5-7 lists the parameters, gives a brief description of each parameter, and gives valid values for each parameter,

Table 5-7. Pulsing parameters

Parameter	Description	Valid Values	Command
Master/Slave	Sets a Paramount generator to be a master unit or a slave unit. Set a stand alone unit to master.	Master or Slave	Set: **26** Report: **172**
Pulse Sync Out	Turns the (*PSYNC*) signal on or off.	On or Off	Set: **26** Report: **172**
Frequency	Sets the length of pulsing cycles; that is, the time from the beginning of one RF On event to the beginning of the next RF On event.	10 Hz to 100 kHz in 1 Hz increments	Set: **93** Report: **193**
Duty Cycle	Sets the percentage of each pulsing cycle for which output is on.	The documentation of the commands for this parameter define restrictions on duty cycle range.	Set: **96** Report: **196**
Memory Mode	Determines whether the unit saves pulsing settings in volatile or nonvolatile memory.	RAM or NVRAM	Set: **26** Report: **172**
Explicit enable mode	Sets whether or not you can turn pulsing on or off when RF output is on. You can set the following parameters: • Mode ◦ Implicit enable mode: With a valid pulsing frequency and duty cycle, the unit will automatically start pulsing. ◦ Explicit enable mode: Allows you to turn pulsing on and off when output is on. Pulsing will not start automatically. • Pulsing on/off: This parameter is only available when the unit is set to explicit enable mode	Mode: • Implicit enable mode • Explicit enable mode Explicit enable pulsing on/off • On • Off	Set: **26** Report: **172**

Table 5-7. Pulsing parameters (Continued)

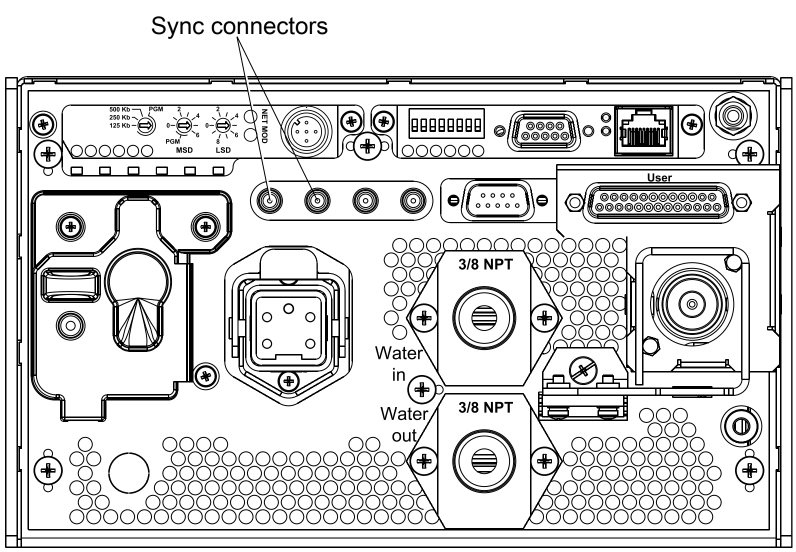
Parameter	Description	Valid Values	Command
Slave Input Delay	Allows the slave generator to delay its initial response to the *PSYNC* signal. For example, if you set the pulse frequency at 1 kHz, the pulse repetition period is 1000 µs. For pulse frequencies 1 kHz and lower, the maximum slave input delay time is 10 µs shorter than the pulse repetition period; therefore, the maximum slave input delay is 990 µs. For pulse frequencies above 1 kHz, the maximum slave input delay time is 5 µs shorter than the pulse repetition period.	Valid range is 0 µs to 100,000 µs For pulse frequencies 1 kHz and lower, the maximum setting is [pulse repetition period – 10 µs]. For pulse frequencies above 1 kHz, the maximum setting is [pulse repetition period – 5 µs].	Set: **26** Report: **172**

Setting Up Pulsing Master and Slave

To prepare for master/slave operation, you need a coaxial cable.

TO SET UP MASTER/SLAVE PULSING

1. Make sure that RF output is off.
2. Connect one end of the coaxial cable to the **Sync Out** connector (SMA) on the unit that will be the master unit.
3. Connect the other end of the coaxial cable to the **Sync In** connector (SMA) on the unit that will be the slave unit.



4. Using command **26**, set the pulsing mode, master or slave mode, and pulse sync output for each unit. You can use command **172** to report these values.

Enabling Pulsing and Setting Pulsing Parameters

If your Paramount generator has the pulsing option, you can enable or disable pulsing output. You can make pulsing settings through the **Serial** port or Virtual Front Panel (VFP). If you are using VFP, see the VFP help system for an explanation of how to enable or disable pulsing.

TO ENABLE/DISABLE PULSING AND SET PULSING PARAMETERS

1. To enable pulsing, send a valid set of frequency and duty cycle settings to the Paramount generator:
   - Command **93** – pulsing frequency
   - Command **96** – duty cycle

   Sending an invalid combination of settings disables pulsing.

   The unit has two enable modes (see command **26**, bytes 0 and 1 = 6):
   - Implicit enable mode: When you set a valid pulsing frequency and duty cycle, the generator automatically begins pulsing.
   - Explicit enable mode: When you set a valid pulsing frequency and duty cycle, you must turn pulsing on (see command **26**, bytes 0 and 1 = 7).
2. To use the slave input delay, send command **26**, Bytes 0 and 1 = 4; Bytes 2 and 3 = delay time (valid range is 0 to 100,000 µs). The maximum slave input delay is pulse time - 10 µs.

Host port commands **193** and **196** report the frequency and duty cycle settings. Host port command **172** reports the slave input delay setting.

Depending on the memory mode you select (see command **26**, bytes 0 and 1 = 5), the generator may or may not save pulsing settings when you turn it off:

- If you set memory mode to RAM, the generator does not save pulsing settings.
- If you set memory mode to NVRAM, the generator saves pulsing settings.

To return pulsing settings to default, if the values are in RAM, cycle power to the unit. If the values are in NVRAM, use command **7** to restore factory defaults.

Setting Up Slave Mode Pulsing with Short RF On Times

When pulsing in slave mode, the generator produces RF ON pulses 25 µs or longer without user intervention. In order to pulse with an RF On time that is shorter than 25 µs, you must tell the slave generator to expect pulses shorter than 25 µs.

1. Calculate the frequency:

   Frequency (Hz) = 1 / (2 x the RF On time in seconds)

For example, to allow 10 µs pulses, calculate the pulsing frequency: 1 / (20e-6) = 50,000

2. Send a pulse frequency command (command **93**) with the calculated frequency.

Turning RF On When Using Master/Slave Pulsing

Since the slave turns RF on when a low to high transition occurs on the pulse sync input, and the master puts out a high level on its pulse sync output whenever RF is on, it is important to make sure the slave sees the low to high transition from the master. To ensure that the slave does not miss the first transition, make sure to turn the slave RF on before turning the master RF on.

To start in continuous wave (CW) mode (pulsing enabled but with duty cycle or frequency set to 0 so that the unit puts out a continuous wave RF signal when RF is on) and then switch to pulsing, use this procedure.

1. If master RF is on, turn it off.
2. If slave RF is on, turn it off.
3. Ensure that you have set up both units for pulsing:
   a. Set the master to master mode.
   b. Set the slave to slave mode.
   c. Set the master frequency, duty cycle, or both to 0.
4. Turn the slave RF on.

   This enables the slave RF. The slave remains in RF off state until you issue RF on to the master.
5. Turn the master RF on.

   When the master turns RF on, the slave sees the low to high transition on the pulse sync input and also turns RF on. The slave follows any successive RF on/off and/or pulsing commands issued to the master.

   ☞ **Important**
   While the slave is waiting for the pulse sync transition, it reports warning **47**, **Pulse Sync Warning**, to indicate that it is missing a pulse sync signal. You can ignore this warning.

If you started operating the master in a CW mode and turned the master RF on first, the slave would not be able to see the low to high transition on the pulse sync input and would eventually fault out due to the unexpected sequence of events.

ARC MANAGEMENT

Understanding Arc Management

Your Paramount generator may have Arc Management System technology, which allows a generator to detect and manage arcs. To determine if your unit has this feature, use the following configuration note.

> **ATTENTION:**
>
> CONFIGURATION NOTE
>
> To determine if your unit has the arc management feature, you can access the product identification number (PIN) that the unit returns when it receives command 221. The 31 characters (0 through 30) in this PIN provide information about the configuration of the unit. You can also retrieve the PIN using Virtual Front Panel (VFP). Character 19 indicates if arc management is installed in the unit.
>
> Example PIN: 2 2 3 2 1 0 0 1 2 2 2 1 1 0 1 1 2 7 1 1 1 0 0 0 0 0 0 0 0 0 0
>
> Possible values for character 19 are:
>
> - 0 = No arc management
> - 1 = Arc management installed

ARC MANAGEMENT ALGORITHM

An arc management algorithm allows the Paramount generator to detect and manage arcs. The unit may use one or more of three arc detection methods:

- Detect changes in gamma (reflected power coefficient). This is the primary arc detection method.
- Detect that reflected power has exceeded the reflected power limit.
- Receive an arc indication signal from another unit.

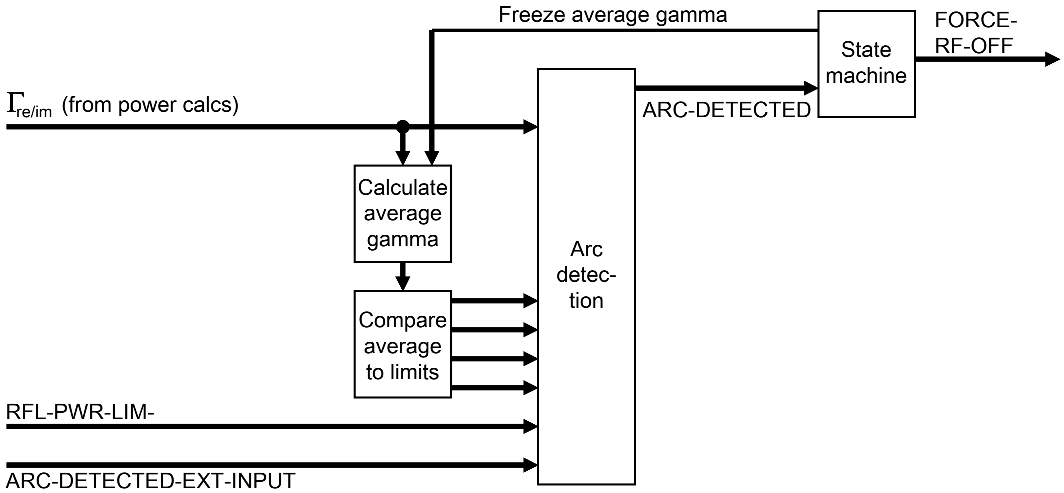


Figure 5-10. Block diagram of the Paramount generator arc management system

Arc Detection

DETECTING CHANGES IN GAMMA

Gamma is the reflected power coefficient. The Paramount generator calculates gamma from power measurements. Devices within the unit continuously measure reflected power and forward power. The unit calculates reflected power and forward power, and then it calculates gamma:

gamma = reflected power / forward power

With gamma values, the unit calculates an average gamma. To create a high threshold, the unit adds a user-set value to the average gamma; to create a low threshold, the unit subtracts the same user-set value from the average gamma.

The unit uses the arc management algorithm to compare gamma to the thresholds. If gamma exceeds a threshold, the unit determines that an arc has occurred and starts the arc suppression process.

DETECTING REFLECTED POWER GREATER THAN REFLECTED POWER LIMIT

You can set a reflected power limit from 100 W to 20% of the unit maximum power. This limit can serve one or both of two functions:

- Limit the amount of reflected power. If actual reflected power reaches the maximum value, the unit cannot increase forward power. This limit functions independently of arc management.
- Assist arc suppression.

If you want the reflected power limit to assist arc suppression, you can enable a reflected power limit mode. If you set a reflected power limit, the unit limits the amount of reflected power. With this mode enabled, if measured reflected power exceeds the user-set reflected power limit, the unit determines that an arc has occurred and starts the arc suppression process. To use the reflected power limit mode to assist arc suppression, you need to use this mode in conjunction with gamma detection.

RECEIVING AN ARC INDICATION SIGNAL

You can connect two or more units together to synchronize arc management. The connected units can function as a master/slave group, a symmetrical group, or a daisy-chained group:

- Master/slave group: The master controls the slave, but receives no information from the slave. In this group, you can enable one unit to send an arc indication signal through an external arc connector (the **Sync Out** connector on the back of the unit). You can enable the unit receiving the arc indication signal (through the **Sync In** connector on the back of the unit) to determine that an arc has occurred and to start the arc suppression process.
- Symmetrical group: Two units exchange signals. In this group, you can enable both units to output an arc indication signal through an external arc connector (the **Sync Out** connector on the back of the unit). You can enable both units to receive the arc indication signal (through the **Sync In** connector on the back of the unit) to determine that an arc has occurred and to start the arc management process.
- Daisy-chained group: More than two units exchange signals in a loop. In this group, you can enable all units to output an arc indication signal through an external arc connector (the **Sync Out** connector on the back of the unit). You can enable all units to receive the arc indication signal (through the **Sync In** connector on the back of the unit) to determine that an arc has occurred and to start the arc suppression process.

The arc indication signal mode does not function by itself. You can use this mode in conjunction with gamma detection and in conjunction with the combination of gamma detection plus the reflected power limit mode. You cannot use the arc indication signal mode without gamma detection.

Arc Management

When an arc occurs, the unit takes these actions:

- Freezes the average gamma signal at its current value
- Increments the arc counter
- Turns RF off for a user-defined time period (called the arc suppression time)

At the end of the arc suppression time, the unit takes these actions:

- Turns RF on
- Waits for plasma to stabilize (the factory sets this wait time typically at 20 µs)

- Resumes arc detection for a certain time (the factory sets this “hold” time typically at 40 µs)
- Releases the freeze on the average gamma signal

If the unit detects no arc during the hold time, it continues arc detection and resets the number of attempts number to zero.

If the unit detects an arc during the hold time, it takes these actions:

- Increments the number of attempts
- Restarts the arc suppression process.

  Each time the arc suppression process repeats, it turns RF off for twice the previous arc suppression time. For example, if the arc suppression time is 5 µs, the unit takes these actions:

  - The first time the unit detects an arc, it turns RF off for 5 µs.
  - The second time it detects an arc within the hold time, it turns RF off for 10 µs.
  - The third time it detects an arc within the hold time, it turns RF off for 20 µs, and so on.

The process continues until the arc is quenched or the RF off time reaches the maximum value of 65.5 ms. RF off time stays at 65.5 ms for every subsequent attempt until the algorithm reaches the maximum number of attempts or until the unit detects no arc during a hold time. You can set the maximum number of attempts—the valid range is 1 to 250. Setting this value to 0 allows an infinite number of attempts.

If the RF latch bit is set to off and the maximum number of attempts has been reached but the arc persists, the unit turns RF off. If the RF latch bit is set to on, the unit continues indefinitely to attempt quenching the arc.

Arc Management Parameters

You can set several arc management parameters or enable/disable the arc management feature. The following table describes the parameters and shows the AE Host command used to set or report each parameter value.

Table 5-8. Arc management parameters

Parameter	Description	Command
Arc suppression time	The amount of time (µs) that the unit turns RF off when it detects an arc. If the first attempt does not quench the arc, the unit doubles the suppression time (up to the maximum suppression time) on each following attempt until it extinguishes the arc or it reaches the maximum number of attempts. Setting this parameter to 0 disables the arc management	Set: **36**, subcommand 0 Report: **199**, subcommand 3

Table 5-8. Arc management parameters (Continued)

Parameter	Description	Command
	algorithm but leaves the arc counter enabled. The valid arc suppression time range is 5 µs to 511 µs. The unit stores the arc suppression time value in nonvolatile memory.	
Initial delay time	Specifies the amount of time that must elapse before the unit enables the arc management algorithm after turning RF output on. The arc counter also remains disabled during this time. The valid initial delay time range is 0 ms to 10 s. The unit stores the initial delay time value in nonvolatile memory.	Set: **36**, subcommand 1 Report: **199**, subcommand 8
Setpoint delay time	The unit temporarily disables the arc management algorithm each time it receives a new setpoint that differs from the previous setpoint by 10 watts or more. This parameter specifies the amount of time that must elapse before the unit re-enables the arc management algorithm after a significant setpoint change. The arc counter also remains disabled during this time. The valid setpoint delay time range is 0 ms to 245 ms. The unit stores the setpoint delay time value in nonvolatile memory.	Set: **36**, subcommand 2 Report: **199**, subcommand 9
Number of attempts	Specifies the number of times the arc management algorithm attempts to quench an arc before terminating its attempts. The valid range of attempts is 0 to 250. The unit stores the number of attempts value in nonvolatile memory.	Set: **36**, subcommand 3 Report: **199**, subcommand 10
Reflected power limit mode	Enables or disables the reflected power limit mode, in which the unit considers an arc to be present when reflected power reaches its maximum limit. The unit stores the reflected power limit mode value in nonvolatile memory.	Set: **36**, subcommand 4 Report: **199**, subcommand 4
Enable external arc input	Enables/disables the external arc input mode for determining, in addition to the internal arc management algorithm, when an arc is present. If enabled, the unit determines that an arc is present if a logic high pulse is present on the arc input connector. The unit stores the enable external arc input value in nonvolatile memory.	Set: **36**, subcommand 5 Report: **199**, subcommand 5

Table 5-8. Arc management parameters (Continued)

Parameter	Description	Command
RF power latch state	Controls whether the unit should turn off output when the arc management algorithm terminates because it has reached its maximum number of attempts. 0 = turn RF off; 1 = leave RF on and restart the arc suppression process. The unit stores the RF power latch state value in nonvolatile memory.	Set: **36**, subcommand 6 Report: **199**, subcommand 6
Arc output signal control	Controls whether the external output connector outputs the arc indication signal. This parameter is volatile and defaults to 1 (output on) each time you cycle power to the unit.	Set: **36**, subcommand 7 Report: **199**, subcommand 7
Reflection coefficient window	Sets the value to be added to average gamma to determine high and low thresholds; the unit adds this value to average gamma to determine the high threshold and subtracts this value from average gamma to determine the low threshold. The valid range is 1 to 50, which corresponds to gamma from 0.01 to 0.50.	Set: **36**, subcommand 8 Report: **199**, subcommand 11
Cumulative arc events	Resets the cumulative arc events value to zero. The only valid parameter value for this subcommand is zero.	Set: **36**, subcommand 9 Report: **199**, subcommand 12

Setting Up Arc Management

You can set up several arc management configurations:

- Stand-alone unit.
- Master/slave system: Two units. If the master detects an arc, both units respond with the arc suppression process. If the slave detects an arc, it responds with the arc suppression process. The master receives no signal from the slave; therefore, it does not respond to the arc.
- Symmetrical system: Two units. If either unit detects an arc, both units respond with the arc suppression process.
- Daisy chain system: More than two units linked together in a loop. If any unit detects an arc, all units respond with the arc suppression process.

If you are connecting more than one unit for arc management, you need one or more 50 Ω coaxial cables. You connect the units through the **Sync Out** and **Sync In** ports on the rear panel of the unit. Each unit needs to be connected to a host computer or a programmable logic controller (PLC) to set arc management parameters.

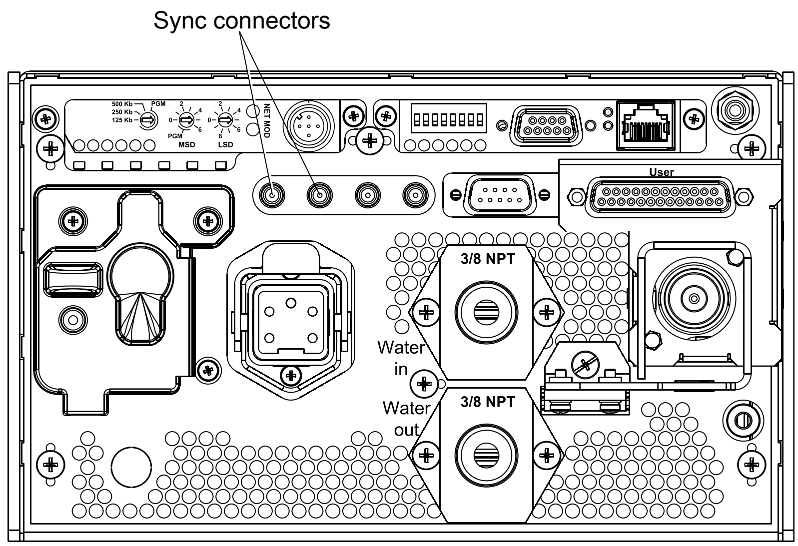


Figure 5-11. Paramount generator rear panel

TO SET UP ARC MANAGEMENT FOR A STANDALONE UNIT

1. Make sure that RF output is off.
2. Enable arc management by setting the arc suppression time (command **36**; Byte 0 = 0) to 5 µs to 511 µs.
3. Enable/set arc management parameters as necessary for your process.

TO SET UP ARC MANAGEMENT FOR A MASTER/SLAVE SYSTEM

1. Make sure that RF output is off on all units.
2. Connect the **Sync Out** port on unit 1 (master) to the **Sync In** port on unit 2 (slave).

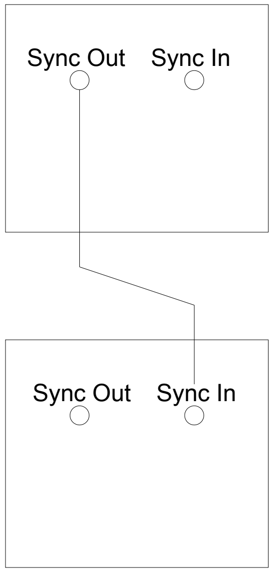


Figure 5-12. Arc management in a master slave system

3. Enable arc management for each unit by setting the arc suppression time (command **36**; Byte 0 = 0) to 5 µs to 511 µs.

   Each unit in a multi-unit system uses its own arc suppression time setting, operating independently of other units in the system. Setting each unit's parameters properly requires that you perform a system level analysis.

4. Make sure that the arc output signal is enabled in the master unit.

   By default, the arc output signal (command **36**; Byte 0 = 7) is enabled. However, another user may have disabled this signal in one or both units.

5. Enable external arc input (command **36**; Byte 0 = 5) in the slave unit.
6. Enable/set other arc management parameters as necessary for your process.

TO SET UP ARC MANAGEMENT FOR A SYMMETRICAL SYSTEM

1. Make sure that RF output is off on all units.
2. Connect the **Sync Out** port on unit 1 to the **Sync In** port on unit 2.

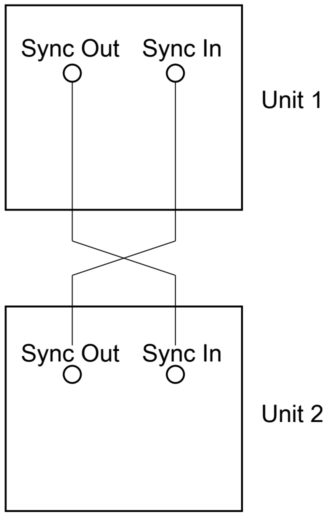


Figure 5-13. Arc management in a symmetrical system

3. Connect the **Sync Out** port on unit 2 to the **Sync In** port on unit 1.
4. Enable arc management for each unit by setting the arc suppression time (command **36**; Byte 0 = 0) to 5 µs to 511 µs.

   Each unit in a multi-unit system uses its own arc suppression time setting, operating independently of other units in the system. Setting each unit's parameters properly requires that you perform a system level analysis.
5. Make sure that the arc output signal is enabled in both units.

   By default, the arc output signal (command **36**; Byte 0 = 7) is enabled. However, another user may have disabled this signal in one or more units.
6. Enable external arc input (command **36**; Byte 0 = 5) in both units.
7. Enable/set other arc management parameters as necessary for your process.

TO SET UP ARC MANAGEMENT FOR A DAISY CHAIN SYSTEM

1. Make sure that RF output is off on all units.
2. Connect the **Sync Out** port on unit 1 to the **Sync In** port on unit 2.

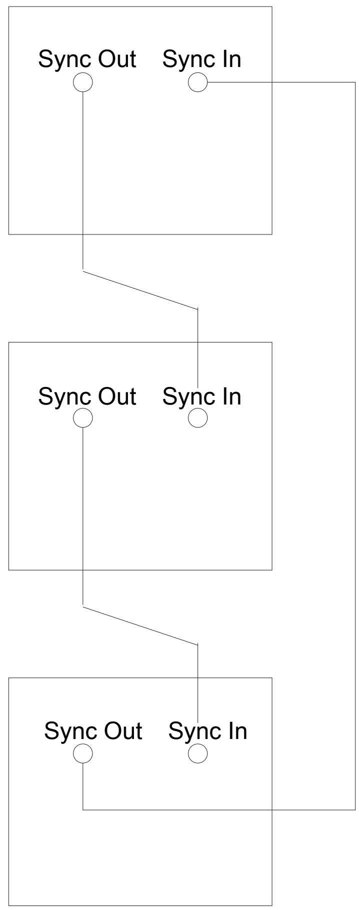


Figure 5-14. Arc management in a daisy chain system

3. Connect the **Sync Out** port on unit 2 to the **Sync In** port on the next unit in the chain.
4. Repeat Step 3 for all units in the chain.
5. Connect the **Sync Out** port on the last unit in the chain to the **Sync In** port on unit 1.
6. Enable arc management by setting the arc suppression time (command **36**; Byte 0 = 0) to 5 μs to 511 μs for each unit in the chain.

   Each unit in a multi-unit system uses its own arc suppression time setting, operating independently of other units in the system. Setting each unit's parameters properly requires that you perform a system level analysis.
7. By default, the arc output signal (command **36**; Byte 0 = 7) is enabled. However, another user may have disabled this signal in one or more units. When you set up a daisy chain system, make sure that the arc output signal is enabled in all units.
8. Enable external arc input (command **36**; Byte 0 = 5) in all units.
9. Enable/set other arc management parameters as necessary for your process.

HIGH ACCURACY LOW OUTPUT (HALO)

Understanding HALO

Your Paramount generator may include a high accuracy low output (HALO) feature. HALO increases the accuracy of power set points and measurements and allows the unit to operate at low power settings.

To determine if your Paramount generator has this feature, use the following configuration note.

ATTENTION:

CONFIGURATION NOTE

To determine if your generator has HALO, you can access the product identification number (PIN) that the unit returns when it receives command 221. The 31 characters (0 through 30) in this PIN provide information about the configuration of the unit. You can also retrieve the PIN using Virtual Front Panel (VFP). Character 20 indicates whether HALO is installed in the unit.

Example PIN: 2 2 3 2 1 0 0 1 2 2 2 1 1 0 1 1 2 7 1 1 1 0 0 0 0 0 0 0 0 0 0

Possible values for character 20 are:

- 0 = No HALO
- 1 = HALO installed

For information regarding accuracy values for units with and without HALO, refer to the electrical specifications.

You can use the HALO feature for chucking and dechucking as well as other applications that require low power with precise control and measurement.

VA LIMIT MODE

Understanding VA Limit Mode

VA limit mode is a software based power control program which allows automatic switching between forward power regulation and delivery power regulation as a function of load reflection coefficient, gamma (Γ). This feature aids plasma striking in certain tools.

In VA limit regulation mode, the unit starts in forward power regulation mode when you first turn RF on. When gamma^2 becomes less than the low threshold, the unit switches the regulation mode to delivered power mode. If $gamma^2$ rises over the high threshold, the unit switches regulation mode back to forward power mode.

The factory typically sets the low and high thresholds at these values:

- VA limit mode low threshold is (1000 x $gamma^2$)

  With a factory setting of gamma = 0.4, the factory setting for the low threshold is 160.

- VA limit mode high threshold (1000 x $gamma^2$) = 190

RECIPE MODE

Understanding the Recipe Feature

The recipe feature allows you to program the Paramount generator for up to 15 individual recipes. Each recipe can have up to 15 steps. For each step, you can set a variety of parameters including:

- The length of the step (measured either in time or the number of joules delivered)
- The power setpoint for the step
- Whether and how the unit ramps to the setpoint
- The frequency mode for the step
- The output frequency in fixed frequency mode

You can also set the following parameters for the entire recipe:

- The number of times the recipe will iterate before ending
- Whether or not the unit will keep output on when the recipe is complete

Recipe Parameters

The recipe feature allows you to program up to 15 individual recipes. Each recipe can include up to 15 steps. The following table identifies the parameters that can be set for each recipe.

The recipe feature is enabled by setting an active recipe with command **28**. When recipes are enabled (by sending command **28** to a value from 1 through 15), the unit will run the selected recipe when RF output is turned on.

All other recipe parameters are set with a single command (command **21**). You can send a single parameter each time you send the command, which means that the command must be sent multiple times to program a recipe. These parameters can also be read back individually with a single read command (command **188**).

For a given recipe, you can set two types of parameters:

- Global recipe parameters

  These parameters apply to the entire recipe. They are set individually for each recipe.

- Recipe step parameters

  These parameters apply to a specific step in the recipe and they are set individually for each recipe. Some of the recipe step parameters are optional. Optional steps are ignored if the value is set to the disabled state.

When programming recipes, take the following into consideration:

- When a recipe is started by turning RF output on, the unit saves the values for all of the parameters that can be changed by the recipe (setpoint, for example). The recipe then runs all steps and iterations. The behavior of the unit after the recipe is complete depends on the setting of the **Final output state** parameter.
  - If the **Final output state** parameter is set to a value of 0, the unit will turn off after all recipe steps and iterations are complete and will then restore all of the previously saved values.
  - If the **Final output state** parameter is set to 1, the unit keeps RF output on when all the recipe steps and iterations are complete, and it does not restore any parameters to the previously saved values. In this situation, these parameters stay at the same values that they are at during the last step of the recipe. Unit control is returned to the interface that is currently set to control the unit.
- You cannot change recipe parameters while recipes are running.
- When running a recipe, the unit will attempt to run the number of steps defined for that recipe. However, if one of the recipe steps has a step type that is set to 0, that step will be skipped.
- If all recipe steps have valid step types and durations, the recipe will go through all steps, then will repeat the recipe the number of times defined by the number of recipe iterations parameter. Once all iterations are complete, the unit will turn RF off.

Table 5-9. Recipe feature parameters

Parameter	Description
Set active recipe (command **28**)	This command sets the recipe that will run when output is turned on. Valid values are 0 through 15. A value of 0 disables the recipe feature.
Recipe number	Specifies the recipe that is being changed or reported. The unit can save up to 15 recipes.
Recipe step number	Specifies the step in a given recipe that is being changed or reported. Each recipe can have up to 15 steps.
Global Recipe Parameters	

Table 5-9. Recipe feature parameters (Continued)

Parameter	Description
These parameters affect the entire recipe, but they are set individually for each recipe.	
Number of recipe steps	Specifies the number of steps in the specified recipe. Valid values are 1 to 15.
Number of recipe iterations	Specifies the number of times that the unit will run the recipe before turning output off. Valid values are 1 through 65,535.
Final output state	Sets the unit to turn output off or leave output on after all recipe steps and iterations are complete. • If the **Final output state** parameter is set to a value of 0, the unit will turn off after all recipe steps and iterations are complete and will then restore all of the previously saved values. • If the **Final output state** parameter is set to 1, the unit keeps RF output on when all the recipe steps and iterations are complete, and it does not restore any parameters to the previously saved values. In this situation, these parameters stay at the same values that they are at during the last step of the recipe. Unit control is returned to the interface that is currently set to control the unit.
Recipe Step Parameters These parameters are set separately for each step in a given recipe.	
Recipe step type	Sets how the duration of the recipe is measured. This parameter can also be used to disable a recipe step. In operation the unit skips any steps that are set to disabled. Valid values: • 0 = Disabled • 1 = Timed step • 2 = Joules step
Recipe step duration	Sets the duration for the step, based on the recipe step type. • If the step type is set to timed, the duration is set in units of 0.01 second. • If the step type is set to joules, the duration is set in joules. Valid values are from 1 to 2,147,483,647.
Power setpoint	Sets the power output for the unit for the duration of the step. For standard units, setpoint is set in watts. For HALO units, setpoint is set in tenths of watts. This value cannot be set greater than the maximum power output for the unit. For the unit to correctly execute a recipe, the power setpoint must be set to a valid value for each recipe step.
Setpoint ramp mode	Disables or enables and sets the ramp mode for the step. When disabled, no ramp will be applied to any setpoint change that is associated with the step.

Table 5-9. Recipe feature parameters (Continued)

Parameter	Description
	You can enable the ramp mode to ramp either at a specified watts per second rate or you can specify it to ramp over a specified amount of time. Valid values: • 0 = Disabled (no ramping) • 1 = Watts per second ramp mode • 2 = Timed ramp mode
Setpoint ramp rate	Sets the duration of the ramp. This value is only used if the setpoint ramp mode is enabled. If ramp mode is enabled, the units for this value depend on the selected ramp mode. • When the step is set for watts per second ramp mode, this value sets the number of watts that the unit will ramp per second. • When the step is set for timed ramp mode, this value sets the duration of the ramp in milliseconds. The valid range of values for this parameter is 0 through 65,535.
Frequency mode	Sets the output frequency mode for the recipe step. You can set the frequency mode to: • Disabled To disable the frequency mode for this recipe step, set both this value and the fixed frequency value to zero. • Fixed frequency mode To set fixed frequency mode for this step, set this value to 0 and set the fixed frequency value to the desired frequency. • Variable frequency mode To set variable frequency mode for this step, set this value to 1.
Fixed frequency value	When the frequency mode for the step is set to fixed frequency, this value can: • Disable frequency mode for this step. To disable the frequency mode for this recipe step, set both this value and the frequency mode to zero. • Set the fixed frequency value for this step in kHz To operate in fixed frequency mode, this value must be within the specified frequency range for the unit. If the step is set for variable frequency mode, this value is ignored.

IMD SUPPRESSION FEATURE

The Paramount intermodulation distortion (IMD) suppression feature filters out the energy at a user-defined IMD frequency from the reflected power calculation, increasing the accuracy of the reflected power as measured by the generator. To determine if your unit has this feature, use the following configuration note.

> **ATTENTION:**
>
> CONFIGURATION NOTE
>
> To determine if your generator has the IMD feature, you can access the product identification number (PIN) that the unit returns when it receives command 221. The 31 characters (0 through 30) in this PIN provide information about the configuration of the unit. You can also retrieve the PIN using Virtual Front Panel (VFP). Character 23 indicates whether the unit has the IMD feature.
>
> Example PIN: 2 2 3 2 1 0 0 1 2 2 2 1 1 0 1 1 2 7 1 1 1 0 0 1 0 0 0 0 0 0 0
>
> Possible values for character 23 are:
>
> - 0 = No IMD
> - 1 = IMD installed

Measuring reflected power can be used as a method for determining whether or not an RF generator/match network pair is well tuned. However, the generator measures reflected power as a range of frequencies centered on the actual generator frequency. If the system is operating with a second generator, the measured reflected power can include power intermodulation distortion (IMD) elements that are not actually reflected power from the generator itself. Rather, these IMD elements are power from the other generators on the system.

For example, the following diagram shows the reflected power as measured on a generator that is running at 13.56 MHz. In this example, you can see a number of spikes on the graph. These spikes show the frequencies at which the majority of the reflected power is being measured. As you can see, the center spike is measured at 13.56 (the actual frequency of the generator). However, to either side of that spike, there are additional spikes at 13.56 MHz ± 430 kHz and at ± 860 kHz. These measurements are IMD elements that are caused by a 430 kHz generator that is also running on the system.

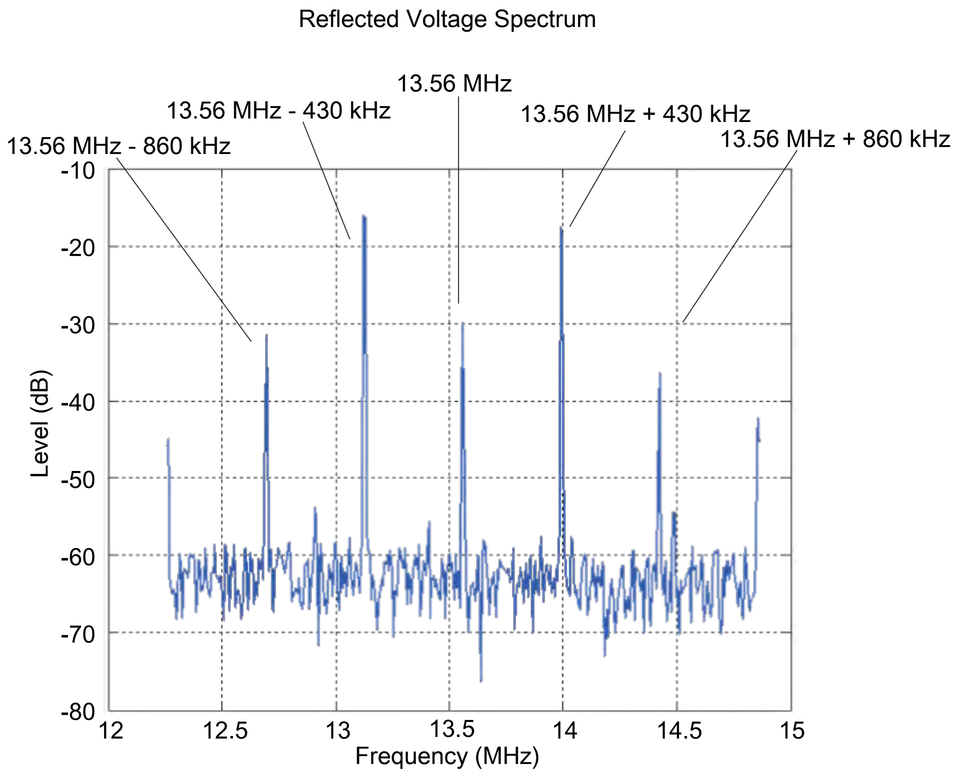


Figure 5-15. IMD elements of reflected power

The IMD components of measured reflected power may cause an error in the reported reflected power from the generator. In the example above, the total reflected power is 40 W. The following table shows the amount of power measured at both the generator and the IMD frequencies. In this example, only a small amount of the measured reflected power, 0.9 W, is actually reflected power from the 13.56 MHz generator. The vast majority of the total reflected power is made up of the IMD elements from the 430 kHz generator, with most of it being at 13.56 MHz ± 430 kHz.

Table 5-10. Components of reflected power by frequency—before IMD filtering

Frequency (MHz)	Power (W)
12.7	0.1
13.1	21.7
13.6	0.9
14.0	17.2
14.4	0.1

As shown in this example, IMD can cause a substantial overstatement of the actual reflected power on the generator, causing a well-tuned generator/match pair to appear to be out of tune.

The following graph shows how, using the previous example, the reflected power measurement would be reduced from 40 W to 2.4 W by applying the IMD filter at 430 kHz.

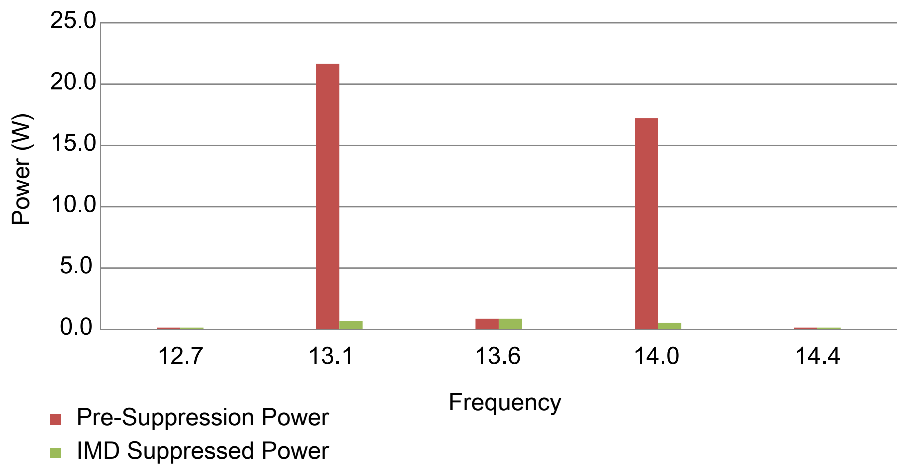


Figure 5-16. Reduction of error in reflected power measurement using the IMD suppression feature

Table 5-11. Components of reflected power by frequency—after IMD filtering

Frequency (MHz)	Power (W)
12.7	0.1
13.1	0.7
13.6	0.9
14.0	0.5
14.4	0.1

Setting Up the IMD Suppression Feature

If a unit is equipped with the IMD suppression feature, the only setting that you need to make is the frequency that will be filtered. This setting is made with host command **118**, subcommand 43.

MAINTENANCE

Consumable Parts

Some parts in the Paramount are consumable and may wear out over time. For a current list of consumable and wear components in the Paramount as well as for estimated lifetimes and recommended refurbishment schedules, please contact AE Global Services.

Troubleshooting and Global Services

Before calling AE Global Services, perform recommended checks and troubleshooting procedures. If you are still unable to resolve the issue and resume normal operation after following these checks and procedures, contact AE Global Services.

USING LOCKOUT/TAGOUT

The Paramount generator has a lockout/tagout device on the power switch. This device allows you to secure the power switch in the off (down) position to ensure your safety while you work on any item that receives output from the unit. You might also want to use the unit lockout/tagout while performing some tasks on the unit itself (for example, connecting or disconnecting output power or connecting/disconnecting water fittings).

☞ **Important**
The disconnect switch is not a circuit breaker.

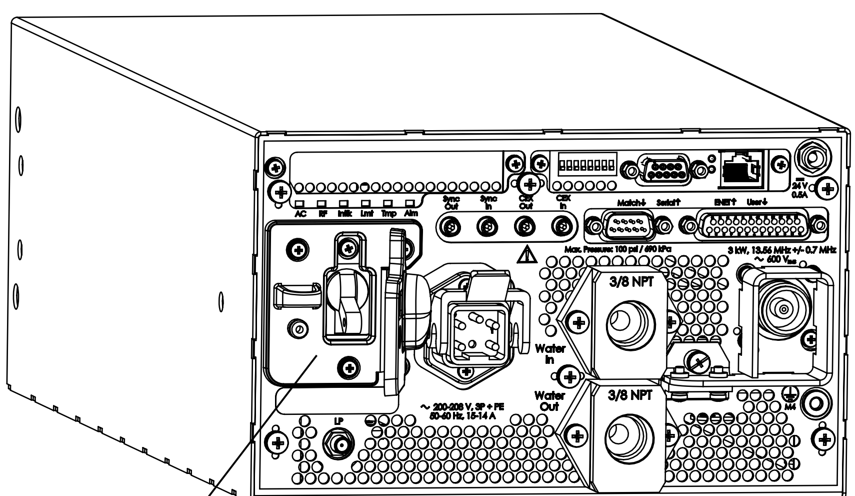


Figure 6-1. Lockout/tagout device on rear of unit

To Lock Out/Tag Out the Power Switch

1. Turn the input power switch off.
2. Close the lockout cover, pushing the cover over the power switch until it snaps into place.
3. Insert the lock into the hasp in the lockout cover and click the lock shut.

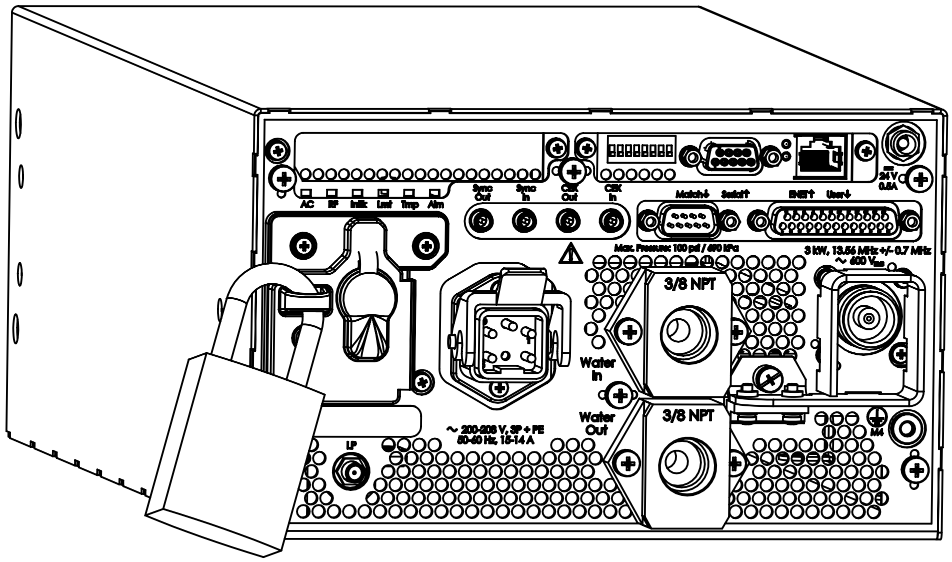


Figure 6-2. Lockout/tagout cover closed and locked

4. Attach the tag to the lock or the lockout hasp.

To Remove Lockout/Tagout

1. Make sure all connections are secure on the Paramount generator front and rear panels.
2. Remove the tag from the lock or hasp.
3. Open the lock and remove it from the hasp.
4. Open the lockout cover.
5. Turn the power switch on to provide power to the generator.

INTERNAL DIAGNOSTICS

Paramount generator units have self-diagnostics that indicate unit operational status. You can use these diagnostics to test a unit without removing it from a production system. For example, the system stops and you need to check all components to determine which of its components has a problem. You can quickly determine your Paramount generator unit's operational status.

You must change the unit's control mode to Diagnostic before starting the diagnostic test. After you start the test, the self diagnostics perform these tasks:

- Turn RF on and operate the generator into an open load condition.
- Determine if the values of three parameters are within ranges set in a diagnostic tab file:
    - DC rail voltage
    - DC current
    - Forward power
- Turn RF off.
- Returns a status code and bit flags.

To Run Internal Diagnostics

You can run this test by issuing AE Host commands or by using virtual front panel (VFP). This procedure describes how to run the test with AE Host commands. For information on how to use VFP to run the test, see the VFP help system.

1. Turn RF off.
2. Remove AC power from the unit by taking one or both of the following actions:
    - Turn off circuit breaker.
    - Disconnect AC power.
3. Prepare the output connector for the test.
    a. Remove the interlock shroud on the RF output.
    b. Disconnect the output cable.
    c. Attach an RF cover.

       An RF cover is a cap that provides an "open" RF connection. To obtain an RF cover, contact AE Global Services.
    d. Install the interlock shroud.
4. Restore AC power to the unit by taking one or both of the following actions:
    - Reconnect AC power.
    - Turn on circuit breaker.
5. Using command **14**, byte 0 = 8, change the control mode to Diagnostic.
6. Issue command **95** with byte 0 = 1 (enable diagnostic mode and start diagnostics).

The unit turns RF on for a second, and then turns RF off. When it turns RF off, the unit disables the diagnostics mode.

7. Issue command **244**.

   The unit returns a diagnostic status code:

   - Byte 0 = Status code:
     - 0 = Diagnostics in progress
     - 1 = Diagnostic test complete - passed
     - 2 = Diagnostic test complete - failed
     - 3 = Diagnostic test interrupted
     - 4 = Diagnostic mode disabled
   - Byte 1 = Failure status (bit flags):
     - Bit 0 = Forward power
     - Bit 1 = DC rail voltage
     - Bit 2 = DC current
     - Bits 3 through 7 = Unused
   - Bytes 2 through 4 = Unused
8. Remove AC power from the unit by taking one or both of the following actions:
   - Turn off circuit breaker.
   - Disconnect AC power.
9. Prepare the output connector for normal operation.
   a. Remove the interlock shroud on the RF output.
   b. Remove the RF cover.
   c. Connect the RF output cable.
   d. Install the interlock shroud.
10. Restore AC power to the unit by taking one or both of the following actions:
    - Reconnect AC power.
    - Turn on circuit breaker.
11. Issue command **14** to reset the control mode.

    The unit is ready for normal operation.

TROUBLESHOOTING CHECKLIST

> ⚠ **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.

> ⚠ **DANGER:**
> Personnel must receive proper training before installing or troubleshooting 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.

Table 6-1. Using LED states for troubleshooting

Troubleshooting Check	Action
Is the **AC On** LED lit?	If No: There may be an external line fault. 1. Make sure there that there are no loose wires or unreliable connections in the AC input line. 2. Make sure the AC power cord is plugged into an appropriate power source. 3. Make sure the AC power switch on the rear panel of the generator is in the ON position. 4. Make sure that all three phases on the AC voltage line are present and meet specifications. 5. Send an RF off command to reset the unit. 6. If this LED remains unlit, call AE Global Services.
Is the **Alarm** LED lit?	If Yes: The unit has detected a fault. This fault will generate error data that is provided through the serial port. See the error code troubleshooting information.
Is the **Interlock** LED lit?	If No: The interlock is not satisfied or was interrupted. 1. Make sure that the RF output cover is firmly attached to satisfy the interlock. 2. Ensure that the interlock pins on the **User** port are satisfied. 3. Once interlock conditions are satisfied, send an RF off command to reset the generator and LED states.

Table 6-1. Using LED states for troubleshooting (Continued)

Troubleshooting Check	Action
Is the **RF On** LED lit?	If No: The unit may not have received an RF on command. 1. Make sure you are in the correct communication mode. 2. Send an RF off command, and then send an RF on command.
Is the **Overtemp** LED lit?	If Yes: The coldplate temperature has exceeded the limit, disabling output. This fault clears when the coldplate temperature falls below warning levels. 1. Make sure that the inlet cooling water is flowing at the specified rate. 2. Make sure that inlet water temperature does not exceed specification. 3. Make sure that inlet and outlet cooling water connections are connected in the correct configuration. The inlet and outlet cooling water ports are labeled. 4. Make sure that the ambient air temperature around the Paramount generator during operation does not exceed the specified limit. 5. Make sure air inlet and outlet vents have proper clearance. 6. Check air inlet and outlet for debris.
Is the **Power Limit** LED lit?	If Yes: When the **Power Limit** LED is lit, the generator is unable to supply enough power to match the set point due to a limiting condition. When an internal protection limit is exceeded, the RF output is limited, but not shut off. If this LED is lit along with a high reflected power reading, it is most likely that the generator is protecting itself in response to an external load condition. 1. Disable the output. 2. Inspect and evaluate the unit's RF output connector, output cable, tuner, and chamber. Look for signs of arcing and heat stress. 3. Verify high impedance between the center conductor and outer shields on the connectors and cables. 4. Verify cable continuity. Swap suspected cables or units with known good cables or units. Consult "Power Limit LED Troubleshooting" on page 6-7 for additional information on troubleshooting the power limit.
Turn off AC power.	Make these checks: • Check for visible damage to the unit, cables, and connectors.

Table 6-1. Using LED states for troubleshooting (Continued)

Troubleshooting Check	Action
	• Ensure all unit connectors are installed correctly and are fastened tightly. • Check whether any system-related circuit breakers have been tripped. • Ensure ground connections are adequate and secure.
Turn AC power on. Is the **Power Limit** LED on when you turn the unit on?	If Yes: Continue troubleshooting the power limit to determine whether the unit is faulty or whether the system is creating a situation in which the unit cannot provide the necessary output. If you cannot return the unit to normal operation after power limit troubleshooting, call AE Global Services. If No: Send an RF on command, and your unit should be operating properly.

Power Limit LED Troubleshooting

The **Power Limit** LED lights when the unit cannot deliver enough power to match setpoint. Any of the following conditions can cause the LED to light:

- Measured unit output deviates from setpoint by more than a maximum allowable value.
- The setpoint is less than the unit's low power limit and > 3 W

  The low power limits are:

  - 10 W for standard 1013 unit
  - 12.5 W for standard 1250 units
  - 15 W for standard 1513 units
  - 20 W for standard 2013 units
  - 30 W for standard 3013 units
  - 5 W for HALO units

  .

The fact that this LED is on does not necessarily indicate a problem with the unit. A setpoint below the unit's low power limit, a user-set power limit, or setpoint ramping can cause the **Power Limit** LED to light, but do not indicate a problem within the unit.

MEASURED UNIT OUTPUT DEVIATING FROM SETPOINT

The unit measures its power output, compares it to setpoint, and then compares the difference to a maximum value:

- For power output up to 300 W, the maximum allowable deviation from setpoint is 3 W.
- For power output above 300 W, the maximum allowable deviation from setpoint is 1% of setpoint (for example, if setpoint is 2000 W, the maximum allowable deviation is 20 W).

If the measured unit output deviates from setpoint by a value that is greater than the maximum allowable deviation, the **Power Limit** LED lights. In this situation, a problem could exist with the unit, or with system setup:

- Cables
- The impedance matching unit between the unit and the load
- The load (typically a plasma chamber).

LOCATING THE PROBLEM

Is the unit faulty, or does a problem exist in the system? The first step in locating the problem is determining whether the unit is being used within its power delivery capability.

1. Obtain the impedance measured by the unit (use VFP or AE Host command **225**).
2. Use the measured impedance in the following formula to calculate the load reflection coefficient presented to the unit:

   $$|\Gamma| = \left|\frac{Z - 50}{Z + 50}\right|$$

   Where

   - Z is the impedance measured by the generator
   - Γ is the reflection coefficient corresponding to Z
3. Using the calculated gamma value and the delivered and forward power specifications, determine what the generator’s delivered or forward power should be:
   - If you are operating the generator in delivered power mode, determine what the generator’s delivered output power should be.
   - If you are operating the generator in forward power mode, determine what the generator’s forward output power should be.
4. Compare the unit’s measured output power with the unit’s setpoint. If they are not the same, subtract the measured output power from the setpoint to determine the amount of deviation.

5. Determine if your unit is faulty, or if some other component in your system might be faulty.

   a. Compare the actual deviation from setpoint with the maximum allowable deviation from setpoint.

      If these conditions exist:

      - Measured unit output < setpoint
      - Actual deviation > maximum allowable deviation
      - Forward power < 300 W

      Then the unit is likely faulty.

      If these conditions exist:

      - Measured unit output < setpoint
      - Actual deviation > maximum allowable deviation
      - Forward power > 300 W

      Go to the next comparison.

   b. Compare the measured delivered or forward output power with what the delivered or forward output power should be at the calculated gamma value.

      If these conditions exist:

      - Generator is delivering output power > maximum allowable deviation
      - Measured output power < value from the delivered and forward power specified for your unit

      Then the unit is likely faulty.

      If the generator is delivering output power < maximum allowable deviation, then the unit is probably operating normally.

If you still doubt the location of a problem after following this procedure, you can test the generator using open and short loads.

External Load Checks - Open/Short RF Output Path

Use extreme caution as this section involves troubleshooting the output of 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.

DANGER:

Personnel must receive proper training before installing or troubleshooting 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.

There are four basic components that could impede the RF path: the Paramount generator output connector, the output cable, the tuner, or the chamber.

TO DETERMINE THE COMPONENT IMPEDING RF OUTPUT

1. Turn the input power switch (rear panel) breaker off to ensure that there is no RF power at the output of the unit.
2. For the unit output connector:
   a. Remove the output cable and visually inspect the output connector for signs of arcing or heat stress.
   b. Verify an open is measured between the center conductor and outer shield.
   c. Make sure the output connector is mounted firmly to the chassis.
3. For the output cable:
   a. Visually make sure there is a good connection between the output cable and end connectors on both sides of the output cable.
   b. Verify the continuity of the center conductor.
   c. Verify the continuity of the outer shield.
   d. Verify that there is no continuity between the center conductors and outer shields.
   e. Swap cables if possible and retry operating the Paramount generator.
4. For the tuner and the chamber:

   The only way to truly isolate the tuner or the chamber is to swap the tuner or the Paramount generator with another known good unit. You can also run the unit into a 50 Ω dummy load and follow the steps in the troubleshooting checklist.

Also consider these questions:

- Are you currently setting up a new chamber system?
- Is your reflected power reading close to the Paramount generator reflected power limit? See the electrical specifications for the unit.
- Has any work been done recently on the chamber?
- Have there been any changes in your process recently

If you answered yes to any one of the previous questions and the Paramount generator passed its internal diagnostics test, the unit is probably working properly and it may be reacting to an external load condition. You may want to consult your process engineer or system manufacturer to troubleshoot chamber related issues.

TROUBLESHOOTING USING ERROR CODES

Accessing Error Codes

You can access Paramount generator error codes in two ways:

- You can use serial communication (the **Serial** or **Service** port) to request a report of active warning or fault error codes (command **223**). Once you have received a list of active errors, see the error code table to look up these error codes and troubleshoot the associated faults or warnings.
- You can use the Paramount VFP (Virtual Front Panel) program to look up active error codes. Use the help system that came with the VFP program if you have trouble finding the list of active error codes. Once you have the list of active error codes, see the error code table to look up these error codes and troubleshoot the associated faults or warnings.

Virtual Front Panel allows you to control and monitor your Paramount generator using a personal computer via serial communication. If you do not have the VFP program with your unit and would like a copy of the program, contact AE Global Services.

Fault and Warning Types and Clearing Faults

The unit can report one or more types of faults or warnings:

- 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.
- Latching Faults–When these faults occur, they remain latched until the unit receives an RF off command. If the cause of the fault has not cleared, the fault does not clear.
- Non-Latching Faults–Faults that are self clearing.
  - Fault occurs when RF is off: A fault is non-latching only if the fault occurs while RF is off: If the fault condition clears, the fault self clears; however, if the cause of the fault has not cleared, the fault does not clear. The unit does not require an RF off: command before turning output on. As soon as the fault condition clears, you can turn output on.
  - Fault occurs when RF is on: If output was on when the fault occurred, output turns off and the fault latches. The unit requires an RF off command before turning output on.

- Non-Latching Warnings – Warnings self clear when the condition that caused the warning clears. If a warning occurs while output is on, output remains on.

Error Code Table

Use the following table to understand error codes and actions you can take if you encounter one or more of them.

Table 6-2. Error codes

Error Code	Problem Indicated	Suggested Action
16 **Service Required Fault**	Non-latching fault The unit has experienced a fault that requires assistance from AE Global Services.	Contact AE Global Services.
30 **Interlock Open Fault**	Non-latching fault An interlock is open.	Verify interlock. If the fault persists, contact AE Global Services.
31 **Coldplate Overtemperature Warning**	Non-latching warning Coldplate temperature is moving higher than specification. Coolant may be out of specification. Water may be flowing in the wrong direction.	Verify that the cooling specifications for flow rate and maximum temperatures are met. Verify that water is flowing in the correct direction. If the warning persists, contact AE Global Services.
31 **Coldplate Overtemperature Fault**	Non-latching fault Possible obstruction in the water line. Water may be flowing in the wrong direction.	Verify that the cooling specifications for flow rate and maximum temperatures are met. Verify that water is flowing in the correct direction. If the fault persists, contact AE Global Services.
32 **Ambient Air Overtemperature Warning**	Non-latching warning Air temperature is moving higher than specification. Possible obstruction of the air inlet panel.	Verify ambient temperature at air inlet on the rear panel. Verify there is no obstruction within 2″ of the air inlet panel. If you find an obstruction, clear it. If the warning persists, contact AE Global Services.

Table 6-2. Error codes (Continued)

Error Code	Problem Indicated	Suggested Action
32 **Ambient Air Overtemperature Fault**	Latching fault Possible obstruction at or near air inlet panel.	Verify ambient temperature at air inlet on the rear panel. Verify there is no obstruction within 2″ of the air inlet panel. If the ambient temperature is within operating range and the air inlet panel is clear, contact AE Global Services.
39 **Out Of Setpoint Warning**	Non-latching warning This warning can occur anytime a nonfavorable (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 3 W, 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 setpoint is neither above nor below power limits for the generator. If the problem persists, contact AE Global Services.
40 **Coldplate Temperature Rate Fault**	Latching fault Coolant flow rate and temperature may be out of specification. Water may be flowing in the wrong direction. Water temperature is rising too fast.	Verify that the cooling specifications for flow rate and maximum temperatures are met. Verify water is flowing in the correct direction. If the fault persists, contact AE Global Services.
41 **Low AC Line Voltage Warning**	Non-latching warning	If the warning persists, contact AE Global Services.
42 **High AC Line Voltage Warning**	Non-latching warning	If the warning persists, contact AE Global Services.
47 **Pulse Sync Warning**	Non-latching warning	If the warning persists, contact AE Global Services.
47 **AC Line Sag Fault**	Latching fault	If the fault persists, contact AE Global Services.
49 **AC Line Sag Warning**	Non-latching warning	If the warning persists, contact AE Global Services.

Table 6-2. Error codes (Continued)

Error Code	Problem Indicated	Suggested Action
50 **Arc Management Fault**	Latching fault	If the fault persists, contact AE Global Services.
52 **Pulse Sync Fault**	Latching fault	If the fault persists, contact AE Global Services.
53 **Ignition Warning**	Non-latching warning	If the warning persists, contact AE Global Services.
56 **Network DHCP Warning**	Non-latching warning	If the warning persists, contact AE Global Services.
57 **Network DNS Warning**	Non-latching warning	If the warning persists, contact AE Global Services.
61 **Output Frequency Fault**	Latching fault	If the fault persists, contact AE Global Services.
61 **Pulsing Frequency Warning**	Non-latching warning	If the warning persists, contact AE Global Services.
62 **Pulsing Duty Cycle Warning**	Non-latching warning	If the warning persists, contact AE Global Services.
63 **Reflected Power Timer Warning**	Latching warning	If the warning persists, contact AE Global Services.
75 **Air Particulate Detected (Smoke) Fault**	Nonvolatile fault	If the fault persists, contact AE Global Services.
93 **Reflected Power Timer Fault**	Latching fault	If the fault persists, contact AE Global Services.
101 **Inverter Not Ready Fault**	Non-latching fault	Contact AE Global Services.
144 **Pulsing Frequency Fault**	Latching fault	If the fault persists, contact AE Global Services.
145 **Pulsing Duty Cycle Fault**	Latching fault	If the fault persists, contact AE Global Services.
146 **Pulsing Hi Power Fault**	Latching fault	If the fault persists, contact AE Global Services.
200 **Unable To Tune Fault**	Latching fault This fault asserts when the frequency tuning algorithm is not successful.	Check the RF output cable connections and integrity. Verify that the match position is correct.

Table 6-2. Error codes (Continued)

Error Code	Problem Indicated	Suggested Action
	This fault can indicate a problem external to the generator. Possible problems: • The plasma did not ignite • The match position is not correct	Ensure that process parameters are within limits. If the fault persists, contact AE Global Services.
201 **Comm Watchdog Timer Fault**	Latching fault	If the fault persists, contact AE Global Services.
402 **DeviceNet Power Fault**	Non-latching fault	If the fault persists, contact AE Global Services.
403 **DeviceNet Network Fault**	Non-latching fault	If the fault persists, contact AE Global Services.
408 **EtherCAT Watchdog Fault**	Latching fault	Cycle AC power to the unit. If the fault persists, contact AE Global Services.

AE GLOBAL SERVICES

Please contact AE Global Services if you have questions or problems that cannot be resolved by working through the provided troubleshooting. When you call Global Services, make sure to have the unit serial number and part number. These numbers are available on unit labels.

☞ **Important**

For returns and repairs, please call AE Global Services to get the correct shipping address.

Table 6-3. AE Global Services 24 X 7 contact information

Office	Contact
AE World Headquarters	Address: 1625 Sharp Point Drive Fort Collins, CO 80525 USA Phone (24 hrs/day, 7 days/week): 800.446.9167 or +1.970.221.0108 Email: (We will respond to email by the next business day.) mailto:technical.support@aei.com
Sekidenko thermal product support	Contact by phone or email: +1.360.694.7871 mailto:thermalapplications@aei.com
Power Control Module product support	Contact by phone or email: +49 (0)2902 763 520 (technical support during German business hours) mailto:powercontroller@aei.com
High Voltage product support: HiTek Power, Ltd.	Contact by phone or email: +44 (0) 1903 712400 mailto:support.centre@aei.com
High Voltage product support: UltraVolt, Inc.	Contact by phone or email: +1.631.471.4444 mailto:sales.support-uv@aei.com
Local or regional sales or service office	Visit the Advanced Energy website for current contact information: http://www.advanced-energy.com

RETURNING UNITS FOR REPAIR

Before returning any product for repair and/or adjustment, first follow all troubleshooting procedures. After following troubleshooting procedures, if your unit is unable to resume normal operation, 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.

Purging Water for Transport or Storage

Before transporting or storing water-cooled units, you must first purge water from the unit. Failure to do so can result in damage to the unit and will void the unit warranty.

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:

Purge all water from the unit before shipping. Failure to do so can result in damage to the unit during shipping and will void the unit warranty.

To purge water from the unit:

1. Uninstall the unit and, if applicable, remove the unit from the rack.
2. Apply compressed air to the water intake connector. Water will exit through the water outflow connector.
3. Apply compressed air until water no longer exits the water outflow connector.

If you need additional information on how to purge water from the unit, contact AE Global Services.

DECOMMISSIONING THE UNIT

When it becomes necessary to decommission the Paramount unit, use the following guidelines:

- Chamber residue and electronic components: discard in accordance with local safety/environmental regulations

- Aluminum parts, steel parts, and copper wiring: recycle
- Plastics: recycle or discard in accordance with local safety/environmental regulations

Index

O

P

R

S

T

U

V

W