User Manual

Laser System Controller

- eDrive
- eDrive Nitro
- eDrive Aero Laser Diode Driver

CEO-UMAN-0001H
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NORTHROP GRUMMAN

Important Information

Copyright

Patents

Safety Information

Product End-of-Life Handling

NG is committed to protecting the environment. Although the driver is not included in the list of devices governed by the Waste Electrical and Electronic Equipment directive (WEEE) and Restriction of Hazardous Substances in the European Union (RoHS EU) directives, NG will attempt to provide return service and disposal of your used equipment. When you are ready to reclaim the instrument, you must properly transfer it according to local regulations concerning WEEE equipment or ship the instrument to the NG recycling center. Please contact NG for the recycling center shipping address and instructions.

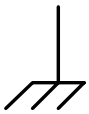
Conventions

The following conventions appear in this manual:

This icon denotes a caution or a warning, which advise you of precautions to take to avoid injury, data loss, or a system crash.

Initial Capped	The first letter in uppercase refers to menu options, e.g., **Phase Delay**, **Pulse Width**.
CAPS	Front-panel buttons, knobs, and connectors appear in all uppercase letters, e.g., **MENU, CURRENT**.
▸	The ▸ symbol separates a sequence of button pushes, e.g., **MENU** ▸ **CHANNEL SETUP** ▸ **PULSE WIDTH** means that you press the **MENU** button, then push the **CHANNEL SETUP** soft key, and then press the **PULSE WIDTH** soft key.
italic	Italic text denotes references to other resources that may be helpful or bring attention to important information.
	This icon denotes a note, which alerts you to important information.
I **O**	Power Switch Position Symbols I = On O = Off

The following conventions may appear on the product:

DANGER	An injury hazard immediately accessible as you read the marking.
WARNING	A hazard not immediately accessible as you read the marking.
CAUTION	A hazard to property including the product.
	ESD: Handle Appropriately
	Laser Emission: Use caution.
	Shock Hazard: Use caution.
	Caution: Risk of danger. Refer to manual.
	Chassis Ground
I **O**	Power Switch Position Symbols I = On O = Off

General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. To avoid potential hazards, use this product only as specified. If the equipment is used in a manner not specified by Northrop Grumman, the protection provided by the eDrive equipment may be impaired.

Only qualified personnel should perform service procedures.

Avoid Fire or Personal Injury. Use only the power cord specified for this product and certified for the country of use.

Connect and Disconnect Properly. Do not connect or disconnect cables when they are connected to a voltage source.

Ground the Product. This product is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, ensure that the product is properly grounded. The power cord must be connected to a properly grounded wall outlet socket.

Observe All Terminal Ratings. To avoid fire or shock hazard, observe all ratings and marking on the product. Consult the product manual for further ratings information before making connections to the product.

Do Not Operate Without Covers. Do not operate this product with the covers or panels removed.

Use Proper Fuses. Use only the fuse type and rating specified for this product.

Avoid Exposed Circuitry. Do not touch exposed connections and components when power is present.

Do Not Operate With Suspected Failures. If you suspect there is damage to this product, have it inspected by qualified service personnel.

Provide Proper Ventilation. Refer to the installation instructions for details on installing the product so it has proper ventilation.

Do Not Operate in Wet/Damp Conditions.

Do Not Operate in an Explosive Atmosphere.

Keep Product Surfaces Clean and Dry.

About This Manual

This manual contains operating information for the eDrive series laser system controllers and supports firmware version 2.6.0 and later. The manual consists of the following chapters:

- *Chapter 1: Getting Started* outlines features of the driver and explains typical installation instructions.
- *Chapter 2: Understanding Driver Functions* describes basic operations and functions of the driver: driver configuration, the Timing Engine, triggering and gating, the power train, and operating limits.
- *Chapter 3: Operating Basics* covers basic operating principles of the driver.
- *Chapter 4: Application Examples* summarizes how to interface the driver with a computer host and how to interface a laser to the driver.
- *Chapter 5: Communications* details how to interface the driver to a computer host using the RS-232, RS-485, and Ethernet ports.
- *Chapter 6: User Interface Reference* explains the menu system and available selection parameters.
- *Appendix A: Specifications* detail the electrical and physical specifications for the driver and a key to the ordering code.
- *Appendix B: Connector Interfaces* describes connector functions, pin-outs, and signaling.
- *Appendix C: Accessories* shows the standard and optional accessories.
- *Appendix D: Maintenance* provides general care and cleaning instructions for the driver.
- *Appendix E: Cyclical Redundancy Check Calculations* explains how CRC codes are calculated.
- *Appendix F: Acronyms* defines the abbreviations commonly used throughout this manual.

Table of Contents

List of Figures and Tables

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Chapter 1: Getting Started

This chapter provides a brief overview of the features of your eDrive and explains typical installation and connection configurations. The following information is available in this chapter:

- General features
- Panel displays
- Installation
- Basic connections

General Features

The eDrive family consists of three models: the eDrive, the eDrive Nitro, and the eDrive Aero. As the baseline product, the standard eDrive provides all general features.

The eDrive is a next generation laser system controller. It manages all critical diode-pumped solid-state (DPSS) laser parameters including the diode drive current, the Q-switch, and system interlocks. It is capable of driving diodes in either continuous wave (CW) or quasi-continuous wave (QCW) operating mode. The eDrive is equipped with multiple control options, including an easy-to-use local front panel, and a host of digital remote control options (including compatibility with LabVIEW). It has been designed for maximum reliability and all system components are conservatively rated. High power circuits are physically separated from low power circuits. Minimal internal interconnect wiring reduces the risk of failure. By adding optional Array Interface Modules (AIMs), the eDrive can be expanded to operate multiple additional diode current drive channels simultaneously.

The eDrive Nitro includes the eDrive model's general features and can be upgraded to include an optional internal RF driver for acousto-optic (AO) Q-switching, an integrated array power supply providing up to 1200 W, and a laser interface connector for direct connection of your laser system to the eDrive.

In addition to the general features, the eDrive Aero includes the radio frequency (RF) driver, internal power supply, fiber pump source, and laser interface connector. It is designed for integration with an external fiber-pumped gain module.

The following list highlights key features of the eDrive.

- 40 by 4 character display, four soft keys, four dedicated function keys, rotary encoder for parameter selection, keylock switch, and emergency off switch
- Internal timing generation accomplished by the Timing Engine
- External trigger input
- System interlocks (user interlock, water flow, water level)
- High voltage, high current array control channel
- Internal power supply (option for eDrive Nitro)
- Internal RF Q-switch driver (option for eDrive Nitro)
- RS-232, RS-485, and Ethernet connectivity support
- Remote control capability
- High-power output lugs that provide robust electrical and mechanical connection of your laser system to the eDrive

Panel Displays

Figures 1-1 and **1-2** illustrate the eDrive panel displays.

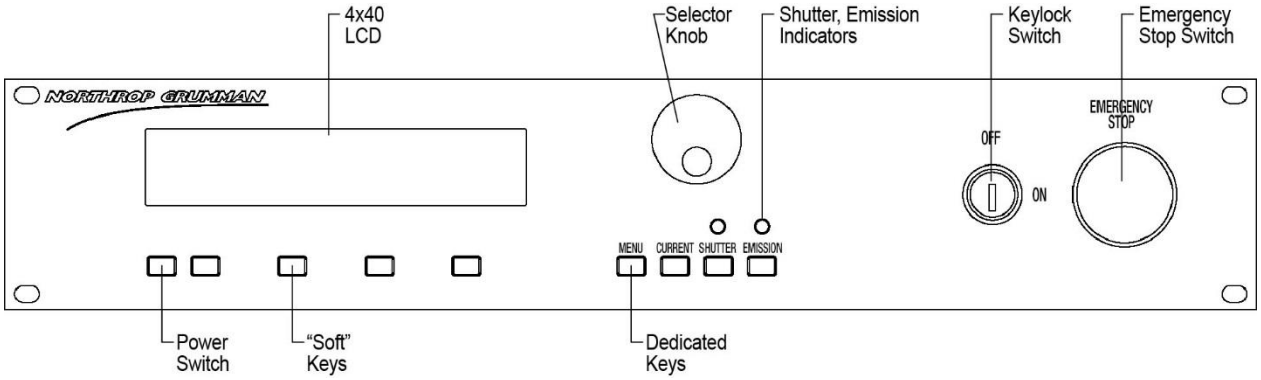

Figure 1-1. 2U eDrive Front Panel

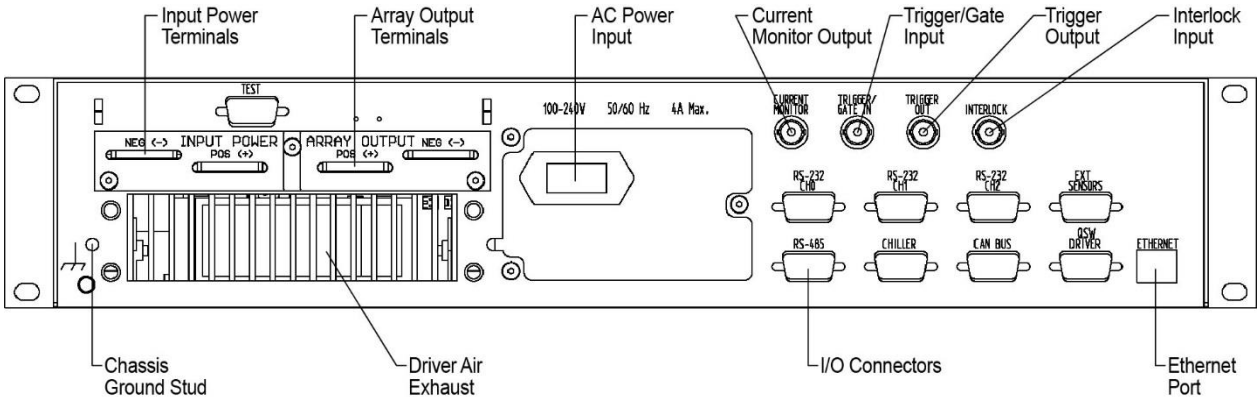

Figure 1-2. 2U eDrive Rear Panel

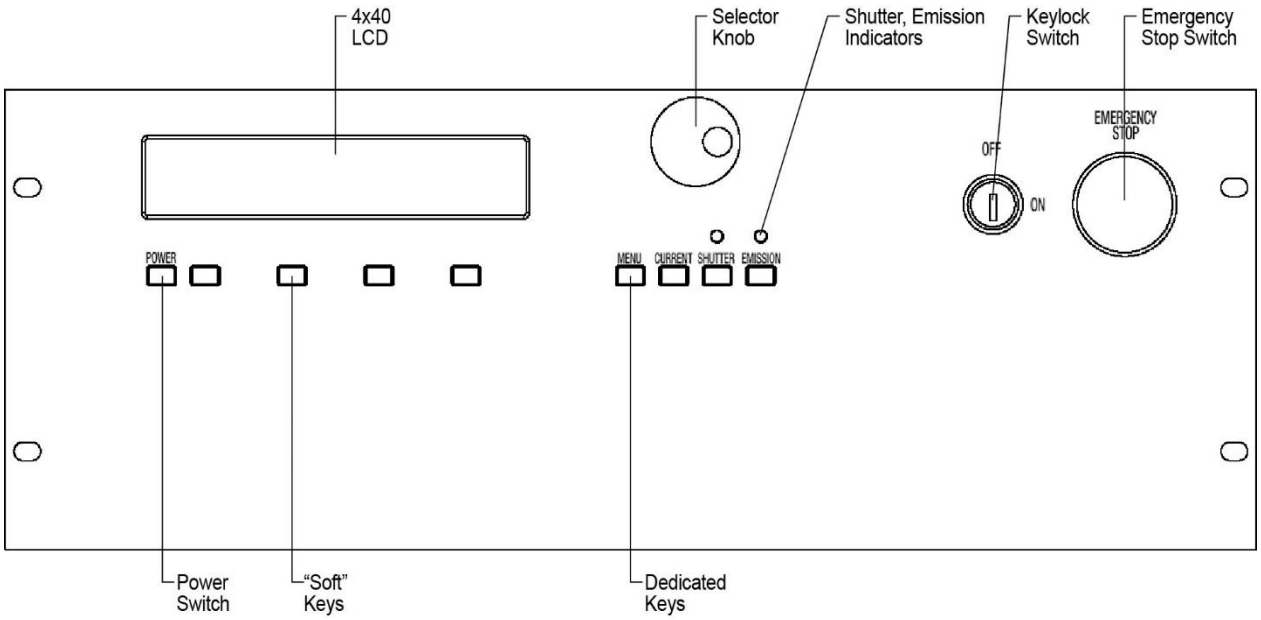

Figure 1-3. 4U eDrive Nitro and Aero Front Panels

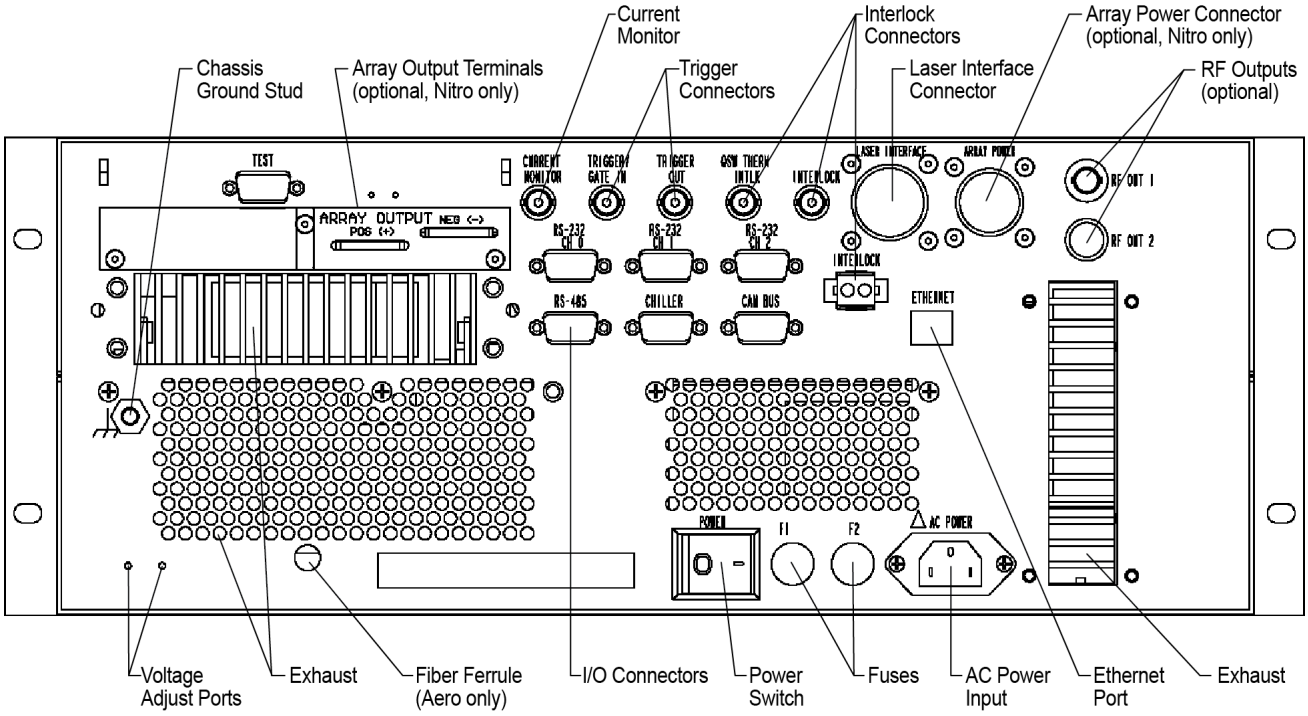

Figure 1-4. 4U eDrive Nitro and Aero Rear Panels

Installation

Input Power

Only power cords suitable for your driver can be used. Connect the power cord to a properly grounded wall outlet socket. The power source must deliver power according to **Tables 1-1** and **1-2**. Power switching is automatic; there are no configuration switches to set for high or low power ranging. Observe the recommended fuses for each voltage range; use type 3 AB ceramic body, Slo-Blo® fuses.

NOTE: There are no user replaceable fuses in the eDrive base unit.

Table 1-1. eDrive (Base) Input Power Specifications

AC Input		Frequency
100-240 VAC	4A max.	50/60 Hz

Table 1-2. eDrive Nitro, Aero Input Power Specifications

AC Input		Frequency	Fuse Ratings (F1, F2)
120V ±10%	15A	50/60 Hz	T 15A 250V
240V ±10%	8A	50/60 Hz	T 8A 250V
Fuse Dimensions: 0.25 x 1.25 inches			

Rack Mounting

The eDrive was designed to be mounted and used in an EIA-310D compliant rack. When installing the 2U eDrive or 4U eDrive Nitro into the rack, first install rack mounting screws into the two bottom holes of the front panel flanges and then install screws into the top holes. This will help minimize any potential damage that might occur to the eDrive front panel if the driver were to shift during installation.

For the 2U eDrive, it is recommended that two people install the unit into a rack if no supporting rails are used. One person should support the driver while the other installs rack mounting screws. Rails are recommended whenever possible for more robust installation.

For the 4U eDrive Nitro and Aero, it is recommended that two people install the unit into a rack. Supporting rails should be used. Align the driver and fasten the front panel flanges into place.

WARNING. Using the eDrive Nitro or Aero without mounting rails can result in personal injury or serious damage to the driver.

Rack mounting kits are available as an accessory and include mounting hardware. Side rails are recommended in order to support the weight of the eDrive.

Basic Connections

Chassis Ground Connection

A chassis ground stud is provided to facilitate connection of the eDrive chassis to the rack or building ground. The cable kit is available as an optional accessory and includes a grounding cable and hardware (see *Appendix C: Accessories*).

Interlock Connections

Most laser system failures occur when the system is operated without the benefit of protection features. Proper use of the eDrive system interlocks will minimize the possibility of system failure due to overheating.

Coolant Interlocks. To connect a chiller to the eDrive, first remove the coolant interlock bypass connector from the chiller connector and attach the cable from the chiller. Be sure to observe correct pinout. Refer to *Appendix B: Connector Interfaces* for the connector pinout for your application.

User Interlocks. The user interlock is a general purpose interlock. It may be used to connect to a facility door switch, an optics bench mounted emergency stop switch, or other appropriate interlock device. There is one user interlock connector on the Rear Panel of the eDrive and two user interlock connectors on the Rear Panel of the eDrive Nitro and Aero. One type is a BNC connector and the other is a plastic two-position connector. The BNC type connector is provided for convenience in wiring.

WARNING. The BNC connector may carry a low voltage, which necessary for energizing the coil of the internal interlock relay. Isolated this connector from other conduction paths. *Do not* allow either the BNC pin or connector barrel to touch other conductive elements other than the user interlock switch.

Laser Interface Interlocks. The eDrive Nitro and Aero laser interface connector provides several system interlocks that are helpful in operating a laser system safely. These include a cover interlock, a coolant interlock, and a Q-switch thermal interlock. You may route

these signals to components inside your laser system such as a cover switch, a flow rate switch, and a Q-switch thermal sensor switch. Refer to *Appendix B: Connector Interfaces* for signal and connector details.

Array Power Connections

The eDrive power terminals are equipped with mounting holes for two-hole compression lugs. These lug types have two advantages over standard ring terminals: superior contact quality and increased mechanical stability. Since there are two fasteners per lug and a much larger contact area, contact resistance will be lower between the eDrive output terminal and the cable terminal. Also, the two-hole feature prevents rotation of the terminal during installation and in the event the cable is pulled, which might cause the connection to loosen.

NOTE: To achieve high performance, it is critical that power wiring in the laser be properly applied. Make note these following issues.

- Use sufficient heavy gauge wiring or special low inductance wiring to connect your driver to your laser system.

Table 1-3. Recommended Wire Sizes

Average Current	Wire Size
0 to 25 A	10 AWG
25 to 50 A	8 AWG
50 to 100 A	6 AWG

- Use wire rated for use at voltages at least as high as the voltages that will be connected to the lug terminals.
- Do not use cables that are any longer than necessary. Long cable lengths are undesirable for two reasons: resistive losses and inductive effects.
- Minimize inductive loading on the driver output by keeping the current loop area to a minimum. This is important for pulsed operation since it improves pulse waveform quality and enhances driver current regulation stability.
- For ultimate performance, a low inductance Litz wire cable or flat cable can be used on the driver output circuit. Both cable types are available as optional accessories (see *Appendix C: Accessories*).

Signal Connections

Signal connections to the eDrive are made with common connector types to ensure ease in obtaining the necessary parts. Custom cables can be ordered from the factory to meet your specific installation requirements. Contact the factory for a quote.

Refer to *Appendix B: Connector Interfaces* for details on the signals connectors of the eDrive series.

eDrive Coolant Connections

If using a water-cooled eDrive, the coolant water tubing must be connected to the stainless steel water connections on the unit's Rear Panel. Use clear 3/8-inch tubing with a minimum pressure rating of 180 PSI to carry the coolant water to and from the eDrive unit. These hoses should be secured onto the eDrive connections using hose clamps to ensure they do not become loose and leak. During operation a minimum coolant flow rate of 1 gallon per minute should be maintained. To prevent damage to the unit, do not exceed a maximum pressure of 60 PSI.

It is recommended that these water connections be checked regularly for leaks or loose fittings and that any damaged or leaking components are replaced. Check for any tubing discoloration, which might indicate contamination or degradation leading to clogging or leakage.

2

Chapter 2: Understanding Driver Functions

This chapter contains information on the primary functions of the eDrive that allow it to function most effectively. The following eDrive functions are described:

- General driver functions
- Driver configuration
- The Timing Engine
- Triggering and gating
- The power train
- Operating limits

General Functions

The block diagram shown in **Figure 2-1** illustrates the various functions of the standard 2U eDrive and their relationship to each other.

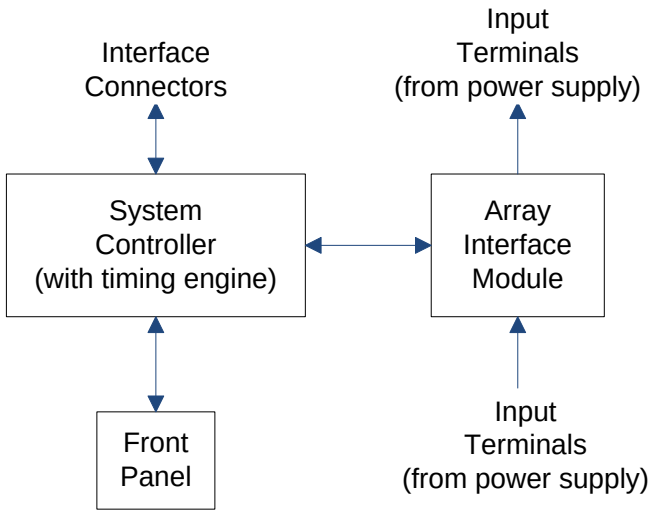

Figure 2-1. 2U eDrive Block Diagram

The block diagram shown in **Figure 2-2** illustrates the various functions of the 4UeDrive Nitro and their relationship to each other.

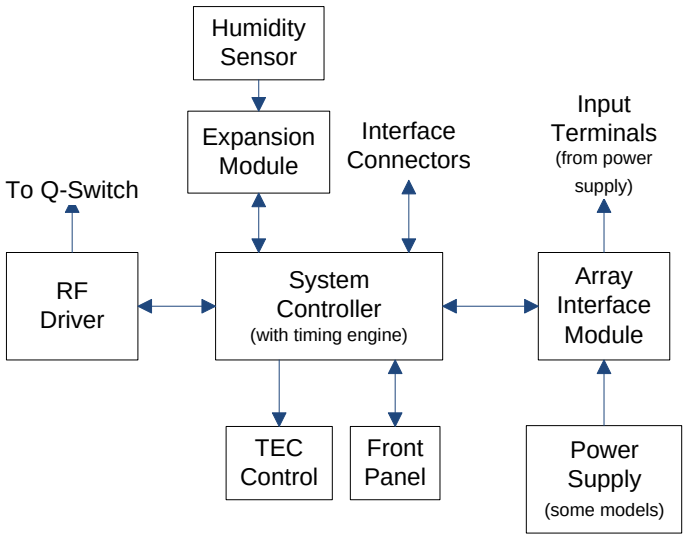

Figure 2-2. 4U eDrive Nitro Block Diagram

The block diagram shown in **Figure 2-3** illustrates the various functions of the 4U eDrive Aero and their relationship to each other.

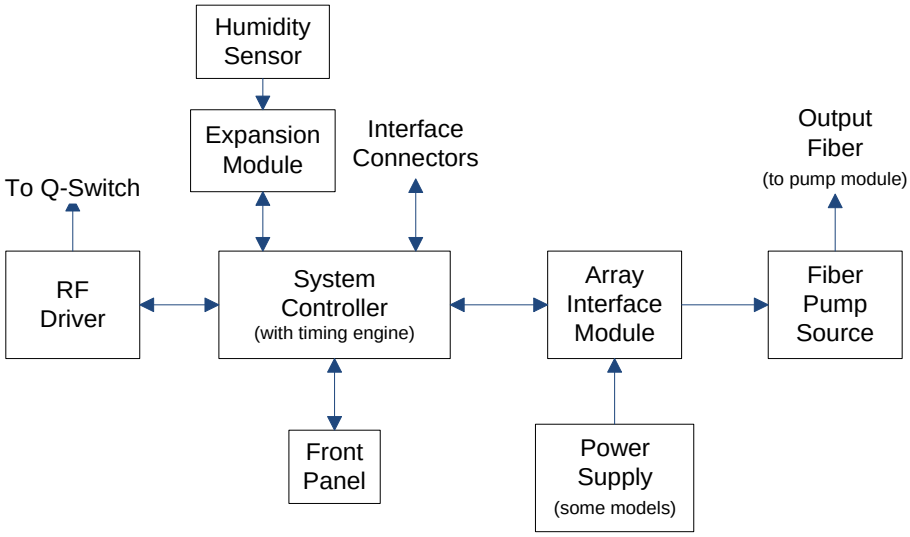

Figure 2-3. 4U eDrive Aero Block Diagram

Driver Configuration

Configuration Retention

The eDrive series uses non-volatile memory to retain user settings when powered off. These settings are restored when the driver is powered on, minimizing setup time on each use. The driver never powers on in the active driving state.

Configuring Safety Settings

The eDrive series has several safety settings that allow you to limit the extent of variability of operating parameters. These include a current limit settings and duty cycle limit setting.

Before you use your eDrive to drive a laser component, consider the use of the current and duty cycle limit settings to help prevent accidental overdrive of the laser component. Refer to *Chapter 3: Operating Basics* for details.

The Timing Engine

The Timing Engine provides flexible control of all laser system signal timing operating like a pulse generator built into the eDrive. The Timing Engine provides the following functions:

- Frequency control of pulsed laser system operation
- Pulse width control of the Q-switch and enable trigger signal
- Pulse width control of the current output pulse
- Timing control of the Q-switch and current pulses as they relate to the external trigger input and to each other
- Gating function control

Triggering and Gating

Modes

The eDrive can operate using an internal timing source to provide triggering or can utilize an external trigger source. The various triggering scenarios are outlined in **Table 2-1**.

Table 2-1. Modes for Triggering and Gating

Mode	Description	External Trigger*	Internal Trigger Gating*	Trigger/Gate Input†
CW	No triggering is used since the outputs are on continuously.	OFF	OFF	--
CW with internal Q-switch triggering	No external triggering is used since the trigger frequency is internally set.	OFF	OFF	--
	The trigger and gate input may be configured to operate as a gate signal to halt all internal triggering.	OFF	ON	Gate
CW with external Q-switch triggering	The trigger and gate input is configured as an external trigger supplied by the user.	ON	--	Trigger
	The eDrive does not control the			
		OFF	OFF	--

QCW with internal triggering	No external triggering is used since the trigger frequency is internally set. Q-switching can be enabled or disabled in this mode. The trigger and gate input may be configured to operate as a gate signal to halt all internal triggering	OFF	ON	Gate
QCW with external triggering	An external trigger is supplied by the user. The eDrive does not control the frequency. Q-switching can be enabled or disabled in this mode.	ON	--	Trigger

* External Trigger and Internal Trigger Gating refer to the command bits described in *Chapter 5: Communications*.
† Trigger/Gate Input refers to the connector on the Rear Panel of the eDrive described in *Appendix B: Connector Interfaces*.

Parameters

The eDrive controls the timing of the signals of the laser system. Refer to *Chapter 6: User Interface Reference* for details on setting timing parameters.

The timing diagram, shown in Figure 2-4, represents internal or external triggering. It illustrates the offset from the trigger signal T1, the pulse width of the current pulse T2, and the offset of the Q-switch trigger T3. These parameters are typically adjusted for pulsed Q-switched laser systems. For CW Q-switched systems, the current pulse timing is irrelevant. T4 is the width of the Q-switch trigger pulse.

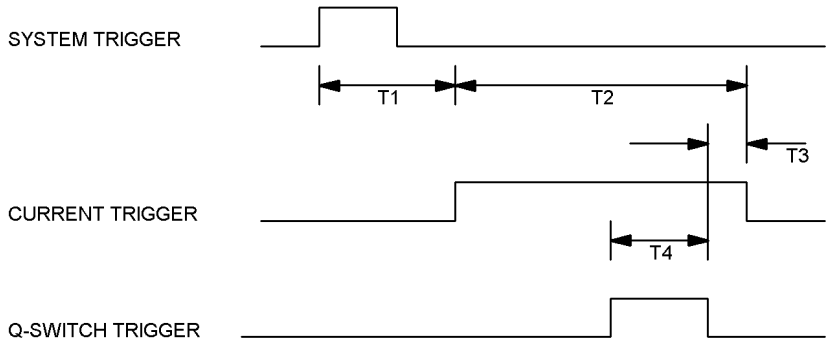

Figure 2-4. Internal or External Triggering

The timing diagram shown in **Figure 2-5** illustrates the external gating signal preventing internal triggering from occurring. The system trigger is, in this case, the internal

timebase. The external gate is the signal applied to the Trigger/Gate Input. When the gate signal is low, the internal triggers do not affect the outputs. When the gate signal is high, the triggers resume normal operation.

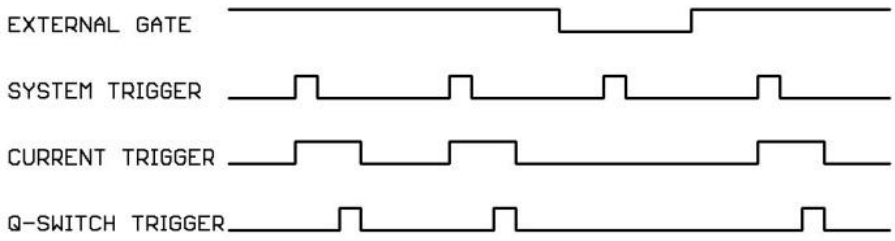

Figure 2-5. Timing for Internal Triggering with External Gating

Power Train

The heart of the eDrive is a high-performance current regulator. This regulator provides stable current levels during operation and also switches the current on and off during pulsed-mode operation. The power provided to the current regulator can be an external source, as in the case of a 2U eDrive and some 4U eDrives, or an internal source, as in the case of some 4U eDrives.

When power is provided internally, it is sourced from one or two power modules that together provide the needed levels of voltage and current. This raw power is delivered to the output through the array interface module (AIM) of the eDrive. When the eDrive model includes integral power supplies, the power input terminals are typically removed.

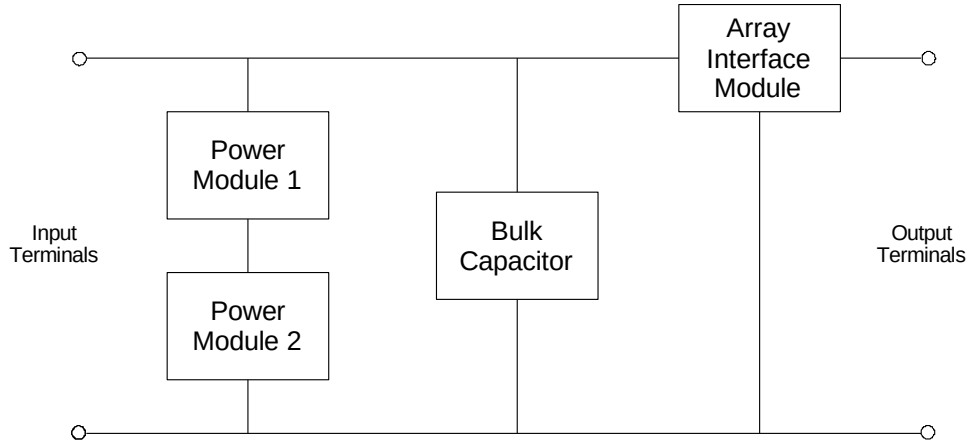

Figure 2-6. Power Train

To provide current regulation some voltage must be dropped across the AIM. This requires the power supply voltage be marginally higher than the expected output voltage.

The magnitude of that margin depends upon the expected current load of the output. *Chapter 3: Operating Basics* details proper sets for the power supply voltage.

When operating a pulsed-mode eDrive, the average current delivered from the supply can be much less than in CW mode. eDrive models capable of QCW contain a storage capacitor that delivers most of the actual pulse current to the arrays. During the idle phase of the output waveform, the supply charges the capacitor in preparation for the next pulse. For this operation, the average current required from the supply can be estimated from the equation:

$$I_{avg} = I_{peak} * D$$

where D is the duty cycle of the output pulse waveform.

The duty cycle, D, is the percentage of the period that the signal is actively driving current. It can be calculated from the equation:

$$D = PW * PRF \text{ `}$$

where PW is the pulse width and PRF is the pulse rate frequency of the laser.

When choosing connector contacts and wire sizes, calculate the RMS current of the pulsed waveform using equation:

$$I_{rms} = I_{peak} * \sqrt{D}$$

where D is the duty cycle of the output pulse waveform.

Operating Limits

The eDrive must dissipate any power provided by the power supply that is not delivered to the array. If the power supply voltage level is too high or the delivered current is too high, the excess power (voltage-current product) will add heat to the AIM possibly resulting in an overheating condition.

To help the user understand the limits on these parameters, two operating envelope charts for the eDrive have been provided. These charts assume that the power supplies have been properly adjusted. To properly adjust your eDrive power supply, refer to *Chapter 3: Operating Basics.* If cooling air or water is within specification, the charts will aid in determining the trade-offs between duty cycle and array current for a fixed power supply voltage.

The eDrive can be configured with two current regulation options. One is optimized for speed and the other is optimized for power. Larger metal oxide semiconductor field effect

transistor (MOSFET) devices can handle more current than smaller MOSFET devices but also require more settling time to stabilize. There is a trade-off between current capacity and speed. Speed is optimized with the standard eDrive. If your application requires higher power but does not require the fast transition times of the standard eDrive, please specify the higher-power configuration when ordering.

eDrive 100A

In this configuration, the typical minimum rise time is approximately 35 µs. **Figure 2-7** illustrates current vs. duty cycle operating regions. This chart demonstrates a power supply set to 7 V (volts) above the array voltage.

WARNING. These charts provide the maximum operating limits of the eDrive. While your eDrive may achieve better performance, damage may occur.

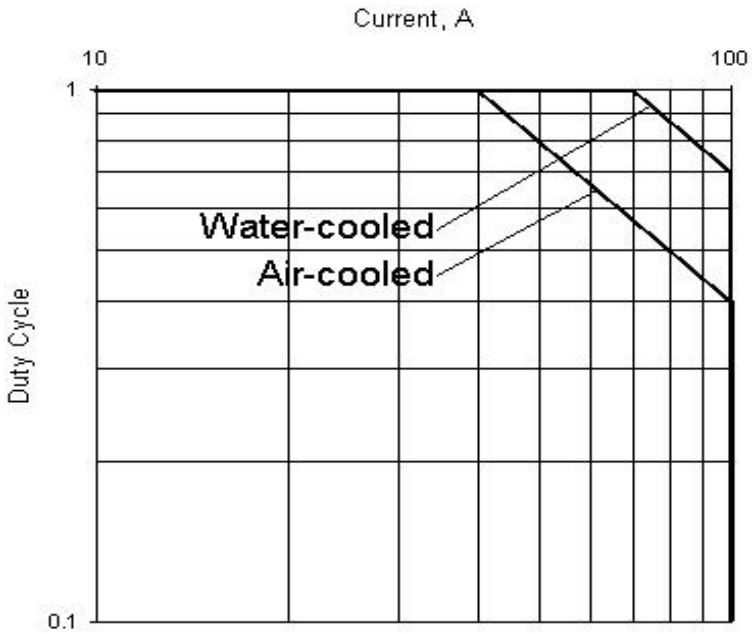

Figure 2-7. eDrive Configured at 100 A

eDrive 300A

In this configuration, the typical minimum rise time is approximately 35µs. **Figure 2-8** illustrates current vs. duty cycle operating regions. This chart demonstrates a power supply set to 7 V above the array voltage.

WARNING. These charts provide the maximum operating limits of the eDrive. While your eDrive may achieve better performance, damage may occur.

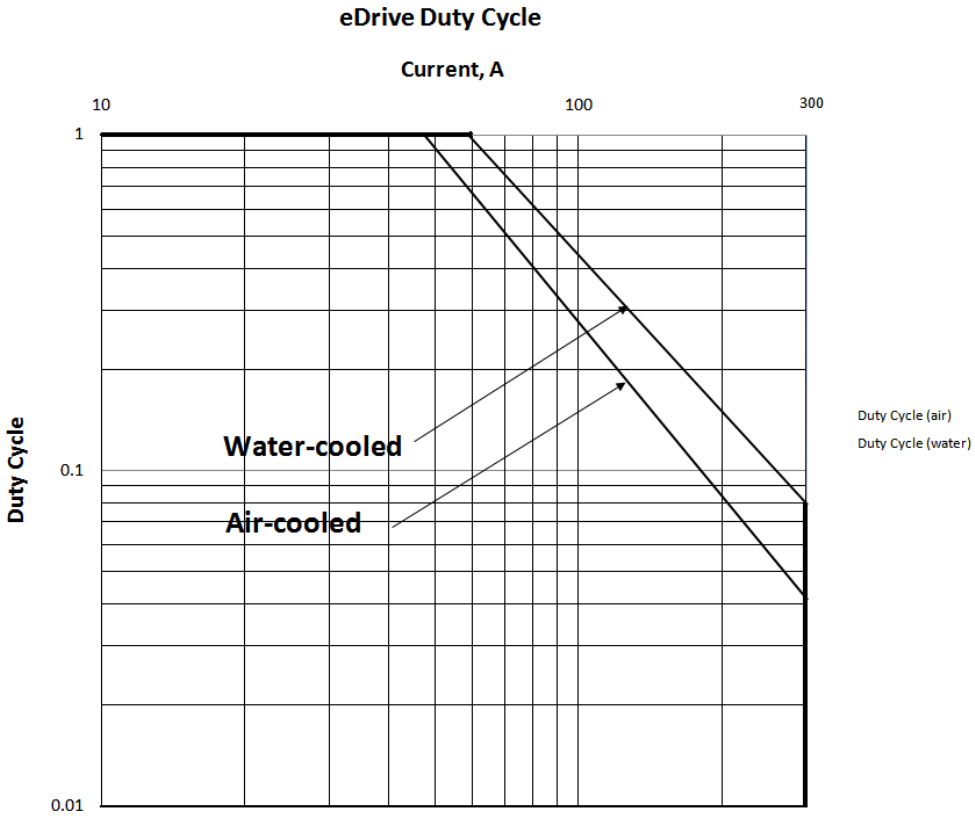

Figure 2-8. eDrive Configured at 300 A

Chapter 3: Operating Basics

This chapter describes basic operation of your eDrive laser system controller. This chapter discusses:

- Powering eDrive on and off
- Using the selection knob
- Navigating the menu systems
- Configuring and testing chiller operation
- Setting the eDrive operating mode
- Using the eDrive Aero fiber pump source
- Setting the eDrive operating limits
- Setting the array power supply
- Controlling and improving waveform characteristics
- Configuring the integrated acousto-optic (AO) Q-switch radio frequency (RF) driver
- Connecting an external Q-switch driver

Powering the eDrive On and Off

Be sure to connect your eDrive to a suitable power source properly.

The eDrive Nitro and similar 4 U models have a Rear Panel power control switch. This switch is marked with the universal switch position legends, **O** and **I.** Press the power switch to the **I** side. This enables the power to be controlled from the front panel.

To turn your eDrive on, from the front panel turn the key lock switch to the **ON** position and press the **POWER** switch momentarily. The eDrive will boot up and display the user interface menus.

To turn your eDrive off, either turn the key lock switch to the **OFF** position or press and hold the **POWER** switch for three seconds.

Using the Selection Knob

The selection knob allows you to quickly select a wide range of values in the eDrive. When the display reads **Rotate Dial to Change Value**, use the selection knob to make adjustment to the parameter selected.

When it is impractical to make adjustments to the values with normal selection knob behavior, the display will instruct you to press the selection knob to change the scale. Press and hold the selection knob for a brief period until the scale changes to 10x or 100x. This will quickly facilitate excursions in the selected value. Press the selection knob again to return to 1x mode for fine adjustments.

Navigating the Menu Systems

The eDrive series controllers provide extensive control of laser system and array parameters. To realize this capability, a set of user menus is available. Refer to *Chapter 6: User Interface Reference* for a detailed description of the entire menu system.

The menu system utilizes six buttons and a selection knob on the front panel. Four of the buttons are referred to as “soft”. The function of each of these four soft buttons depends on the legend displayed directly above the button. The other two buttons, **MENU** and **CURRENT**, control commonly used functions.

The **MENU** button performs the following functions:

- Navigates to the main menu. If you have navigated to sub menus within the menu system, pressing **MENU** will take you upward in the menu structure until you return to the main menu.
- Switches between menu modes. Press and hold **MENU** for three seconds to switch between the full menu system and the restricted menu system called Quick Menus. Quick Menus provides access to basic system options while preventing access to system configuration and setup features. The full menus might be considered useful for the experienced laser scientist, engineer, or technician.
- The **CURRENT** button takes the user to a special current control and monitor display and is accessible only in the full menus. This button is ignored in the Quick Menus.

Configuring and Testing Chiller Operation

This section will step you through configuring and testing the chiller operation of the eDrive and laser system.

1. Verify that your chiller is connected properly, turned on, and that the flow rate is correct.
2. Connect the coolant flow switch to the Chiller connector on the Rear Panel of the eDrive. See *Appendix B: Connector Interfaces* for pin designations. If your laser system includes an internal flow switch, verify that the signal connector is connected properly.
3. Power on the eDrive. If any errors are indicated on the display, isolate and correct the problem before continuing.
4. Verify the coolant flow interlock. To do this, turn off your chiller and verify that the eDrive displays a coolant flow fault. Turn on the chiller, select **Clear**, and verify that the error display is no longer present.

Setting the eDrive Operating Mode

To set the operating mode for your system configuration, follow these steps:

1. Make sure the eDrive is powered on.
2. From the main menu, select Channel Setup. Notice whether the channel is in CW mode or QCW mode. If you wish to change modes:
   a. Make sure emission is off. If not, press **EMISSION**.
   b. Toggle the channel status to disabled. If the display does not show Channel Disabled, select **Channel Enabled** to toggle to the disabled state.
   c. Select the desired operation mode by selecting **Enable Pulsed Mode** or **Enable CW Mode**.
   d. Select **Channel Disabled** to toggle back to the enabled state.

WARNING. To avoid overheating the eDrive, be sure to adjust the power supply when switching between operating modes.

Using the eDrive Aero Fiber Pump Source

Safety

The eDrive Aero is a standard eDrive with an integral fiber pump source as the power output device. Since it is a laser power source, it is important to observe safety precautions at all times during the installation, operation, and maintenance of your system. When attaching a fiber optic cable to the eDrive Aero, use proper handling to prevent damage to the delicate fiber components.

WARNING. Do not attempt to place the eDrive Aero into active emission with no fiber optic cable attached to this connector. Damage to equipment or personnel may result.

DANGER. This connector emits visible and invisible laser radiation. Avoid direct, indirect, or scattered exposure to eyes or skin. Damage to personnel or equipment may result. This is a Class IV laser product.

Configuration

It is important to properly set the operating parameters for the eDrive Aero before beginning active emission. The eDrive Aero has been configured with the proper internal power supply. The user interface will limit the supply current to levels appropriate for the integral fiber pump source. For details on the menu system and parameter options, please refer to *Chapter 6: User Interface*. Refer to the laser user guide for specific settings required for operation.

Setting the eDrive Operating Limits

To set your eDrive to help prevent accidental overdrive, follow these steps:

1. Make sure the eDrive is powered on.
2. From the main menu, select Channel Setup ▸ Channel 1 ▸ Set Current Limit. Use the selection knob to set your maximum current amplitude to a value considered safe for the intended array. The eDrive will not allow the current amplitude to be set higher than the limit.
3. If the driver is in pulsed mode, from the main menu, select Channel Setup ▸ Channel 1 ▸ Set Duty Cycle Limit. Use the selection knob to set your maximum duty cycle to a value considered safe for the intended array. The eDrive will not allow the duty cycle to be set higher than the limit.

Setting the Array Power Supply

This section describes how to properly set the power supply. When selecting a power supply to use with eDrive models with no integral supply, select a power supply that provides a regulated voltage output with less than 0.5 V ripple. Additionally, it is essential that the power supply chosen provide both overcurrent protection and short-circuit protection. For pulsed applications, be sure your supply can provide the required average power for the pulse characteristics.

External Supply

This procedure assumes that there is a load connected to the eDrive output. This output may be the actual laser module or a simulated load.

Some eDrive-series products are configured to operate with an external power supply. To set your external power supply, follow these steps:

1. Turn on the power supply.

2. Set the power supply voltage. The required power supply voltage (Vps) can be approximated by summing the expected array voltage (Va) and the array interface module (AIM) dropout voltage, which is calculated as the product of the expected array current (Ia) and the characteristic impedance of the AIM (ZAIM), which is typically 0.08 Ω:

$$V_{ps} = I_a * Z_{AIM} + V_a$$

Use the published module, array voltage from the datasheet of your laser product, or if you are using packaged diode bars, calculate the expected array voltage by multiplying the number of diode bars by the forward voltage drop. (For NG bars, use a forward voltage drop of approximately 1.85 V to 2.00 V per bar.)

WARNING. To avoid overheating the eDrive, be sure to adjust the power supply when switching between operating modes.

Example 1. You are driving a 12-bar array in CW mode. The expected voltage drop across the array is approximately 12 * 2.00 V, or 24.00 V. The AIM has a characteristic impedance of approximately 0.08 Ω. At 40 A, the voltage drop across the AIM will be approximately 3.2 V. The approximate total voltage required for CW operation is 24.0 V + 3.2 V = 27.2 V.

Example 2. You have purchased a CW pump module. The datasheet for the module states that it is rated for 18 V nominal operation at 30 A. Set your power supply to 18 V + (0.08 * 30) = 20.4 V.

When operating in QCW operation monitor the shape of the current waveform to establish your final voltage. When testing pulsed system operation, always select a low frequency pulse rate initially (approximately 10 Hz or less). This will allow you to evaluate current pulse waveform characteristics before driving significant power into your system. See the *Pulse Waveform Characteristics section* this chapter for more details.

1. Set the current limit on the supply to the lowest level to begin checkout.
2. Turn on your eDrive.
3. From the main menu, select **Channel Setup ▸ Channel 1 ▸ Set Current**. Use the selector knob to select a low current level of approximately 10 A.
4. Press **EMISSION**. After a pre-fire state, the eDrive begins to drive the array.
5. Slowly begin to adjust the power supply current limit until you reach the 10 A expected drive level.

6. Continue to increase the current amplitude settings on both eDrive and power supply until the desired current level is achieved.
7. Press **EMISSION** to return the eDrive to the standby state.

WARNING. For safety purposes, and to protect against faults or short circuits, the power supply should incorporate fusing or internal overcurrent protection circuitry. The DC output voltage should be connected to the input of the eDrive equipment. This protection circuitry should be set to disable the output of the power supply if the output current exceeds the eDrive current limit. Overcurrent protection circuitry, which utilizes a current fold-back protection, could result in damage to the diode arrays as it prevents the eDrive from properly regulating the diode current.

Refer to Tables 1-1 or 1-2 for information on the maximum allowable compliance voltage and maximum allowable operating current for the eDrive model being used. These limits settings should agree with the limits provided by the power supply protection circuitry.

Internal Supply

Some eDrive models are configured with an internal power supply. For these models, the voltage and current rating of the supply already were configured to approximate the array being driven. Therefore the array voltage and AIM dropout voltage have already been considered. However, it may be necessary to adjust the supply to meet the requirements of your application or to achieve optimal performance.

This procedure assumes that there is a load connected to the eDrive output. This output may be the actual laser module or a simulated load. To set the internal power supply, follow these steps:

1. Turn on your eDrive.
2. From the main menu, select **Channel Setup ▸ Channel 1 ▸ Set Current**. Use the selector knob to select a nominal current level for your array or laser.
3. Press **EMISSION**. After a pre-fire state, the eDrive begins to drive the array.
4. Monitor the set and sensed current displayed on the eDrive front panel. They should track each other to within 2 percent or less.

If the eDrive fails to reach the commanded current amplitude level, it may be necessary to increase the supply voltage slightly. The eDrive models with internal power supplies are adjustable by approximately ±4 percent. Adjust the supply voltage by continuing with the steps below:

5. Carefully position the eDrive to allow easy access to the Rear Panel.
6. Locate the voltage control access ports on the Rear Panel as shown in Figure 3-1.

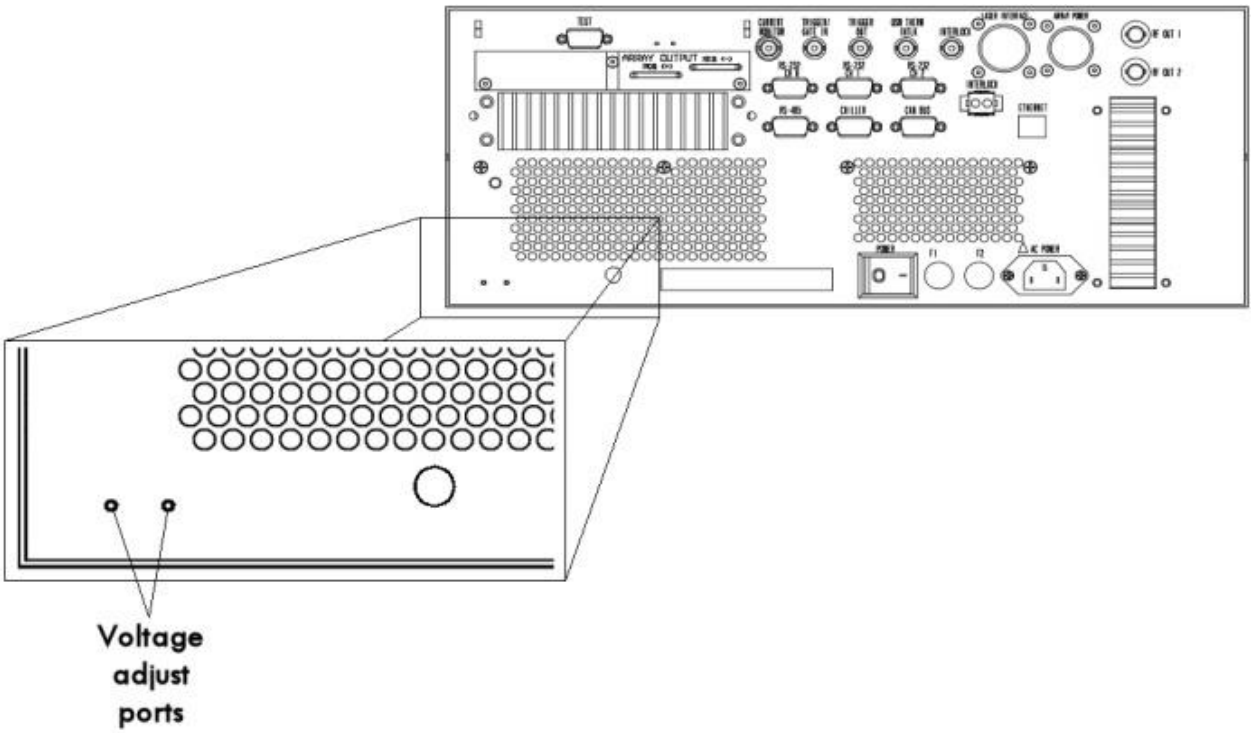

Figure 3-1. Voltage Control Access Ports

7. Using a plastic adjustment tool, turn one or both of the controls clockwise to achieve higher supply voltage. Monitor the sensed current on the eDrive front panel. As the power supply voltage is increased, the sensed current should continue to rise until it reaches the set current level. When this occurs, turn the setting one more turn to provide a small additional margin.

NOTE: Some eDrives may have only one power module and only one control may be operational.

CAUTION. Using an electrically-conductive adjustment tool could result in personal injury or equipment damage. Do not insert electrically conductive tools into the openings of the enclosure of any eDrive model.

8. Press **EMISSION** to return the eDrive to the standby state.

WARNING. Operating the eDrive with the load improperly connected or short-circuited can result in damage to the load and the eDrive. Whenever a new load connection is made or when there is a possibility that the load connection may have changed, it is advisable that a brief test be conducted operating the driver at a low current setting of

less than 1.0 A. This will allow testing the connections prior to operation at high current levels, which could result in excessive power dissipation on the eDrive.

Pulse Waveform Characteristics

Using the power supply adjustment procedures outlined in the *Internal Supply* section will assist you in obtaining the best operating point for your eDrive and laser. For ultimate performance, waveform characteristics of the current pulse should be analyzed to make the final adjustments.

To monitor the current pulse characteristics, connect an external clamp-on current probe to the eDrive output or connect a BNC cable to the **CURRENT MONITOR** output shown in **Figure 3-2**.

Figure 3-2. Current Monitor Connector

Connect either the current probe or cable to an oscilloscope (See **CAUTION** below if connecting BNC cable to **CURRENT MONITOR**). Follow the procedures outlined in the *Setting the Array Power Supply section* for setting the power supply.

CAUTION: If using an oscilloscope to measure the current monitor voltage, the oscilloscope should be floating (using a ground isolator on the oscilloscope power cord). If the scope is grounded, the diode current can pass through a ground loop (shown in **Figure 3-3**) and burn the current monitor negative wire (**Figure 3-4**). The presence of a ground loop bypassing the FET could potentially also result in damage to the hardware being controlled by the eDrive.

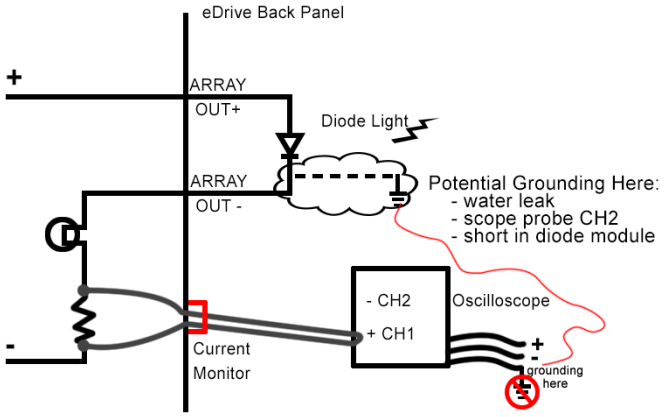

Figure 3-3. Current Monitor Ground Loop

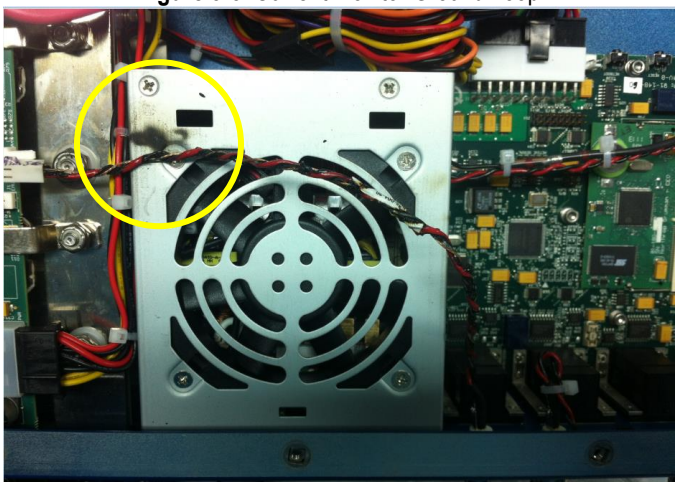

Figure 3-4. Burned Current Monitor Negative Wire

Controlling and Improving Waveform Characteristics

Figure 3-5 illustrates the current pulse waveform characteristics for various power supply voltage settings. In this example, the load is a 12-bar array and the eDrive is set to deliver a 30 A pulse to the load. The oscilloscope is set for 5 A/div vertically and 50.0 µs/div horizontally. Set the voltage lower than the expected load voltage. Increase the voltage in increments of 1 V until the waveform looks flat. Refer to the oscilloscope graph below.

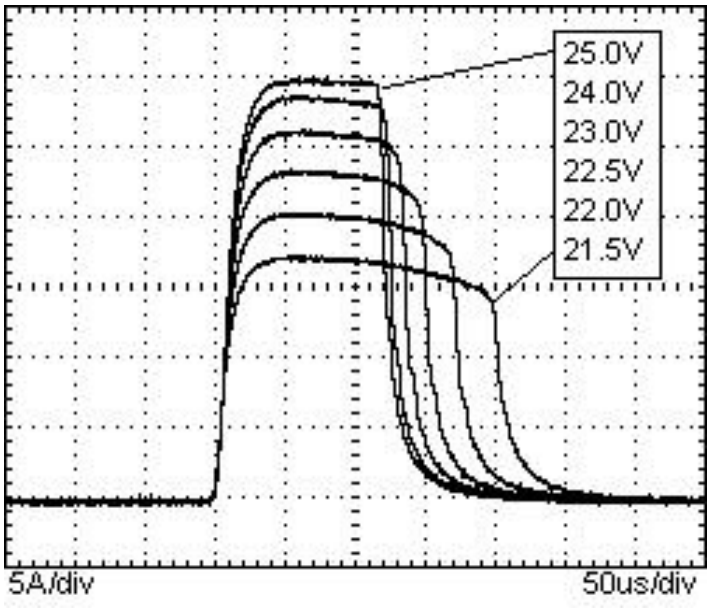

Figure 3-5. Waveform Characteristics for Power Supply Voltage Settings

NOTE: When the power supply voltage is set at too low an amplitude, the current pulse is weak, far below its commanded level, and a longer duration than anticipated. As the supply voltage is increased to the array voltage and beyond, the current pulse amplitude reaches its commanded level of 30 A and the current pulse width reaches its commanded duration. The shape of the waveform becomes flat at its maximum amplitude and exhibits good transient characteristics.

Since the array consists of 12 bars, the expected array voltage is approximately 12 * 1.8 V, or 21.6 V. However, since the eDrive requires some margin above the array voltage, in this case 3.4 V, the desired waveform characteristics are not realized until the supply voltage reaches 25.0 V.

Waveform Characteristics and Pulse Width

Figure 3-6 illustrates the current pulse waveform characteristics for a long current pulse. The load is a 12-bar array and the eDrive is set to deliver a 30 A pulse to the load. The oscilloscope is set for 5 A/div vertically and 100.0 μs/div horizontally.

NOTE: The amplitude of the pulse begins to decrease at approximately 300 μs from the leading edge. This results when the internal capacitor inside the eDrive is drained below the minimum charge to maintain the current amplitude. The power supply cannot respond quickly enough to the change in current. If this waveform characteristic is unacceptable and it may be necessary to add another capacitor external to the eDrive. Contact the factory for ordering information.

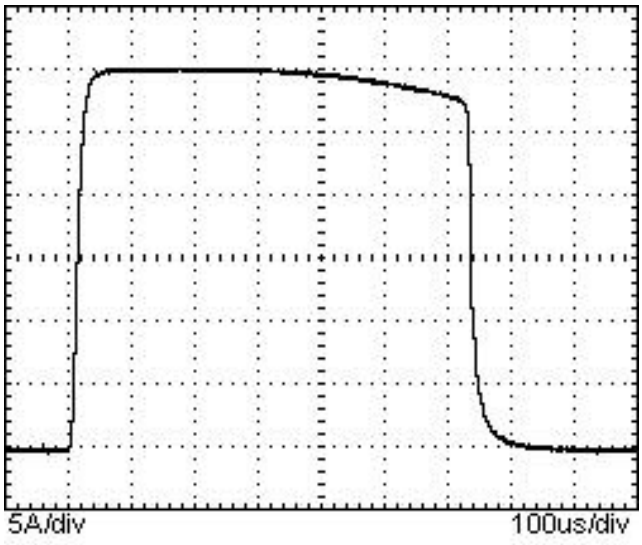

Figure 3-6. Waveform Characteristic for Long Current Pulse

Waveform Characteristics and Standard Hookup Wire

Figures 3-7 and **3-8** demonstrate the rising edge characteristics of a current pulse waveform. The load is a 25-bar array and the eDrive is set to deliver a 70 A pulse to the load. The oscilloscope is set for 20 A/div vertically and 10.0 μs/div horizontally. The hookup wire connecting the eDrive to the array is more than 5 m long and consists of two 6 AWG wires. The external loop area of the current path is not well controlled and is estimated at approximately 0.1 m^2.

In Figure 3-3, the eDrive is *not* set to use slew rate limit control, but is switching as fast as possible.

NOTE: The current waveform overshoots the target of 70 A by 20 A resulting in a peak of 90 A. The eDrive quickly compensates by regulating the current to the commanded 70 A amplitude but the violation has already occurred. This type of waveform characteristic typically occurs with high current amplitudes and poorly controlled inductance on the array hookup wire.

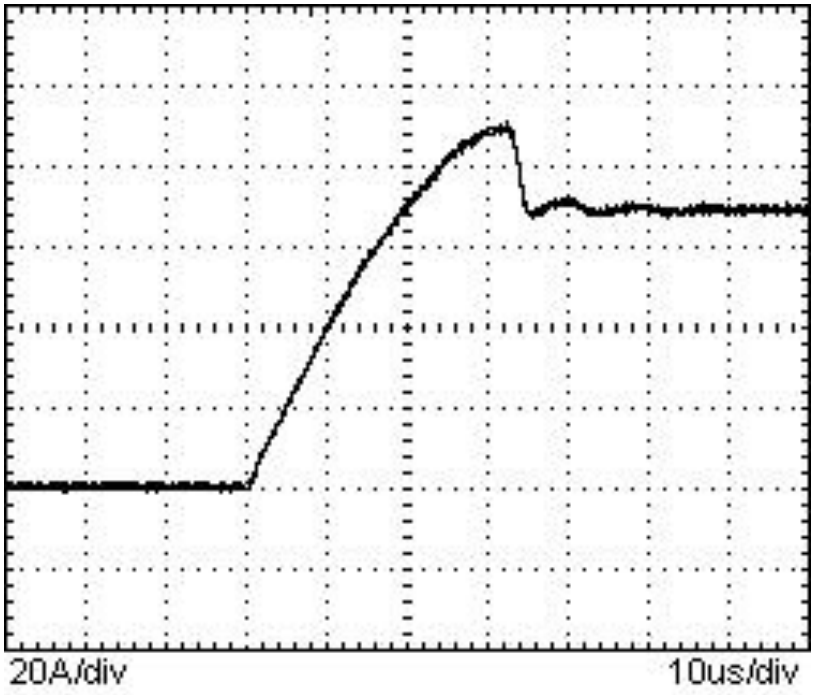

Figure 3-7. eDrive Not Set to Slew Rate Limit Control

In **Figure 3-8**, the eDrive has been set to slew rate limit control. This feature limits the rise time to 40 μs for configurations where special wiring or routing are not options.

NOTE: Note that the current waveform overshoots the target of 70 A but the amount of overshoot has been significantly reduced.

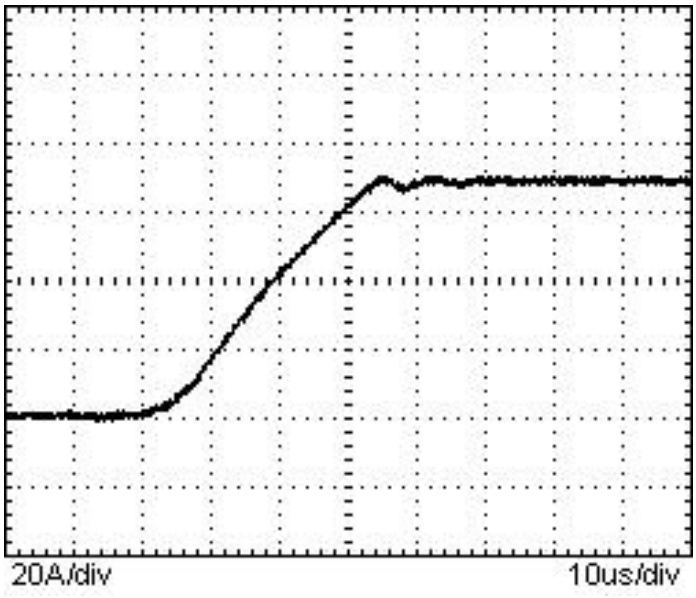

Figure 3-7. eDrive Set to Slew Rate Limit Control

Waveform Characteristics and Controlled Hookup Wire

Figure 3-9 illustrates an oscillogram montage showing the characteristics of a current pulse waveform with varying supply voltages. The load is a 14-bar array. The eDrive is specifically configured at the factory for very fast rise time operation. (Consult factory for ordering information.) It is set to deliver a 70 A pulse to the load.

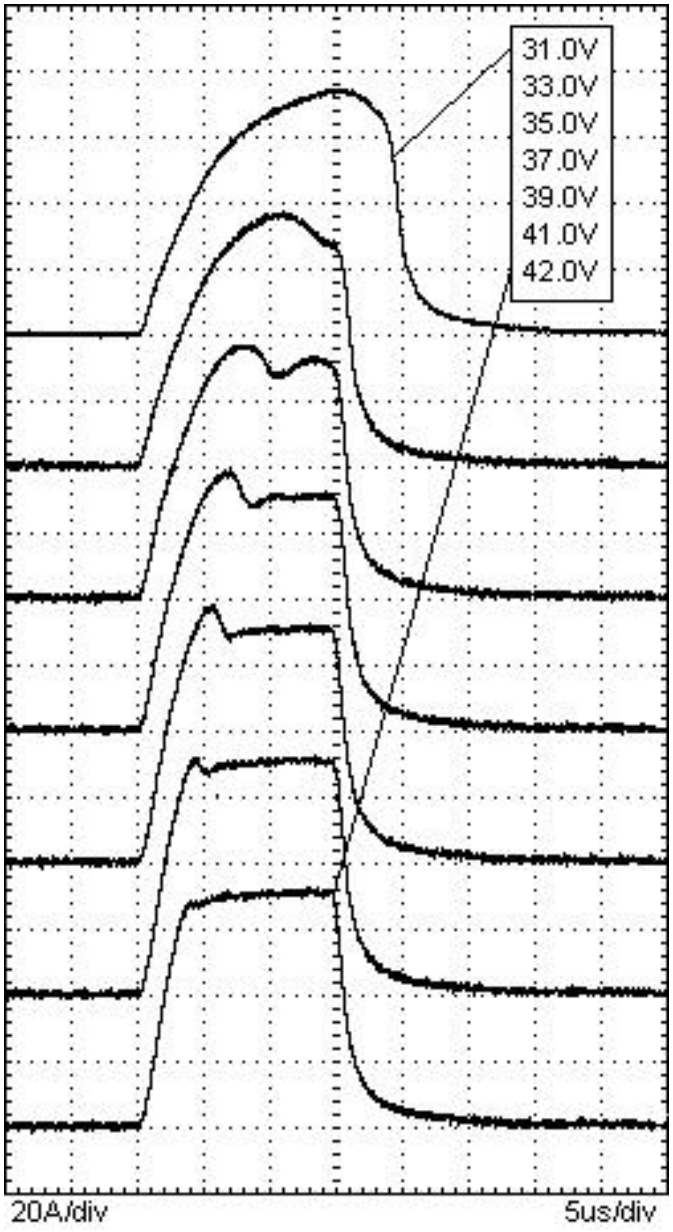

Figure 3-9. Waveform Characteristics with Varying Supply Voltages

The oscilloscope is set for 20 A/div vertically and 5.0 μs/div horizontally. The hookup wire connecting the eDrive to the array is more than 6 m long and consists of very low inductance Litz wire. The external loop area of the current path is well-controlled and estimated to be approximately 0.002 m^2.

NOTE: The waveform characteristics change as the voltage is increased. At the final setting, the voltage is 14 to16 V above the array voltage but the rise time is only approximately 4 μs.

These oscillograms demonstrate the importance of properly adjusting your power supply to meet the conditions of your laser or diode array for optimal performance. The voltage should be set high enough to obtain proper pulse waveform characteristics but should be set low enough to allow for the broadest operating envelope without overheating the eDrive.

Waveform Characteristics and Standby Current

Normally, the current between pulses is zero. In some cases, however, it is desirable to continue to pass some current through the laser. To achieve this, the eDrive can deliver a stand-by current to the laser. This could be used to minimize thermal shock or to achieve the fastest possible turn-on times. To set a standby current, from the main menu select **Channel 1 ▸ Set Standby Current**. Enter a value that is below optical threshold so that the laser does not lase but stays warm. A value between 3 A and 8 A is typical. The oscillogram below shows the stand-by current that follows the first current pulse after **EMISSION** is pressed.

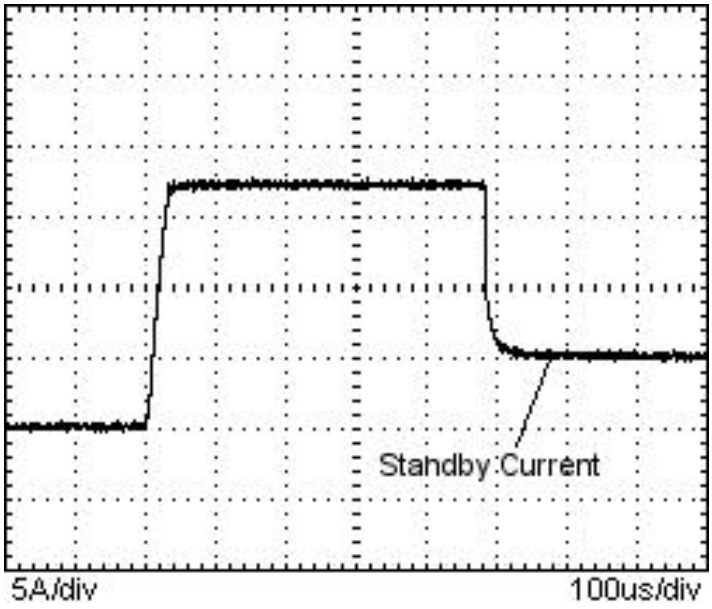

Figure 3-10. Standby Current Characteristics

NOTE: The current before the pulse is 0 A.

Configuring the Integrated AO Q-Switch RF Driver

The eDrive Nitro and Aero have a built-in RF driver for AO Q-switching with proprietary first pulse suppression (FPS) control.

Overview

Figure 3-11 illustrates a typical Q-switching function. The top trace is the trigger signal; the middle trace is the optical output pulse measured with a photo detector; and the bottom trace is the output from the Q-switch RF driver. Notice how the optical output power increases with each successive pulse as the FPS function opens the Q-switch crystal.

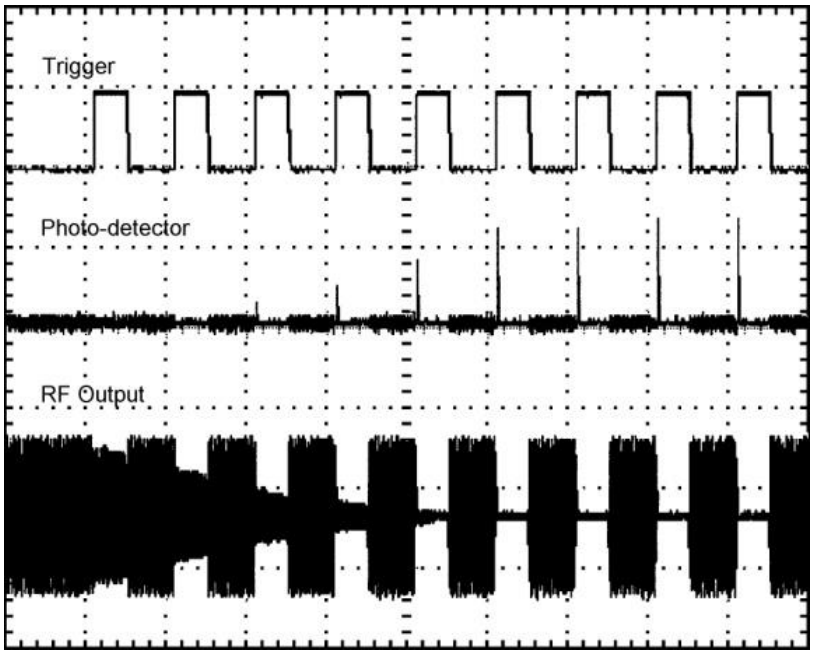

Figure 3-11. Typical Q-Switch Function

FPS is used to eliminate the first powerful pulse that results from an over-energized laser gain medium or cavity when lasing has been held off.

FPS Parameters

The eDrive Nitro and Aero Q-switch function is very flexible and supports control of the following parameters:

1. **Q-switch trigger frequency.** This parameter is the frequency at which the Q-switch trigger occurs.
2. **Q-switch window width.** This parameter is the width of the gap in the RF modulation envelope.
3. **FPS delay.** This parameter is the amount of time without pulse activity that is required in order to trigger a first pulse suppression event.
4. **Q-switch RF power.** This parameter sets the amount of RF power that is delivered to the Q-switch during a nominal pulse. This level allows for advanced power control without adjusting the current output amplitude.
5. **FPS start power.** This parameter sets the amount of RF power that is delivered to the Q-switch at the start of a first pulse suppression event.
6. **FPS window length.** This parameter sets the duration of the RF modulation waveform that occurs during a first pulse suppression event.
7. **FPS modulation type.** This parameter sets the shape of the RF envelope that occurs during a first pulse suppression event.

Some of these parameters are identified graphically in the diagrams below.

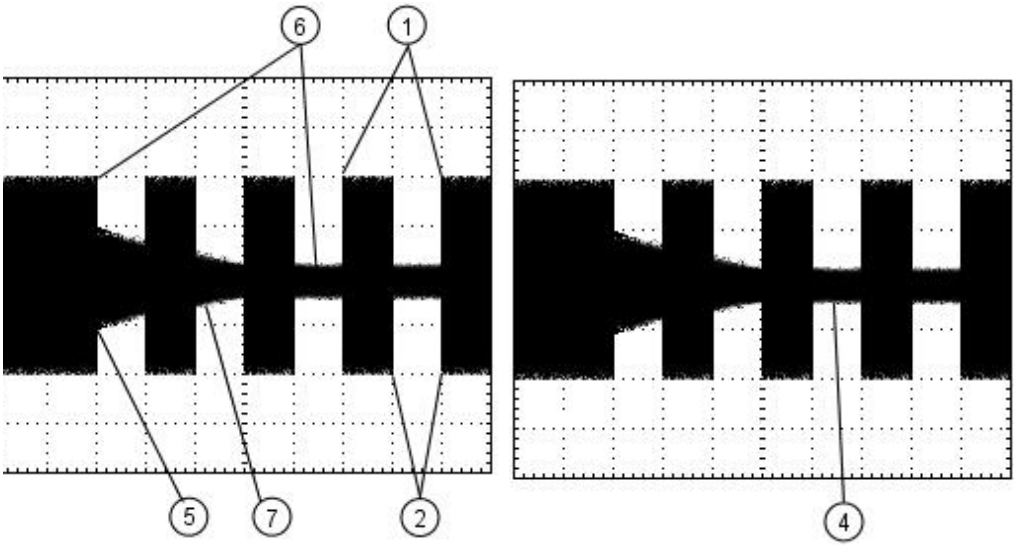

Figure 3-12. FPS Parameters

FPS Power Control

Utilizing the advanced Q-switch power control feature, the eDrive can control the optical power of the laser system without changing the array current. In this instance, the Q-switch uses a continuously variable optical gate rather than just an on and off switch. Notice the difference between the RF amplitude in the two oscillograms in **Figure 3-13** and **Figure 3-13**. **Figure 3-12** shows a significant amount of RF energy in the Q-switch windows even after FPS has completed. This extra RF energy will hold off part of the laser power resulting in reduced optical output.

By manipulating the various parameters, you can achieve a configuration that is particularly tuned to your application.

FPS Modulation Types

The FPS modulation type, or envelope (see *FPS modulation type in the FPS Parameters section*), defines a decay function that is one of the following function types:

- Linear
- Exponential
- Sine
- Sine Squared

These function types may be helpful in fine tuning the FPS operation of your laser system. For most applications, the linear function is recommended.

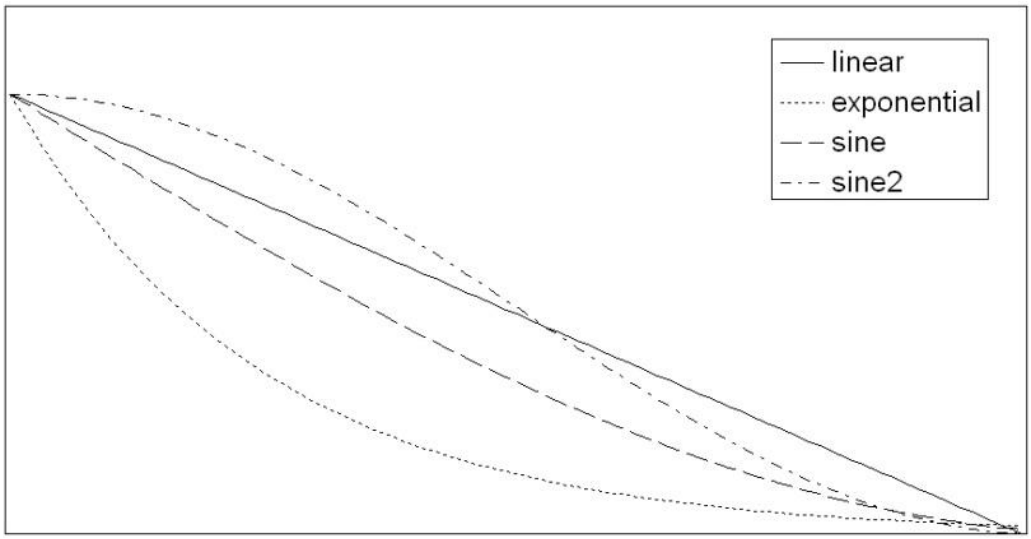

Figure 3-13. FPS Modulation Types

Connecting an External Q-Switch Driver

The eDrive provides an interface to support connection of an external Q-switch driver. This external driver may be an AO driver, an electro optical driver, or a driver or controller of another type.

There are five signals in this interface. (Refer to the *Q-switch Driver section* in *Appendix B: Connector Interfaces* for a signal description.) This interface provides the enable, trigger, first pulse suppression, and reset signals that are needed by a typical external device in order to Q-switch a laser. Consult the factory for details on connecting your specific Q-switch device.

Laser Humidity Sensor

The eDrive receives signals from the laser humidity sensor. If the measured humidity level exceeds the humidity threshold set point the eDrive will begin to beep and display a message on the front panel display every minute until the user pushes the acknowledge button. The message alerts the user that the humidity threshold has been exceeded and to change the desiccant. The warning will continue every two hours until the humidity level drops below the humidity threshold set point. The humidity warning can be disabled by setting the threshold to 101 percent as discussed in the *Utility Function* section of *Chapter 6: User Interface Reference*.

Internal TEC Controller

The eDrive includes an option for a bidirectional, H-bridge controller designed to control thermoelectric modules. These modules are typically used to regulate the operating temperature of a second harmonic generator within a laser. This controller provides the high set point accuracy and temperature control stability needed in a high performance laser system.

The electrical interface to the TEC controller is in the laser interface connector on the Rear Panel of the eDrive. In addition to the output connections, this interface accepts a thermistor temperature sensor input.

The output drive from the internal controller is pulse width modulated for high efficiency. The internal TEC controller maximum output power is 50 W. Output voltage level is user controlled via the front panel menus in the range of 3.5 V to 20 V. The controller utilizes a proportional-integral-derivative PID control function for high set point accuracy and minimum temperature over-shoot.

All operating points and fault conditions are accessible to the user via front panel menus. Settable parameters include temperature set point, temperature tolerance, maximum output voltage, operating mode, high and low temperature faults, and P-I-D tuning parameters. The table below lists important capabilities of the TEC controller.

Table 3-1. Internal TEC Controller Capabilities

Parameters	Performance	Comments
Temperature Range	-20 °C to +100 °C	0.1 °C Resolution
Temperature Tolerance	0.1 °C or larger	
Output Voltage Range	±3.5 V to ±20 V	Peak Output Voltage
Output Current	±7.0 A	Peak Load Current
Maximum Power Output	50 W	Maximum Average Power
Temperature Fault Range	-20 °C to +100 °C	High and Low Latching Faults
Operating Modes	Bi-directional, Heating, Cooling	
P-I-D Tuning Controls	User Adjustable	
Temperature Sensor	5k, 10k, 15k, 50k @ 25 °C	User Selectable

4

Chapter 4: Application Examples

This chapter describes applications demonstrating how to implement your eDrive in various laser system configurations:

- Controlling an eDrive with a computer
- Configuring a laser system to work with eDrive

Controlling an eDrive with a Computer

The eDrive has built-in remote control capability using the serial ports or Ethernet interface. Custom software, such as LabVIEW, Active-X, and DCOM Modbus drivers can be used to communicate with the eDrive.

Using the Serial Port

To set up an automated control system with a local PC using the serial port, connect the eDrive to the serial port on the PC using a standard male-to-female 9-pin serial cable (see part number 88-019-10 in *Appendix C: Accessories*).For details on the protocol, refer to *Chapter 5: Communications*. For details on setting the serial port configuration, refer to *Chapter 6: User Interface Reference*.

When setting up the system, consider using the loop-back mode of the eDrive serial port to verify proper hardware setup. In this mode, the eDrive serial port simply echoes all data it receives. This can be helpful in determining that you have connected the serial link properly and eliminates the added layer of complexity that the communications protocol requires.

Using the Ethernet Interface

To set up an automated control system with a networked PC using the Ethernet interface, connect the eDrive to the network using a standard Ethernet cable, type EIA/TIA-568A (see part number 88-019-10 in *Appendix C: Accessories*). Connect the eDrive to the network just as you would a PC using a hub or switch. For details on setting the Ethernet interface configuration, refer to *Chapter 6: User Interface Reference*.

NOTE: It is possible to connect the eDrive to a PC directly using Ethernet but you will require a special cross-over cable.

When using an Ethernet interface, you must have an IP address available for the eDrive. This can be assigned automatically by a DHCP server on the network or you may assign one manually. You will need to have an IP address and subnet mask for the eDrive and a gateway address. Check with your network administrator for help with these parameters.

When the eDrive is setup on the network as a node configured for DHCP, and if your DHCP server supports network node naming using DHCP Options 12 and 15, then the eDrive will request and use a network name. This network name is formed by joining the string “edrive” with the three-digit eDrive address set in the Ethernet Setup Menu. For example, if you set the Ethernet address with the “Set Address” option (not to be confused with the “Set IP Address” option) to a value of “5”, then the network name would be “edrive005”.

To test the network connection to the eDrive, select **Utility Functions ▸ System Status ▸ Sys Ctrl**. Select **-More-** until the assigned DHCP address is revealed. Record this address for reference.

At the computer command shell, type:

```
ping –a <ip_addr>
```

where <ip_addr> is the DHCP-assigned address recorded above. If the ping command indicates replies have been received, then the connection is validated.

If your DHCP server provides the network name function support, and if you have set the channel address, then you also may be able to type:

```
ping –a edrive<addr>
```

where <addr> is the address set as described above.

The listing below shows an example session. As you can see in the listing, the DHCP server has assigned a network name of "edrive005.domain.com" to the eDrive.

```
C:\>ping -n 1 -w 20 -a 192.168.1.34
Pinging edrive005.domain.com [192.168.1.34] with 32 bytes
of data:
Reply from 192.168.1.34: bytes=32 time=6ms TTL=255
Ping statistics for 192.168.1.34:
Packets: Sent = 1, Received = 1, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
     Minimum = 6ms, Maximum = 6ms, Average = 6ms
```

Configuring a Laser to Work with eDrive

The eDrive provides several interfaces to support a laser.

eDrive

The standard eDrive has a connector labeled “External Sensors”, which includes laser on light and shutter enable output signals. Both signals can directly drive up to 1 A. Figure 4-1 shows an external circuit configuration.

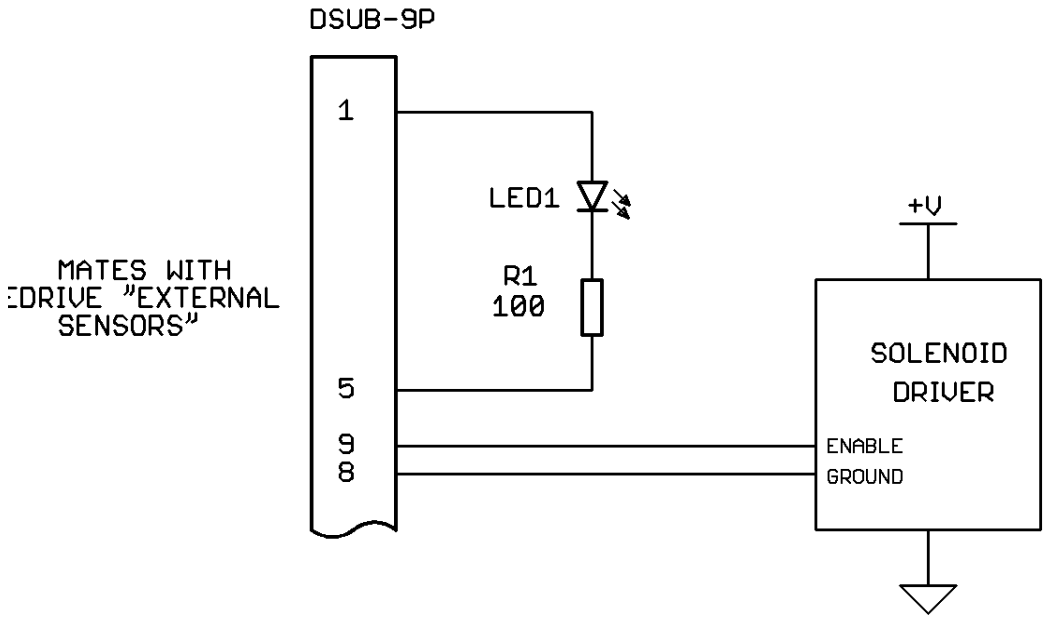

Figure 4-1. Laser Configuration for eDrive

eDrive Nitro and Aero

The eDrive Nitro and Aero have a laser interface connector. This interface provides numerous signal features for interfacing with your laser. Refer to *Appendix B: Connector Interfaces* for more details on each signal. Figure 4-2 illustrates an external circuit configuration.

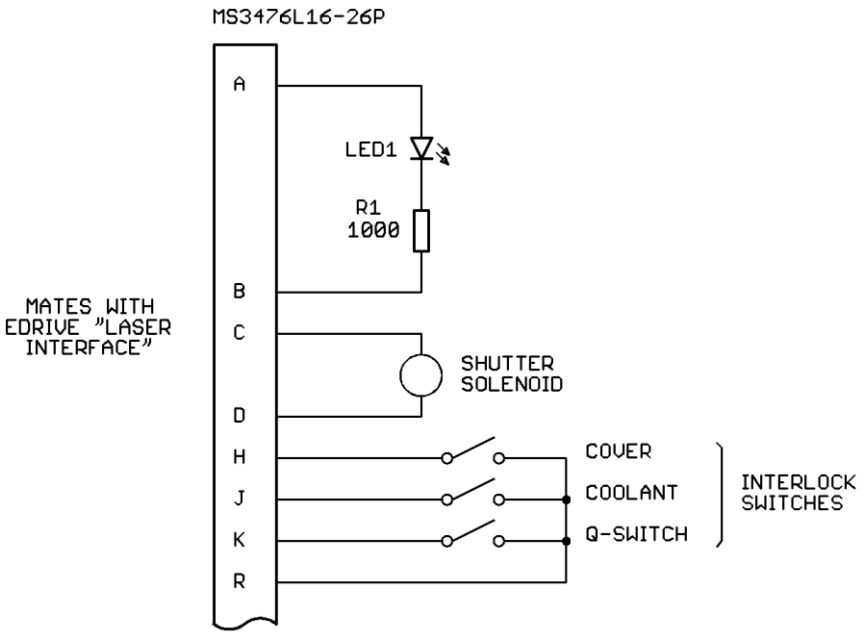

Figure 4-2. Laser Configuration for eDrive Nitro and Aero

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Chapter 5: Communications

This chapter contains information that you need to set up a communications link for remote control of your eDrive:

- Overview
- Configuring serial ports
- Message framing and errors
- Configuring Ethernet ports
- Function description, errors and responses
- Data types accessible by function

Overview

The eDrive can interface with a host computer or controller using serial or Ethernet communications. The eDrive acts as a slave in a master-slave communications scheme.

With serial communications, the eDrive can connect to the host point-to-point using an RS-232 serial link or can be part of a multi-drop network using an RS-485 serial link. For RS-232 communications with a standard PC serial port, use a straight-through, male-to-female serial cable. See *Appendix C: Accessories* for ordering information.

With Ethernet communications, the eDrive can connect to a local area network using a standard Ethernet cable and networking equipment like a hub or switch, or can connect directly to a host network card using a special network cable.

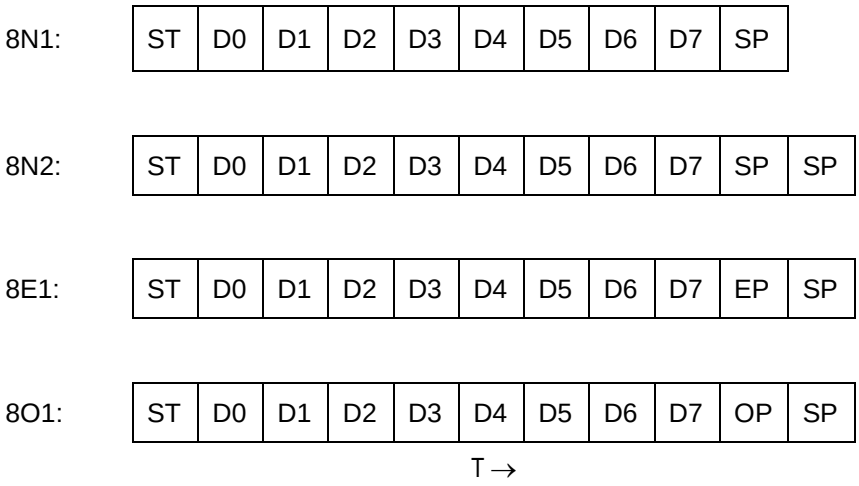
The communications protocol supported on the standard eDrive is based on Modbus, an industry standard for automated equipment. For RS-232 or RS-485 interfacing, the Modbus RTU format is used. For Ethernet interfacing, Modbus TCP format is used.

Since the host is the master in the system, it initiates all messages. The eDrive responds by taking the appropriate action and returning the requested data. With serial communications, the master can address individual slaves or can initiate a broadcast message to all devices on the link. Slaves respond to messages sent directly to them.

Configuring Serial Ports

The serial communications parameters can be set using the front panel interface. Refer to *Chapter 6: User Interface Reference* to set the serial parameters. Serial formats allowed for communications include 8N1, 8N2, 8E1, 8O1.

Data is transferred bit-wise serial with the following formats:



ST = STart bit, Dx = Data bit, SP = StoP bit, EP = Even Parity bit, OP = Odd Parity bit

Figure 5-1. Bit-Wise Serial Formats

Message Framing and Errors

This section describes the message framing of the protocol when using the serial port as the communications channel.

Message Start. Messages start with a silent interval of at least 3.5 character times. This is most easily implemented as a multiple of character times at the baud rate that is being used on the network.

Device Address. The first byte transmitted is the device address. Valid slave device addresses are in the range [0..247] decimal. The individual slave devices are assigned addresses in the range of [1..247]. When the slave sends its response, it places its own address in this address field of the response to let the master know which slave is responding. Address 0 is used for the broadcast address, which all slave devices recognize. This field must match the eDrive address assigned with the front panel. Select **Comm Setup ▸ Rs-232 Channel ? Setup ▸ Set Address** (where ? is either 0 or 1).

Function Number. The second byte transmitted is the function number. Valid codes are in the range [1..255] decimal but not all function numbers are used.

Data. The next group of bytes is the data field. The length of this field is dependent on the function number.

Checksum. The last two bytes are the checksum of the message. The error check value is the result of a cyclical redundancy check (CRC) calculation performed on the message contents. These two bytes contain a 16–bit value transmitted as two 8-bit bytes, the least significant byte (LSB) of the CRC is appended first, followed by the most significant byte (MSB). CRC generation is described in *Appendix E: CRC Calculations.*

Message End. Following the last transmitted character, a similar interval of at least 3.5 character times marks the end of the message. This interval can overlap with the silent interval of the next message.

A message frame is shown in Figure 5-2.

Message Start	Address	Function	Data	Checksum	Message Stop
> 3.5 char times	1 byte	1 byte	n bytes	2 bytes	> 3.5 char times
T →					

Figure 5-2. Message Frame

Serial Framing Errors

The entire message frame must be transmitted as a continuous stream. If a silent interval of more than 3.5 character times occurs before completion of the frame, the eDrive flushes the incomplete message and assumes that the next byte will be the address field of a new message.

If a new message begins before 3.5 character times following the previous message, the eDrive will consider it a continuation of the previous message. This will send an error since the value in the final CRC field will not be valid for the combined messages.

If the eDrive detects a transmission error, the message will not be acted upon. The eDrive will not construct a response to the master. Thus the timeout will expire and allow the master to handle the error.

NOTE: A message addressed to a nonexistent slave device will also cause a timeout.

Ethernet Port Configuration

The Ethernet communications parameters can be set using the front panel interface. Refer to the *Chapter 6: User Interface* Reference to set the Ethernet parameters.

DHCP

Most Ethernet network installations include a DHCP server. This server will dynamically assign IP addresses to machines on the network that request them. If you want your eDrive to request an IP address from the DHCP server and configure its own network parameters, enable the DHCP function.

Once the DHCP function has been enabled and an IP address is assigned by the server, you can discover the IP address by using the front panel. From the main menu, select **Utility Functions ▸ System Status ▸ Sys Ctrl** then select **-More-** repeatedly until the IP address is displayed.

TCP/IP Address, Subnet Mask, and Gateway Address

If you wish to set your own TCP/IP network parameters, contact your system administrator for guidance on selecting the appropriate parameters.

Configuring Ethernet Ports

This section describes the message framing, or encapsulation, of the control protocol when using the Ethernet port as the communications channel. The first part of the message is referred to as the Modbus application protocol header (MBAP), and includes four fields: transaction identifier, protocol identifier, length, and unit identifier. Refer to your Modbus specifications for a full description of the protocol.

Transaction Identifier. This field is used for transaction pairing and consists of two bytes. Since the message may be split over several TCP/IP packets, this field helps to reconstruct the packets into the correct order.

Protocol Identifier. This field is used to identify the protocol as Modbus and consists of two bytes. It is always set to 0 x 0000.

Length. This field is used to indicate the length of the message and consists of two bytes. It is a byte count of all of the following fields including the unit identifier, function code, and data.

Unit Identifier. This byte is the eDrive device address. Valid slave device addresses are in the range [0..247] decimal. The individual slave devices are assigned addresses in the range of [1..247]. This field must match the eDrive address assigned with the front panel. Select **Comm Setup ▸ Ethernet Setup ▸ Set Address.**

Function Number. This field is the function number and consists of one byte. Valid codes are in the range [1..255] decimal but not all function numbers are used.

Data. This field contains all the data for the message. The length of this field is dependent on the function number.

A message frame is shown in Figure 5-3.

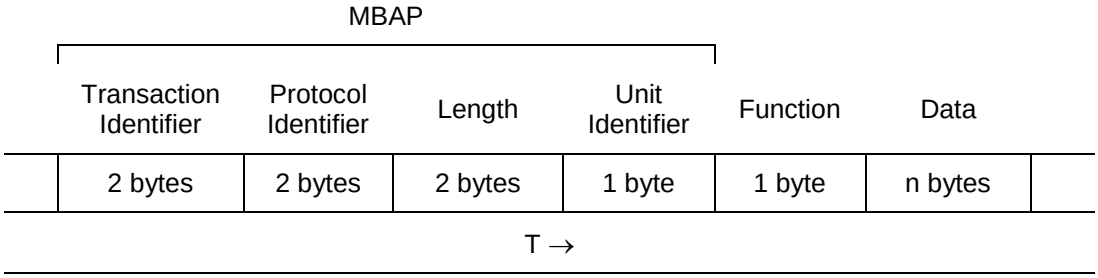


Figure 5-3. Message Frame for Ethernet Communications

Function Description, Errors and Responses

The following functions are identified in the Modbus standard for communications between the master and slave devices. In each case, the query and response is shown for the serial communications method. In general, to reformat for Ethernet communications,

1. The CRC field can be discarded
2. The address field is inserted into the unit identifier byte, which is the last byte of the MBAP.
3. The function field is inserted into the function field
4. The remaining portion of the message is inserted into the data field.

For details on the Modbus TCP query-response, please refer to the Modbus specifications and the Modbus Messaging Implementation Guide available from www.modbus.org.

Function 01: Read Output Bits

This function reads the on and off status of discrete outputs in the eDrive. Broadcast is not supported. This function accesses read and write bits described later in this chapter.

Query

The format of the query is:

Address	Function	Bit Start Address	Bit Count	CRC
1 byte	0x01	2 bytes	2 bytes	2 bytes

The query message specifies the starting bit and number of bits to be read. The bit start address is the address of the first bit to be read. The bit count is the total number of bits to be read. The bit address and bit count are transmitted MSB first.

Response

The format of the response is:

Address	Function	Byte Count	Bit Data	CRC
1 byte	0x01	1 byte	n bytes	2 bytes

The response contains the bit status of the requested bits packed into bytes. The byte count indicated how many packed bytes are being returned.

The packed bits are transmitted as [n+7..n], [n+15..n+8], [n+23..n+16], etc., where n is the address of the starting bit address contained in the query.

Function 02: Read Input Bits

This function reads the on and off status of discrete inputs in the eDrive. Broadcast is not supported. This function accesses read-only bits described later in this chapter.

Query

The format of the query is:

Address	Function	Bit Start Address	Bit Count	CRC
1 byte	0x02	2 bytes	2 bytes	2 bytes

The query message specifies the starting bit and number of bits to be read. The bit start address is the address of the first bit to be read. The bit count is the total number of bits to be read. The bit address and bit count are transmitted MSB first.

Response

The format of the response is:

Address	Function	Byte Count	Bit Data	CRC
1 byte	0x02	1 byte	n bytes	2 bytes

The response contains the bit status of the requested bits packed into bytes. The byte count indicated how many packed bytes are being returned.

The packed bits are transmitted as [n+7..n], [n+15..n+8], [n+23..n+16], etc., where n is the address of the starting bit address contained in the query.

Function 03: Read Holding Registers

This function reads the contents of holding registers in the eDrive. Broadcast is not supported. This function accesses read and write registers described later in this chapter.

Query

The format of the query is:

Address	Function	Reg Start Address	Reg Count	CRC
1 byte	0x03	2 bytes	2 bytes	2 bytes

The query message specifies the starting register and number of registers to be read. The register start address is the address of the first register to be read. The register count is the total number of registers to be read. The register address and register count are transmitted MSB first.

Response

The format of the response is:

Address	Function	Byte Count	Reg Data	CRC
1 byte	0x03	1 byte	2n bytes	2 bytes

Each register is a 2-byte word. For each register, the first byte contains the high order bits and the second byte contains the low order bits. If the value stored in the register is represented by less than 16 bits, the data is right justified within the 16 bits of the register.

The data for each 2-byte register is transmitted high byte first and low byte second.

Function 04: Read Input Registers

This function reads the contents of input registers in the eDrive. Broadcast is not supported. This function accesses read-only registers described later in this chapter.

Query

The format of the query is:

Address	Function	Reg Start Address	Reg Count	CRC
1 byte	0x04	2 bytes	2 bytes	2 bytes

The query message specifies the starting register and number of registers to be read. The register start address is the address of the first register to be read. The register count is the total number of registers to be read. The register address and register count are transmitted MSB first.

Response

The format of the response is:

Address	Function	Byte Count	Reg Data	CRC
1 byte	0x04	1 byte	2n bytes	2 bytes

Each register is a 2-byte word. For each register, the first byte contains the high order bits and the second byte contains the low order bits. If the value stored in the register is represented by less than 16 bits, the data is right justified within the 16 bits of the register.

The data for each 2-byte register is transmitted high byte first and low byte second.

Function 05: Write Output Bit

This function writes the status of an output bit in the eDrive to **ON** or **OFF**. Broadcast is supported. When broadcast, the function writes the same addressed bit in all attached eDrives. This function accesses read and write bits described later in this chapter.

Query

The format of the query is:

Address	Function	Bit Address	Value	CRC
1 byte	0x05	2 bytes	2 bytes	2 bytes

The query message specifies the bit address and the value to be written to that bit address. Transmitting a value of 0x0000 will set the bit to off and transmitting a value of 0xFF00 will set the bit to on. The bit address and value are transmitted MSB first.

Response

The response is a duplicate of the query message which will be transmitted after the command has been successfully executed.

Function 06: Write Single Holding Register

This function writes the contents of a single holding register in the eDrive. When broadcast, the function writes the same addressed register in all attached eDrives. This function accesses read and write registers described later in this chapter.

Query

The format of the query is:

Address	Function	Reg Address	Reg Data	CRC
1 byte	0x06	2 bytes	2 bytes	2 bytes

The query message specifies the register address and the value written to that register address. The register address and value are transmitted MSB first.

Response

The response is a duplicate of the query message, which is transmitted after the command has been successfully executed.

Function 11: Read Communications Status

This function reads the status of the communications channel in the eDrive. The master device can determine whether the messages were handled normally by the eDrive by reading the count before and after a series of messages. The eDrive's event counter is incremented once for each successful message completion. Broadcast is not supported.

Query

The format of the query is:

Address	Function	CRC
1 byte	0x0B	2 bytes

Response

The format of the response is:

Address	Function	Status	Count	CRC
1 byte	0x0B	2 byte	2 bytes	2 bytes

The normal response contains a 2-byte status word, and a 2-byte event count. The status word will be 0xFFFF if a command issued previously is still being processed by the eDrive (a busy condition exists). Otherwise, the status word will be 0x0000.

The count value will indicate how many messages have been processed by the eDrive. The counter rolls back to 0 after 65,536 messages.

The data for each 2-byte value is transmitted high byte first and low byte second.

Function 16: Write Multiple Holding Registers

This function writes the contents of multiple holding registers in the eDrive. When broadcast, the function writes the same addressed register in all attached eDrives. This function accesses read and write registers described later in this chapter.

Query

The format of the query is:

Address	Function	Reg Start Address	Reg Count	Byte Count	Reg Data	CRC
1 byte	0x10	2 bytes	2 bytes	1 byte	2n bytes	2 bytes

The query message specifies the starting register address, the register count, the byte count, which is redundant, and the values to be written to each register addressed. All fields are transmitted MSB first.

Response

The format of the response is:

Address	Function	Reg Start Address	Reg Count	CRC
1 byte	0x10	2 bytes	2 bytes	2 bytes

The normal response returns the slave address, function code, starting address, and quantity of registers preset.

Data Types Accessible by Function

Read/Write Bits

Table 5-1 lists all read and write bits defined in the eDrive. Any bit addresses that are not in the list are reserved and should not be used. These data elements are accessible using Functions 01 and 05.

Table 5-1. Read and Write Bits Accessible Using Functions 01 and 05

Name	Addr	Description
Emission	0	OFF = Laser emission off ON = laser emission o
Enable Standby	1	OFF = The standby state is inactive ON = The standby state is active Commanding emission to OFF will reset this bit
External Trigger	2	OFF = The eDrive will run on internal triggering from the Timing Engine ON = The eDrive will run on external triggering using the Trigger/Gate input
Internal Trigger Gating	3	OFF = The internal trigger is free-running ON = The Trigger/Gate input will be used to gate the internally generated trigger pulses
Shutter	4	OFF = The shutter is always closed ON = The shutter opens when emission is active
Clear Fault	5	Set this bit to clear existing eDrive faults.
QSW Enable	6	OFF = RF AO Q-switch driver is disabled ON = RF AO Q-switch driver is enabled
FPS Enable	7	OFF = Q-switch FPS is disabled ON = Q-switch FPS is enabled
FPS PPK Enable	8	OFF = Q-switch FPS PPK is disabled ON = Q-switch FPS PPK is enabled
Shutter FPS Enable	9	OFF = Shutter FPS is disabled ON = Shutter FPS is enabled

Name	Addr	Description
Marking Mode Trigger	10	OFF = Marking mode trigger coil is disabled ON = Marking mode trigger coil is enabled
Front Panel Locked Out	11	OFF = Front panel access is locked out ON = Front panel access is unlocked
TEC Enable	12	Available only in manufacturing mode
	13	
	14	
	15	
Channel 1 Enable	16	OFF = Channel 1 AIM is disabled ON = Channel 1 AIM is enabled
Channel 1 Mode	17	OFF = QCW (pulsed) operation is selected ON = CW operation is selected Note: This bit can only be changed when the eDrive is not active and Channel 1 is disabled on models equipped with QCW only.
Channel 1 Ramp Control	18	OFF = Disable current ramping for Channel 1 ON = Enable current ramping for Channel 1
Channel 1 Slew Rate Control	19	OFF = Slew rate control is disabled ON = Slew rate control is enabled
Channel 1 Current TOL Enable	20	OFF = Channel 1 current tolerance is disabled ON = Channel 1 current tolerance is enabled
Channel 2 Enable	24	OFF = Channel 2 AIM is disabled ON = Channel 2 AIM is enabled
Channel 2 Mode	25	OFF = QCW (pulsed) operation is selected ON = CW operation is selected Note: This bit can only be changed when the eDrive is not active and Channel 1 is disabled on models equipped with QCW only.

Name	Addr	Description
Channel 2 Ramp Control	26	OFF = Disable current ramping for Channel 2 ON = Enable current ramping for Channel 2
Channel 2 Slew Rate Control	27	OFF = Slew rate control is disabled ON = Slew rate control is enabled
Channel 2 Current TOL Enable	28	OFF = Channel 2 current tolerance is disabled ON = Channel 2 current tolerance is enabled
Channel 3 Enable	32	OFF = Channel 3 AIM is disabled ON = Channel 3 AIM is enabled
Channel 3 Mode	33	OFF = QCW (pulsed) operation is selected ON = CW operation is selected Note: This bit can only be changed when the eDrive is not active and Channel 1 is disabled on models equipped with QCW only.
Channel 3 Ramp Control	34	OFF = Disable current ramping for Channel 3 ON = Enable current ramping for Channel 3
Channel 3 Slew Rate Control	35	OFF = Slew rate control is disabled ON = Slew rate control is enabled
Channel 3 Current TOL Enable	36	OFF = Channel 3 current tolerance is disabled ON = Channel 3 current tolerance is enabled
Channel COM0 Enable	40	OFF = COM0 AIM is disabled ON = COM0 AIM is enabled
Channel COM0 Slew Enable	41	OFF = Slew rate control is disabled ON = Slew rate control is enabled
Channel COM0 TEC Enable	42	OFF = TEC on COM0 is disabled ON = TEC on COM0 is enabled
Channel COM1 Enable	48	OFF = COM1 AIM is disabled ON = COM1 AIM is enabled

Name	Addr	Description
Channel COM1 Slew Enable	49	OFF = Slew rate control is disabled ON = Slew rate control is enabled
Channel COM1 TEC Enable	50	OFF = TEC on COM1 is disabled ON = TEC on COM1 is enabled
Channel RS485 Enable	56	OFF = Interface module on RS-485 is disabled ON = Interface module on RS-485 is enabled
Channel RS485 Slew Enable	57	OFF = Slew rate control is disabled ON = Slew rate control is enabled
	58	
	59	
	60	
	61	

Read-Only Bits

Table 5-2 lists all read-only bits defined in the eDrive. Any bit addresses that are not in the list are reserved and should not be used. These data elements are accessible using Function 02.

Table 5-2. Read-Only Bits Accessible Using Function 02

Name	Addr	Description
Fault State	0	OFF = The eDrive is not in the fault state ON = The eDrive is in the fault state
Off State	1	OFF = The eDrive is not in the off state ON = The eDrive is in the off state
Standby State	2	OFF = The eDrive is not in the standby state ON = The eDrive is in the standby state
Pre-Fire State	3	OFF = The eDrive is not in the pre-fire state ON = The eDrive is in the pre-fire state
Active State	4	OFF = The eDrive is not in the active state ON = The eDrive is in the active state
Channel 1 Present	5	OFF = Current control hardware for Channel 1 is not present ON = Current control hardware for Channel 1 is present
Channel 2 Present	6	OFF = Current control hardware for Channel 2 is not present ON = Current control hardware for Channel 2 is present
Channel 3 Present	7	OFF = Current control hardware for Channel 3 is not present ON = Current control hardware for Channel 3 is present
Chiller Flow Fault	8	OFF = The chiller does not have a flow fault ON = The chiller has a flow fault

Name	Addr	Description
Chiller Level Fault	9	OFF = The chiller does not have a level fault ON = The chiller has a level fault
Emergency Stop Fault	10	OFF = The emergency stop button is not pressed ON = The emergency stop button is pressed
Q-switch Fault	11	OFF = The QSW fault is not active ON = The QSW fault is active
Channel 1 Fault	12	OFF = Channel 1 does not have a fault ON = Channel 1 has a fault
Channel 2 Fault	13	OFF = Channel 2 does not have a fault ON = Channel 2 has a fault
Channel 3 Fault	14	OFF = Channel 3 does not have a fault ON = Channel 3 has a fault
Front Panel Fault	15	OFF = The front panel does not have a fault ON = The front panel has a fault
Laser Cover Interlock	16	OFF = The laser cover interlock is grounded ON = The laser cover interlock is open Note: Available on eDrive Nitro only.
Laser Coolant Flow Interlock	17	OFF = The laser system coolant flow interlock is grounded ON = The laser system coolant flow interlock is open Note: Available on eDrive Nitro only.
Q-Switch Thermal Interlock	18	OFF = The Q-switch thermal interlock is grounded ON = The Q-switch thermal interlock is open Note: Available on eDrive Nitro only.

Name	Addr	Description
Q-Switch Driver Thermal Fault	19	OFF = The internal Q-switch RF driver is operating within safe temperature range ON = The internal Q-switch RF driver has an over temperature fault Note: Available on eDrive Nitro only.
Q-Switch Crystal Thermal Interlock	20	OFF = The Q-switch thermal BNC interlock is shorted (safe) ON = The Q-switch thermal BNC interlock is open (faulted) Note: Available on eDrive Nitro only.
Q-Switch HVSWR Fault	21	OFF = The internal Q-switch RF driver does not have an high-voltage standing-wave ratio (HVSWR) fault ON = The internal Q-switch RF driver has an HVSWR fault Note: Available on eDrive Nitro only.
Q-Switch High Power Fault	22	OFF = The internal Q-switch RF driver does not have a high-power fault ON = The internal Q-switch RF driver has a high power fault Note: Available on eDrive Nitro only.
Laser Shutter State	23	OFF = The shutter output is not energized ON = The shutter output is energized
TEC Present	24	OFF = Internal TEC controller is disabled ON = Internal TEC controller is enabled
TEC Fault	25	OFF = Internal TEC does not have a fault ON = Internal TEC has a fault
TEC Tolerance Fault	26	OFF = Internal TEC tolerance does not have a fault ON = Internal TEC tolerance has a fault
TEC COMM Fault	27	OFF = Internal TEC does not have a communication fault ON = Internal TEC has a communication fault

Name	Addr	Description
Shutter InterlockStatus	28	OFF = The shutter interlock is open ON = The shutter interlock is grounded
TEC Open RTD Fault	29	OFF = Internal TEC does not have an open RTD fault ON = Internal TEC tolerance has an open RTD fault
TEC Over Heat Fault	30	OFF = Internal TEC does not have a heat fault ON = Internal TEC has a heat fault
TEC Under Voltage Fault	31	OFF = Internal TEC does not have a under voltage fault ON = Internal TEC has an under voltage fault
Channel 1 Off State	32	OFF = Channel 1 is not in the off state ON = Channel 1 is in the off state
Channel 1 Standby	33	OFF = Channel 1 is not in the standby state ON = Channel 1 is in the standby state
Channel 1 Active	34	OFF = Channel 1 is not in the active state ON = Channel 1 is in the active state
Channel 1 Fault State	35	OFF = Channel 1 is not in the fault state ON = Channel 1 is in the fault state
Channel 1 State Mismatch Fault	36	OFF = Channel 1 state does not have a fault ON = Channel 1 state has a fault
Channel 1 COMM Fault	37	OFF = Channel 1 processor communication is good ON = Channel 1 processor stopped communicating with the system
Channel 1 Hardware Fault	38	OFF = Channel 1 does not have a hardware fault ON = Channel 1 has a hardware fault
Channel 1 E-Stop Fault	39	OFF = Channel 1 is not on the emergency stop state ON = Channel 1 is on the emergency stop state

Name	Addr	Description
Channel 1 COMM Timeout Fault	40	OFF = Channel 1 processor communication is good ON = Channel 1 has a fault due to slow communications
Channel 1 Interlock Fault	41	OFF = Channel 1 does not have an interlock fault ON = Channel 1 has an interlock fault
Channel 1 Temp Fault	42	OFF = Channel 1 does not have a temperature fault ON = Channel 1 has a temperature fault
Channel 1 Over Current Fault	43	OFF = Channel 1 does not have an over current fault ON = Channel 1 has an over current fault
Channel 1 Low Voltage Fault	44	OFF = Channel 1 does not have a low voltage fault ON = Channel 1 has a low voltage fault
Channel 1 Current Tolerance Fault	45	OFF = Channel 1 does not have a current tolerance fault ON = Channel 1 has a current tolerance fault
Over Frequency Fault	46	OFF = Channel 1 does not have an over frequency fault ON = Channel 1 has an over frequency fault
Channel 2 Off State	48	OFF = Channel 2 is not in the off state ON = Channel 2 is in the off state
Channel 2 Standby	49	OFF = Channel 2 is not in the standby state ON = Channel 2 is in the standby state
Channel 2 Active	50	OFF = Channel 2 is not in the active state ON = Channel 2 is in the active state
Channel 2 Fault State	51	OFF = Channel 2 is not in the fault state ON = Channel 2 is in the fault state

Name	Addr	Description
Channel 2 State Mismatch Fault	52	OFF = Channel 2 state does not have a fault ON = Channel 2 state has a fault
Channel 2 COMM Fault	53	OFF = Channel 2 processor communication is good ON = Channel 2 processor stopped communicating with the system
Channel 2 Hardware Fault	54	OFF = Channel 2 does not have a hardware fault ON = Channel 2 has a hardware fault
Channel 2 E-Stop Fault	55	OFF = Channel 2 is not on the emergency stop state ON = Channel 2 is on the emergency stop state
Channel 2 COMM Timeout Fault	56	OFF = Channel 2 processor communication is good ON = Channel 2 has a fault due to slow communications
Channel 2 Interlock Fault	57	OFF = Channel 2 does not have an interlock fault ON = Channel 2 has an interlock fault
Channel 2 Temp Fault	58	OFF = Channel 2 does not have a temperature fault ON = Channel 2 has a temperature fault
Channel 2 Over Current Fault	59	OFF = Channel 2 does not have an over current fault ON = Channel 2 has an over current fault
Channel 2 Low Voltage Fault	60	OFF = Channel 2 does not have a low voltage fault ON = Channel 2 has a low voltage fault
Channel 2 Current Tolerance Fault	61	OFF = Channel 2 does not have a current tolerance fault ON = Channel 2 has a current tolerance fault
Channel 3 Off State	64	OFF = Channel 3 is not in the off state ON = Channel 3 is in the off state

Name	Addr	Description
Channel 3 Standby	65	OFF = Channel 3 is not in the standby state ON = Channel 3 is in the standby state
Channel 3 Active	66	OFF = Channel 3 is not in the active state ON = Channel 3 is in the active state
Channel 3 Fault State	67	OFF = Channel 3 is not in the fault state ON = Channel 3 is in the fault state
Channel 3 State Mismatch Fault	68	OFF = Channel 3 state does not have a fault ON = Channel 3 state has a fault
Channel 3 COMM Fault	69	OFF = Channel 3 processor communication is good ON = Channel 3 processor stopped communicating with the system
Channel 3 Hardware Fault	70	OFF = Channel 3 does not have a hardware fault ON = Channel 3 has a hardware fault
Channel 3 E-Stop Fault	71	OFF = Channel 3 is not on the emergency stop state ON = Channel 3 is on the emergency stop state
Channel 3 COMM Timeout Fault	72	OFF = Channel 3 processor communication is good ON = Channel 3 has a fault due to slow communications
Channel 3 Interlock Fault	73	OFF = Channel 3 does not have an interlock fault ON = Channel 3 has an interlock fault
Channel 3 Temp Fault	74	OFF = Channel 3 does not have a temperature fault ON = Channel 3 has a temperature fault
Channel 3 Over Current Fault	75	OFF = Channel 3 does not have an over current fault ON = Channel 3 has an over current fault

Name	Addr	Description
Channel 3 Low Voltage Fault	76	OFF = Channel 3 does not have a low voltage fault ON = Channel 3 has a low voltage fault
Channel 3 Current Tolerance Fault	77	OFF = Channel 3 does not have a current tolerance fault ON = Channel 3 has a current tolerance fault
Channel COM0 Off State	80	OFF = Channel COM0 is not in an off state ON = Channel COM0 is in an off state
Channel COM0 Standby State	81	OFF = Channel COM0 is not in a standby state ON = Channel COM0 is in a standby state
Channel COM0 Active State	82	OFF = Channel COM0 is not in an active state ON = Channel COM0 is in an active state
Channel COM0 Fault State	83	OFF = Channel COM0 does not have a fault ON = Channel COM0 has a fault
Channel COM0 COMM Fault	84	OFF = Channel COM0 does not have a COMM fault ON = Channel COM0 has a COMM fault
Channel COM0 Hardware Fault	85	OFF = Channel COM0 does not have a hardware fault ON = Channel COM0 has a hardware fault
Channel COM0 Temp Fault	86	OFF = Channel COM0 does not have a temperature fault ON = Channel COM0 has a temperature fault
Channel COM0 TEC Fault	87	OFF = Channel COM0 does not have a TEC fault ON = Channel COM0 has a TEC fault

Name	Addr	Description
Channel COM0 TEC COMM Fault	88	OFF = Channel COM0 does not have a TEC communication fault ON = Channel COM0 has a TEC communication fault
Channel COM0 TEC Tolerance Fault	89	OFF = Channel COM0 does not have a TEC tolerance fault ON = Channel COM0 has a TEC tolerance fault
Channel COM0 TEC Open RTD Fault	91	OFF = Channel COM0 does not have a TEC open RTD fault ON = Channel COM0 has a TEC open RTD fault
Channel COM1 Off State	96	OFF = Channel COM1 is not in an off state ON = Channel COM1 is in an off state
Channel COM1 Standby State	97	OFF = Channel COM1 is not in a standby state ON = Channel COM1 is in a standby state
Channel COM1 Active State	98	OFF = Channel COM1 is not in an active state ON = Channel COM01 is in an active state
Channel COM1 Fault State	99	OFF = Channel COM1 does not have a fault ON = Channel COM1 has a fault
Channel COM1 COMM Fault	100	OFF = Channel COM1 does not have a COMM fault ON = Channel COM1 has a COMM fault
Channel COM1 Hardware Fault	101	OFF = Channel COM1 does not have a hardware fault ON = Channel COM1 has a hardware fault
Channel COM1 Temp Fault	102	OFF = Channel COM1 does not have a temperature fault ON = Channel COM1 has a temperature fault

Name	Addr	Description
Channel COM1 TEC Fault	103	OFF = Channel COM1 does not have a TEC fault ON = Channel COM1 has a TEC fault
Channel COM1 TEC COMM Fault	104	OFF = Channel COM1 does not have a TEC communication fault ON = Channel COM1 has a TEC communication fault
Channel COM1 TEC Tolerance Fault	105	OFF = Channel COM1 does not have a TEC tolerance fault ON = Channel COM1 has a TEC tolerance fault
Channel COM1 TEC Open RTD Fault	107	OFF = Channel COM1 does not have a TEC open RTD fault ON = Channel COM1 has a TEC open RTD fault
Channel RS485 Off State	112	OFF = Channel RS-485 is not in an off state ON = Channel RS-485 is in an off state
Channel RS485 Standby State	113	OFF = Channel RS-485 is not in a standby state ON = Channel RS-485 is in a standby state
Channel RS485 Active State	114	OFF = Channel RS-485 is not in an active state ON = Channel RS-485 is in an active state
Channel RS485 Fault State	115	OFF = Channel RS-485 does not have a fault ON = Channel RS-485 has a fault
Channel RS485 COMM Fault	116	OFF = Channel RS-485 does not have a communications fault ON = Channel RS-485 has a communications fault
Channel RS485 Hardware Fault	117	OFF = Channel RS-485 does not have a hardware fault ON = Channel RS-485 has a hardware fault

Name	Addr	Description
Channel RS485 Temp Fault	118	OFF = Channel RS-485 does not have a temperature fault ON = Channel RS-485 has a temperature fault

Read/Write Registers

Table 5-3 lists all read and write registers defined in the eDrive. Any register addresses that are not in the list are reserved and should not be used. These data elements are accessible using Functions 03, 06, and 16.

Table 5-3. Read/Write Registers Using Functions 03, 06, and 16

Name	Addr	Description
System Frequency	0	This value represents the frequency of the internal timing engine. If Channel 1 is in CW mode, this frequency is only used for Q-switch pulse generation. If Channel 1 is in QCW mode, this frequency is used for pulsing of Channel 1 and the Q-switch pulses are tied to the current pulse. Range: 2 to 100 kHz LSB value: 1 Hz
Q-Switch Pulse Width	1	This value represents the width of the Q-switch pulse in 0.01 μs increments. The eDrive rounds the value to the nearest 0.04 μs value. Range: 1 to 25,000 LSB value: 0.01 μs
Q-Switch Pulse Offset High	2	This value represents the timing offset of the Q-switch pulse relative to the end of the current pulse and is only valid when Channel 1 is in QCW mode. When the offset is zero, the Q-switch pulse will end at the same time the current pulse ends. A negative value moves the Q-switch pulse before the end of the current pulse. A positive number moves the Q-switch pulse after the end of current pulse. The eDrive rounds the value to the nearest 0.04 μs value. Range: -2,147,483,648 to 2,147,483,647 (limited by system frequency and pulse width) LSB value: 0.01 μs (This value is a signed 32-bit number. For this value to be properly written, write to the high word first, followed by the low word.)
Q-Switch Pulse Offset Low	3	
Q-Switch Power Output	4	This value represents the amount of RF attenuation imposed on the Q-switch driving signal during a Q-switch window. Range: 0 to 1,000 LSB value: 0.1 percent Note: Available on eDrive Nitro only.

Name	Addr	Description
Q-Switch FPS Start Power	5	This value represents the amount of RF attenuation imposed on the Q-switch driving signal at the beginning of a FPS event. Range: 0 to 1,000 LSB value: 0.1 percent Note: Available on eDrive Nitro only.
Q-Switch FPS Window Width	6	This value represents the duration of the Q-switch window. Range: 10 to 1,000 μs LSB value: 1 μs Note: Available on eDrive Nitro only.
Q-Switch FPS Window Type	7	This value represents the type of attenuation function imposed on the Q-switch driving signal during a Q-switch window. Refer to Operating Basics for details. Functions: 0 = Linear, 1 = Exponential, 2 = Sine, 3 = Sine Squared Note: Available on eDrive Nitro only.
Q-Switch FPS Delay High Q-Switch FPS Delay Low	8 9	This value represents the FPS delay setting. This value determines the period of inactivity before an FPS event is triggered upon restart of the pulses. Range: 10 μs to 500 μs LSB value: 1 μs (For this value to be properly written, write to the high word first, followed by the low word.)
Trigger Out CONFIG	10	0 = Trigger out mimics QSW HIGH pulse 1 = Trigger out mimics QSW HIGH pulse 2 = Trigger out sync on leading current pulse Note: Available in pulsed mode only.
Q-Switch FPS PPK Open Offset	11	Range: 0 μs to 5,000 μs LSB value: 1 μs
Q-Switch FPS PPK Closed Offset High	12	Range: 0 μs to 5,000 μs LSB value: 1 μs
Q-Switch FPS PPK Closed Offset Low	13	Range: 0 μs to 5,000 μs LSB value: 1 μs

Name	Addr	Description
Shutter Delay	14	Range: 0 μs to 500 ms LSB value: 1 μs
Over Frequency Limit	15	This value represents the maximum frequency allowed for the internal timing engine. Range: 2 to 100 kHz LSB value: 1 Hz
Channel 1 Active Current	16	Measured in amperes (A), this value represents the current level for Channel 1 when the eDrive is actively driving the array output in either CW or QCW modes. See standby current below. Range: 0 to 1,000 LSB value: 0.1 A
Channel 1 Standby Current	17	Measured in amperes (A), this value represents the current level for Channel 1 when the eDrive is in standby CW or QCW mode or during the inactive portion of the QCW pulse. Range: 0 to 1,000 LSB value: 0.1 A
Channel 1 Pulse Width High	18	This value represents the width of a current pulse for Channel 1. It is only used when the channel is in QCW mode. Range: 10 to 100,000 (limited by the system frequency to prevent the pulse width from exceeding the period) LSB value: 0.1 μs (For this value to be properly written, write to the high word first, followed by the low word.)
Channel 1 Pulse Width Low	19	
Channel 1 Pulse Delay High	20	This value represents the delay of the current pulse of Channel 1 relative to the trigger. It is only used when the channel is in QCW mode. Range: 1 to 100,000 LSB value: 1 μs When using internal triggering, the range is limited by the system frequency so the pulse ends before the start of the next trigger. When using external triggering, all external trigger events are ignored during an active pulse. (For this value to be properly written, write to the high word first, followed by the low word.)
Channel 1 Pulse Delay Low	21	

Name	Addr	Description
Channel 1 Slew Rate	22	This value represents the slew rate for Channel 1. Range: 1 to 3,000 LSB value: 1 A/s
Channel 2 Active Current	32	Measured in amperes (A), this value represents the current level for Channel 2 when the eDrive is actively driving the array output in either CW or QCW modes. See standby current below. Range: 0 to 1,000 LSB value: 0.1 A
Channel 2 Standby Current	33	Measured in amperes (A), this value represents the current level for Channel 2 when the eDrive is in standby CW or QCW mode or during the inactive portion of the QCW pulse. Range: 0 to 1,000 LSB value: 0.1 A
Channel 2 Pulse Width High Channel 2 Pulse Width Low	34 35	This value represents the width of a current pulse for Channel 2. It is only used when the channel is in QCW mode. Range: 10 to 100,000 (limited by the system frequency to prevent the pulse width from exceeding the period) LSB value: 0.1 μs (For this value to be properly written, write to the high word first, followed by the low word.)
Channel 2 Pulse Delay High Channel 2 Pulse Delay Low	36 37	This value represents the delay of the current pulse of Channel 2 relative to the trigger. It is only used when the channel is in QCW mode. Range: 1 to 100,000 LSB value: 1 μs When using internal triggering, the range is limited by the system frequency so the pulse ends before the start of the next trigger. When using external triggering, all external trigger events are ignored during an active pulse. (For this value to be properly written, write to the high word first, followed by the low word.)
Channel 2 Slew Rate	38	This value represents the slew rate for Channel 2. Range: 1 to 3,000 LSB value: 1 A/s

Name	Addr	Description
Channel 3 Active Current	48	Measured in amperes (A), this value represents the current level for Channel 3 when the eDrive is actively driving the array output in either CW or QCW modes. See standby current below. Range: 0 to 1,000 LSB value: 0.1 A
Channel 3 Standby Current	49	Measured in amperes (A), this value represents the current level for Channel 3 when the eDrive is in standby CW or QCW mode or during the inactive portion of the QCW pulse. Range: 0 to 1,000 LSB value: 0.1 A
Channel 3 Pulse Width High	50	This value represents the width of a current pulse for Channel 3. It is only used when the channel is in QCW mode. Range: 10 to 100,000 (limited by the system frequency to prevent the pulse width from exceeding the period) LSB value: 0.1 μs (For this value to be properly written, write to the high word first, followed by the low word.)
Channel 3 Pulse Width Low	51	
Channel 3 Pulse Delay High	52	This value represents the delay of the current pulse of Channel 3 relative to the trigger. It is only used when the channel is in QCW mode. Range: 1 to 100,000 LSB value: 1 μs When using internal triggering, the range is limited by the system frequency so the pulse ends before the start of the next trigger. When using external triggering, all external trigger events are ignored during an active pulse. (For this value to be properly written, write to the high word first, followed by the low word.)
Channel 3 Pulse Delay Low	53	
Channel 3 Slew Rate	54	This value represents the slew rate for Channel 3. Range: 1 to 3,000 LSB value: 1 A/s
Channel 3 Pulse Width Offset	55	This value represents the pulse width offset for Channel 3. Range: 0 to 50,000 LSB value: 100 ns

Name	Addr	Description
Channel 3 Voltage Dropout	56	This value represents the voltage dropout for Channel 3. Range: 0 to 3,000 LSB value: 0.1 V
Channel 3 Current Tolerance	57	This value represents the current tolerance for Channel 3. Range: 1 to 100 LSB value: 0.1 A
Channel 3 Slew rate Fine	58	This value represents the slew rate fine for Channel 3. Range: 1 to 500 LSB value: 1 A/s
Channel COM0 Active Current	64	This value represents the COM0 current setting, kept in 0.1 A increments.
Channel COM0 Standby Current	65	This value represents COM0 the standby current setting, kept in 0.1 A increments.
Channel COM0 Slew Rate	66	This value represents the slew rate for COM0. Range: to 3,000 LSB value: 1 A/s
Channel COM1 Active Current	72	This value represents the COM1 current setting, kept in 0.1 A increments.
Channel COM1 Standby Current	73	This value represents COM1 the standby current setting, kept in 0.1 A increments.
Channel COM1 Slew Rate	74	This value represents the slew rate for COM1. Range: 0.2 to 3,000 LSB value: 1 A/s
Channel RS485 Active Current	80	This value represents the RS-485 current setting, kept in 0.1 A increments.
Channel RS485 Standby Current	81	This value represents the RS-485 standby current setting, kept in 0.1 A increments.

Name	Addr	Description
Channel RS485 Slew Rate	82	This value represents the slew rate for the AIM on RS-485. Range: 1 to 3,000 LSB value: 1 A/s
TEC Temp Setting	88	This value represents the TEC temperature setting of the internal TEC. Range: -40.0 °C to 150.0 °C LSB value: 0.1 °C
TEC Volt Setting	89	This value represents the TEC voltage setting of the internal TEC. Range: 3.50 V to 20.00 V LSB value: 0.01 V
TEC Heat Side MULT	90	This value represents the TEC heat side multiplier of the internal TEC. Range:0.05 to 1.000 LSB value: 0.001
TEC Cool Side MULT	91	This value represents the TEC cool side multiplier of the internal TEC. Range: 0.05 to 1.000 LSB value: 0.001
TEC P CONST	92	This value represents the proportional constant in the PID controller of the internal TEC. Range: .0 °C to 100.0 °C LSB value: 0.1 °C
TEC I CONST	93	This value represents the integral constant in the PID controller of the internal TEC. Range: 0.00 rep/min to 10.00 rep/min LSB value: 0.01 rep/min
TEC D CONST	94	This value represents the derivative constant in the PID controller of the internal TEC. Range: 0.00 cycles/min to 10.00 cycles/min LSB value: 0.01 cycles/min
TEC TOL Band	95	This value represents the TEC tolerance level of the internal TEC. Range: 0.1 °C to 100.0 °C LSB value: 0.1 °C

Name	Addr	Description
Channel COM0 TEC TEMP Setting	104	This value represents the TEC temperature setting of the COM0 TEC. Range: -40.0 °C to 150.0 °C LSB value: 0.1 °C
Channel COM0 TEC VOLT Setting	105	This value represents the TEC voltage setting of the COM0 TEC. Range: 3.50 V to 20.00 V LSB value: 0.01 V
Channel COM0 TEC Heat Side MULT	106	This value represents the TEC heat side multiplier of the COM0 TEC. Range: 0.05 to 1.000 LSB value: 0.001
Channel COM0 TEC P CONST	107	This value represents the proportional constant in the PID controller of the COM0 TEC. Range: 1.0 °C to 100.0 °C LSB value: 0.1 °C
Channel COM0 TEC I CONST	108	This value represents the integral constant in the PID controller of the COM0 TEC. Range: 0.00 rep/min to 10.00 rep/min LSB value: 0.01 rep/min
Channel COM0 TEC D CONST	109	This value represents the derivative constant in the PID controller of the COM0 TEC. Range: 0.00 cycles/min to 10.00 cycles/min LSB value: 0.01 cycles/min
Channel COM0 TEC TOL Band	110	This value represents the TEC tolerance level of the COM0 TEC. Range: 0.1 °C to 100.0 °C LSB value: 0.1 °C
Channel COM1 TEC TEMP Setting	120	This value represents the TEC temperature setting of the COM1 TEC. Range: -40.0 °C to 150.0 °C LSB value: 0.1 °C
Channel COM1 TEC VOLT Setting	121	This value represents the TEC voltage setting of the COM1 TEC. Range: 3.50 V to 20.00 V LSB value: 0.01 V

Name	Addr	Description
Channel COM1 TEC Heat Side MULT	122	This value represents the TEC heat side multiplier of the COM1 TEC. Range: 0.05 to 1.000 LSB value: 0.001
Channel COM1 TEC P CONST	123	This value represents the proportional constant in the PID controller of the COM1 TEC. Range: 1.0 °C to 100.0 °C LSB value: 0.1 °C
Channel COM1 TEC I CONST	124	This value represents the integral constant in the PID controller of the COM1 TEC. Range: 0.00 rep/min to 10.00 rep/min LSB value: 0.01 rep/min
Channel COM1 TEC D CONST	125	This value represents the derivative constant in the PID controller of the COM1 TEC. Range: 0.00 cycles/min to 10.00 cycles/min LSB value: 0.01 cycles/min
Channel COM1 TEC TOL Band	126	This value represents the TEC tolerance level of the COM1 TEC. Range: 0.1 °C to 100.0 °C LSB value: 0.1 °C
Large System FREQ High	128	First two bytes of the channel frequency kept as a multiple of 1 Hz.
Large System FREQ Low	129	Last two bytes of the channel frequency kept as a multiple of 1 Hz.
Humidity Threshold	130	This value represents the humidity level that will trigger a humidity warning. Range: 1 to 101 LSB value: 1 percent humidity Note: A value of 101 turns warning off.

Read-Only Registers

Table 5-4 lists all read-only registers defined in the eDrive. Any register addresses that are not in the list are reserved and should not be used. These data elements are accessible using Function 04.

Table 5-4. Read-Only Registers used in Function 04

Name	Addr	Description
SC Firmware Version X	0	This value represents the firmware version of the system controller (SC). The version number is represented as x.y.z.
SC Firmware Version Y	1	
SC Firmware Version Z	2	
Front Panel Firmware Version	3	The firmware version of the front panel
SC Warranty Timer High	4	This value represents the number of hours accumulated on the warranty timer of the SC. Range: 0 to 4,294,967,295 LSB value: 1 s
SC Warranty Timer Low	5	
EM Firmware Version X	6	This value represents the firmware version of the expansion module (EM). The version number is represented as x.y.z.
EM Firmware Version Y	7	
EM Firmware Version Z	8	
EM Warranty Timer High	9	This value represents the number of hours accumulated on the warranty timer of the EM. Range: 0 to 4,294,967,295 LSB value: 1 second
EM Warranty Timer Low	10	
Channel 1 Firmware Version X	16	This value represents the firmware version of the Channel 1 AIM. The version number is represented as x.y.z.

Name	Addr	Description
Channel 1 Firmware Version Y	17	
Channel 1 Firmware Version Z	18	
Channel 1 Sensed Current Flow	19	This value represents the amount of current presently flowing through Channel 1. If the eDrive is in pulsed mode and active, the current reading during the active pulse will be returned. Range: 0 to 1,000 LSB value: 0.1 A
Channel 1 Power Supply Voltage	20	This value represents the power supply voltage reading for Channel 1. Range: 0 to 3,500 LSB value: 0.1 V
Channel 1 Temperature	21	This value represents the temperature reading for Channel 1. Range: 0 °C to 1,000 °C LSB value: 0.1 °C
Channel 1 Current Limit	22	This value represents the current limit setting for Channel 1. Range: 0 to 1,000 LSB value: 0.1 A
Channel 1 Duty Cycle	23	This value represents the duty cycle limit for Channel 1. Range: 0 to 1,000 LSB value: 0.1 percent
Channel 1 Warranty Timer High	24	This value represents the number of hours accumulated on the warranty timer of the Channel 1 AIM. Range: 0 to 4,294,967,295 LSB value: 1 s
Channel 1 Warranty Timer Low	25	
Channel 1 CW On Time High	26	

Name	Addr	Description
Channel 1 CW On Time Low	27	This value represents the CW On Time for Channel 1 that current levels above 6 A have flowed through the AIM. Range: 0 to 4,294,967,295 LSB value: 1 s
Channel 1 CW Power Cycle Count High	28	This value represents the CW power cycle count for Channel 1 that indicates how many times current flow has been turned on and off in CW mode. Range: 0 to 4,294,967,295
Channel 1 CW Power Cycle Count Low	29	
Channel 1 Pulsed Mode Shot Counter High	30	This value represents the Channel 1 shot counter. Range: 0 to 4,294,967,295
Channel 1 Pulsed Mode Shot Counter Low	31	
Channel 1 Pulsed Current Limit	32	This value represents the current limit on Channel 1 in 0.1 A increments.
Humidity Reading	33	This value represents the humidity reading. Range: 0 to 100 LSB value: 1 percent humidity
Channel 2 Firmware Version X	48	This value represents the firmware version of the Channel 2 AIM. The version number is represented as x.y.z.
Channel 2 Firmware Version Y	49	
Channel 2 Firmware Version Z	50	

Name	Addr	Description
Channel 2 Sensed Current Flow	51	This value represents the amount of current presently flowing through Channel 2. If the eDrive is in pulsed mode and active, the current reading during the active pulse will be returned. Range: 0 to 1,000 LSB value: 0.1 A
Channel 2 Power Supply Voltage	52	This value represents the power supply voltage reading for Channel 2. Range: 0 to 3,500 LSB value: 0.1 V
Channel 2 Temperature	53	This value represents the temperature reading for Channel 2. Range: 0 °C to 1,000 °C LSB value: 0.1 °C
Channel 2 Current Limit	54	This value represents the current limit setting for Channel 2. Range: 0 to 1,000 LSB value: 0.1 A
Channel 2 Duty Cycle	55	This value represents the duty cycle limit for Channel 2. Range: 0 to 1,000 LSB value: 0.1 percent
Channel 2 Warranty Timer High	56	This value represents the number of hours accumulated on the warranty timer of the Channel 2 AIM. Range: 0 to 4,294,967,295 LSB value: 1 s
Channel 2 Warranty Timer Low	57	
Channel 2 CW On Time High	58	This value represents the CW on time for Channel 2 that current levels above 6 A has flowed through the AIM. Range: 0 to 4,294,967,295 LSB value: 1 s
Channel 2 CW On Time Low	59	
Channel 2 CW Power Cycle Count High	60	This value represents the CW power cycle count for Channel 2 that indicates how many times current flow has been turned on and off in CW mode.

Name	Addr	Description
Channel 2 CW Power Cycle Count Low	61	Range: 0 to 4,294,967,295
Channel 2 Pulsed Mode Shot Counter High	62	This value represents the Channel 2 shot counter. Range: 0 to 4,294,967,295
Channel 2 Pulsed Mode Shot Counter Low	63	
Channel 2 Pulsed Current Limit	64	This value represents the pulsed current limit on Channel 2 in 0.1 A increments.
Channel 3 Firmware Version X	80	This value represents the firmware version of the Channel 3 AIM. The version number is represented as x.y.z.
Channel 3 Firmware Version Y	81	
Channel 3 Firmware Version Z	82	
Channel 3 Sensed Current Flow	83	This value represents the amount of current presently flowing through Channel 3. If the eDrive is in pulsed mode and active, the current reading during the active pulse will be returned. Range: 0 to 1,000 LSB value: 0.1 A
Channel 3 Power Supply Voltage	84	This value represents the power supply voltage reading for Channel 3. Range: 0 to 3,500 LSB value: 0.1 V
Channel 3 Temperature	85	This value represents the temperature reading for Channel 3. Range: 0 °C to 1,000 °C LSB value: 0.1°C

Name	Addr	Description
Channel 3 Current Limit	86	This value represents the current limit setting for Channel 3. Range: 0 to 1,000 LSB value: 0.1 A
Channel 3 Duty Cycle	87	This value represents the duty cycle limit for Channel 3. Range: 0 to 1,000 LSB value: 0.1 percent
Channel 3 Warranty Timer High	88	This value represents the number of hours accumulated on the warranty timer of the Channel 3 AIM. Range: 0 to 4,294,967,295 LSB value: 1 s\
Channel 3 Warranty Timer Low	89	
Channel 3 CW On Time High	90	This value represents the CW on time for Channel 3 that current levels above 6 A has flowed through the AIM. Range: 0 to 4,294,967,295 LSB value: 1 s
Channel 3 CW On Time Low	91	
Channel 3 CW Power Cycle Count High	92	This value represents the CW power cycle count for Channel 3 that indicates how many times current flow has been turned on and off in CW mode. Range: 0 to 4,294,967,295
Channel 3 CW Power Cycle Count Low	93	
Channel 3 Pulsed Mode Shot Counter High	94	This value represents the Channel 3 shot counter. Range: 0 to 4,294,967,295
Channel 3 Pulsed Mode Shot Counter Low	95	
Channel 3 Pulsed Current Limit	96	Pulsed current limit on Channel 3 measured in tenths of an ampere.
Channel COM0 Sensed Current	112	Current from COM0 AIM in 0.1 A increments.

Name	Addr	Description
Channel COM0 PS Voltage	113	Current input voltage to AIM board from external power supply in 0.1 V increments.
Channel COM0 Current Limit	114	Continuous current limit in .01 A increments.
Channel COM0 TEC Sensed Temp	115	This value represents the temperature reading for the COM0 TEC. Range: 0 °C to 1,000 °C LSB value: 0.1 °C
Channel COM0 TEC Sensed Voltage	116	This value represents the y voltage reading for COM0 TEC. Range: 0 to 3,500 LSB value: 0.1 V
Channel COM0 TEC Power	117	This value represents the power from COM0 TEC
Channel COM1 Sensed Current	120	Current from AIM in 0.1 A increments.
Channel COM1 PS Voltage	121	Current input voltage to AIM board from external power supply in 0.1 V increments.
Channel COM1 Current Limit	122	Continuous current limit in 0.1 A increments.
Channel COM1 TEC Sensed Temp	123	This value represents the temperature reading for the COM1 TEC. Range: 0 °C to 1,000 °C LSB value: 0.1 °C
Channel COM1 TEC Sensed Voltage	124	This value represents the y voltage reading for COM1 TEC. Range: 0 to 3,500 LSB value: 0.1 V
Channel COM1 TEC Power	125	This value represents the power from COM1 TEC.
Channel RS485 Sensed Current	128	Current from AIM in 0.1 A increments.
Channel RS485 PS Voltage	129	Current input voltage to AIM board from external power supply in 0.1 V increments.

Name	Addr	Description
Channel RS485 Current Limit	130	Continuous current limit in 0.1 A increments.

6

Chapter 6: User Interface Reference

This chapter contains a reference of the front panel user interface including:

- Front panel controls
- Standard menus
- Quick menus
- Current monitor menu
- Error displays

Front Panel Controls

This section provides a brief description of the front panel controls and its features.

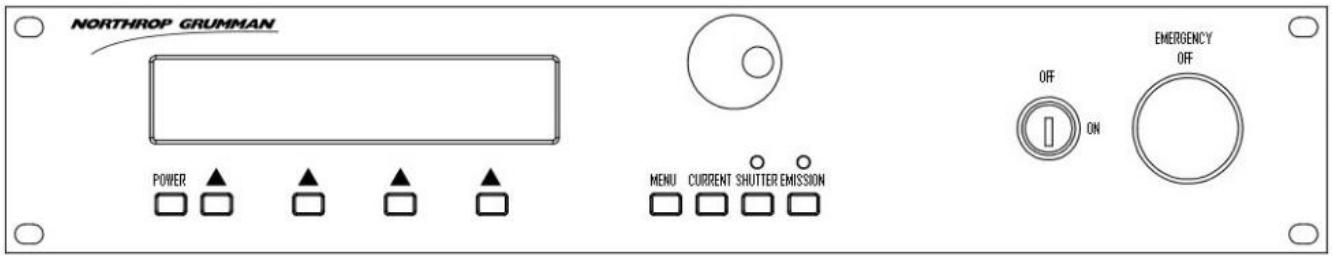


Figure 6-1. Front Panel Controls

LCD

The LCD is a 4 line by 40 character display with backlight.

Power Control Button

The power control button under the LCD is used in conjunction with the keylock switch to power the eDrive on and off. To power on, simply press the **POWER** button while the keylock switch is in the **ON** position. To power off, hold the **POWER** button in for three seconds.

"Soft" Buttons

The four "soft" buttons under the LCD are used in conjunction with the text on the LCD. The functions of these buttons are determined by the text displayed above them.

Menu Button

The **MENU** button has several functions.

- It navigates toward the main menu. If you have navigated to sub menus within the menu system, pressing **MENU** will take you upward in the menu structure until you return to the main menu.
- It switches between menu modes. Press and hold **MENU** for three seconds to switch between the full menu system and the restricted menu system called Quick Menus. Quick Menus offers the user the most basic system options while preventing access to system configuration and setup features. The full menus are most useful to the experienced laser scientist, engineer, or technician. The Quick Menus are useful for the most basic operations and may also be used to restrict access to advanced features for operators with little expertise.

Current Button

Pressing the **CURRENT** button the first time causes the menu system to jump directly to the current control menu of the Quick Menus without leaving the Standard Menus system.

Pressing the **CURRENT** button while already in the current control menu causes the menu system to jump to the large format display.

Refer to *Current Monitor Menu* section later in this chapter.

Shutter Button and Indicator

The **SHUTTER** button provides control over the shutter enable signal. This is not a direct control of the shutter output, it only enables it. In order for the shutter to open, the shutter enable must be active *and* the eDrive must be in the active state. While in the standby or inactive states, the eDrive will not actuate the shutter. While in the active state, the shutter button will open and close the shutter. The state of the shutter enable signal is provided with the green shutter indicator above the button.

Emission Button and Indicator

The **EMISSION** button controls the state of the current output of the eDrive. The state of the output is provided with the white emission indicator above the button. Refer to the state table describing the function.

Table 6-1. States

State	Functional Behavior / Notes	Current Output	Front Panel Emission Light	Laser On Light Signal	Shutter Enable Signal	Beeper
OFF	The unit powers into this safe state.	Off	Off	Off	Off	Off
PREFIRE	When the output is commanded on, the eDrive enters this state for five seconds to alert the users that the output is about to become active.	Off	Blinking	Blinking	Off	Beep-Beep
ACTIVE	This is the state that drives the laser to emit light.	Com-manded current level	On	On	On	Off
STANDBY	This state can only be entered when it is enabled and commanded remotely. This state will deliver a standby current if so configured.	Standby	Blinking	Blinking	Off	Off
FAULT	This state is entered upon detection of a fault condition. The fault must be identified, removed, and cleared before normal operation may resume.	Off	Off	Off	Off	Off

Selection Knob

The selection knob provides the means for quickly selecting wide range values in the eDrive. When the display indicates, use the selection knob to make adjustment to the parameter selected.

When it is impractical to make adjustments to the values with normal selection knob behavior, the display will indicate to press the selection knob to change the scale. Press and hold the selection knob for a brief period until the scale changes to 10x or 100x. This will facilitate quick excursions in the selected value. Press the selection knob again to return to 1x mode for fine adjustments. See the *Quick Menus* section in this chapter for more details on this control.

Keylock Switch

The keylock switch is intended to prevent the eDrive from being powered on. Turning the key to the **OFF** position will power the eDrive off. The key may be removed while in the **OFF** position only.

Emergency Stop Switch

The emergency stop switch is designed to be used in emergencies only. It is not intended to be used for stopping laser emission or powering off the eDrive.

When the **EMERGENCY STOP** switch is pressed, the eDrive clamps the commanded current to zero and notifies the user on the front panel.

To return the switch to the safe state, rotate the red actuator button in the direction indicated by the arrows.

Standard Menus

This section outlines all of the displays used in the eDrive product line. Some of the eDrive menus depend on the presence of related functionality. Menus for optional features will only be present if those options are present.

Banner

This display is presented at boot up time. The model name and firmware version will be displayed. Note that the actual firmware version number may differ for your system.

```
eDrive
Laser System Controller
Firmware Version 2.6.0
```

When your eDrive is first powered on, the next display will be the main menu. If you change to a different menu mode, that mode will be the first displayed after the banner.

Main

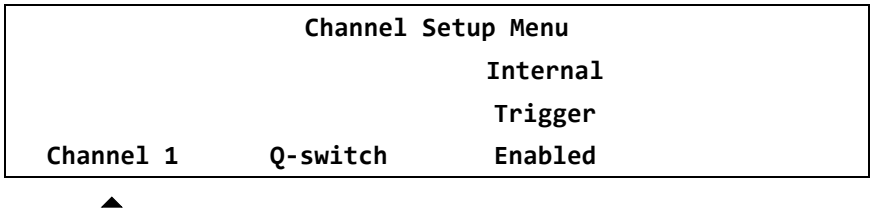
The eDrive displays the Main Menu by default.

```
Main Menu

Channel Setup    Comm Setup    Interface Setup    Utility Functions
      ▲
```

For a description of the communications setup menus, refer to *Communications Setup* in this chapter. For a description of the interface setup menus, refer to *Interface Setup* in this chapter. For a description of the utility functions setup menus, refer to *Utility Functions Setup* in this chapter.

Channel Setup

This is the channel setup menu. For systems with more than one AIM channel, additional channel selections will be available (Channel 2, Channel 3).

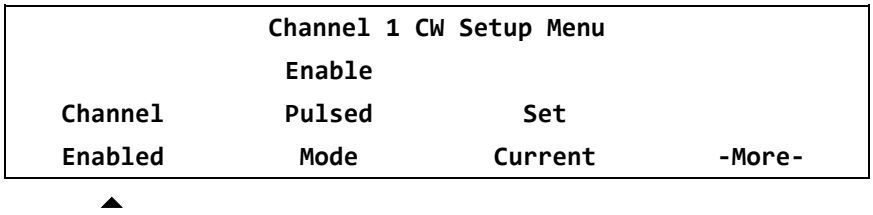


For a discussion of the triggering/gating functions, see *Triggering/Gating Setup* in this chapter.

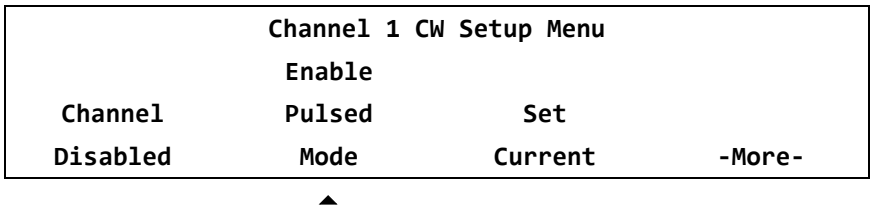
Channel CW Setup

This menu supports configuration of the Channel 1 output (AIM).

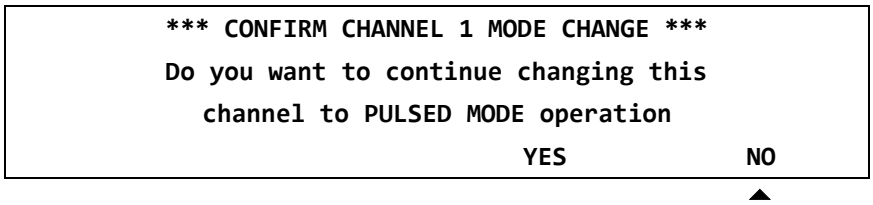
Select **Channel Enabled** to toggle the channel enable.



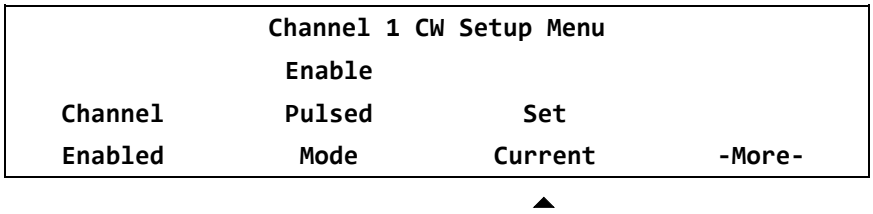
Select **Enable Pulsed Mode** to toggle between CW to QCW (pulsed) mode operation. This operation is only allowed when the channel is disabled and the drive is inactive.



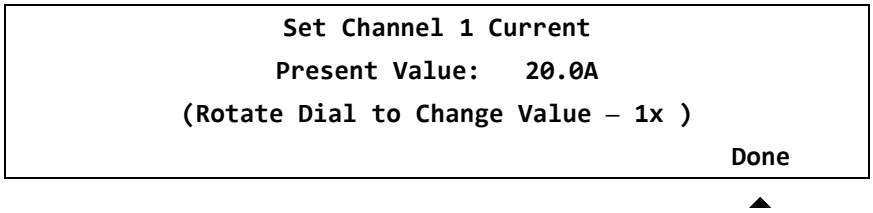
To proceed, you must acknowledge the prompt. Select **No** to continue and follow along in this chapter. (See the Channel 1 *Pulsed Setup Menu* section for details.) Re-enable the channel.



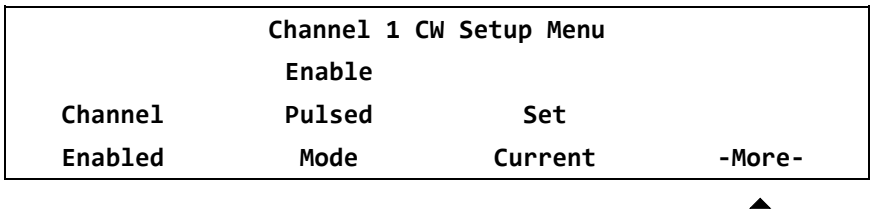
Select **Set Current** to set the current amplitude.



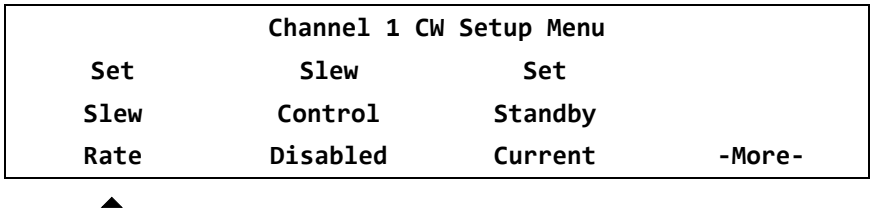
Use the selection knob to set the value. Select **Done** to enter the value.



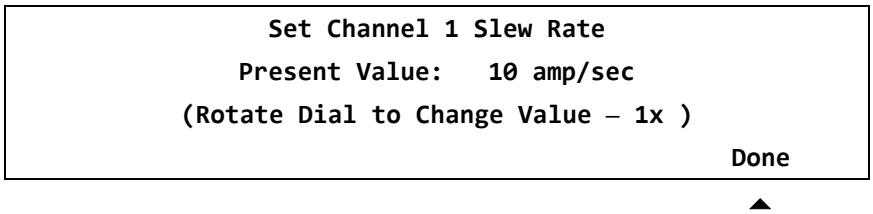
Select **-More-** to access additional options.



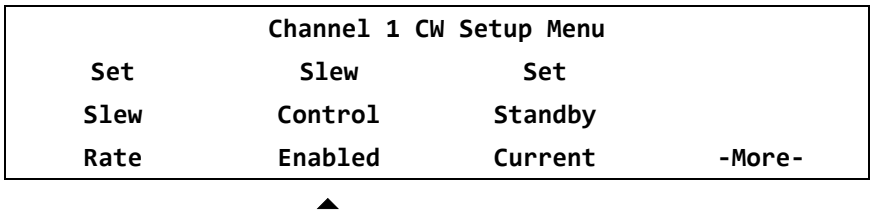
Select **Set Slew Rate** to set the rate of the current ramp.



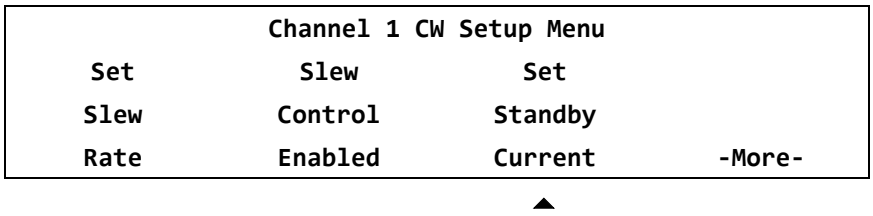
Use the selection knob to set the value. Select **Done** to enter the value.



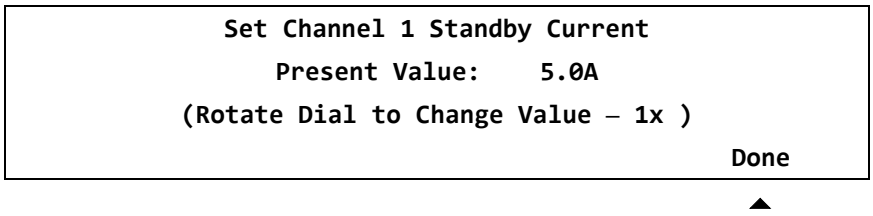
Select **Slew Control Enabled** to toggle between slew control enabled and disabled.



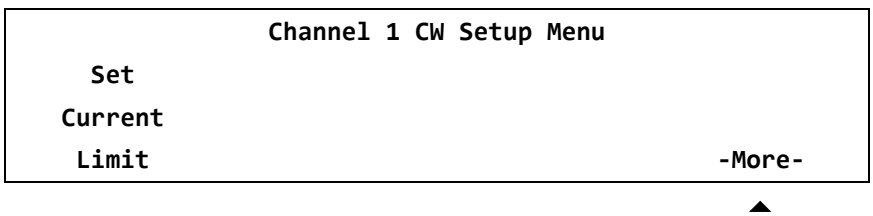
Select **Set Standby Current** to set the standby current.



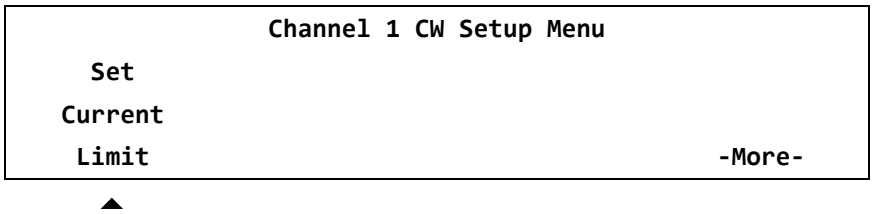
Use the selection knob to set the value. Select **Done** to enter the value.



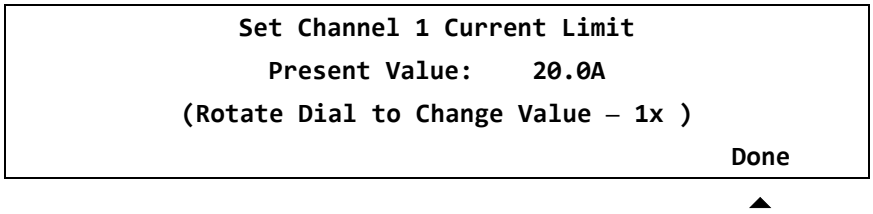
Select **-More-** to access additional options.



Select **Set Current Limit** to set the current limit value.



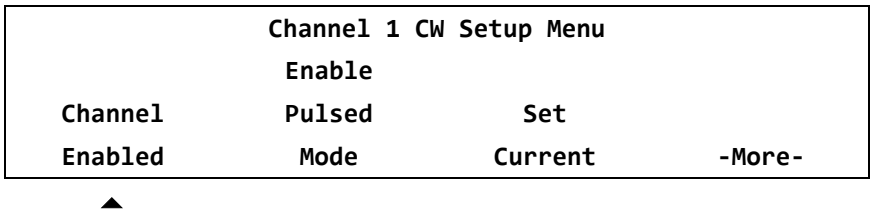
Use the selection knob to set the value. Select **Done** to enter the value.



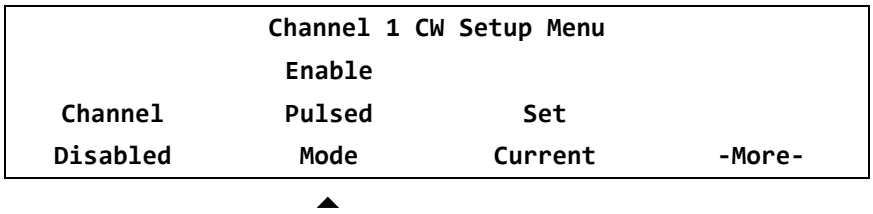
Channel Pulsed Setup

This menu supports configuration of the Channel 1 output (AIM) in pulsed mode operation (equipped models only).

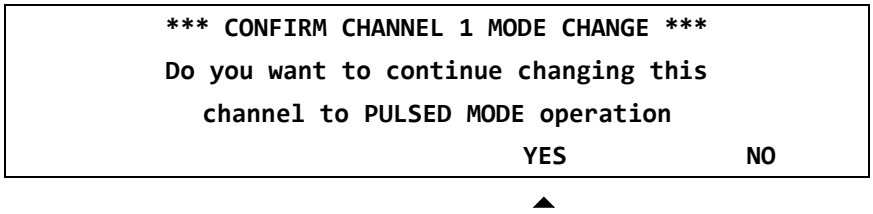
Select **Channel Enabled** to toggle the channel enable.



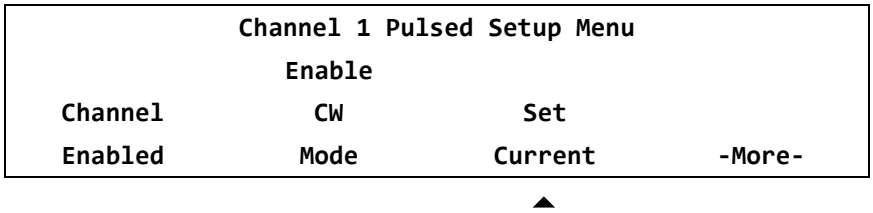
Select **Enable Pulsed Mode** to toggle from CW to QCW (pulsed) mode operation. This operation is only allowed when the channel is disabled.



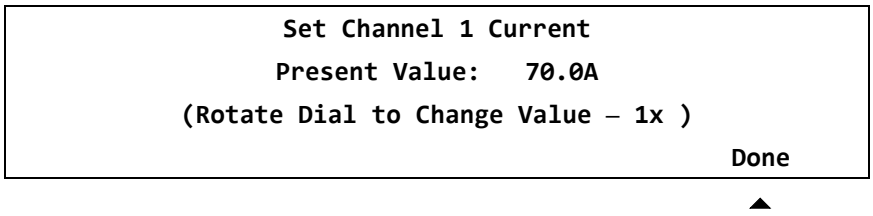
To proceed, you must acknowledge the prompt. Select **Yes**. (See the *Channel CW Setup* section for details.) Re-enable the channel.



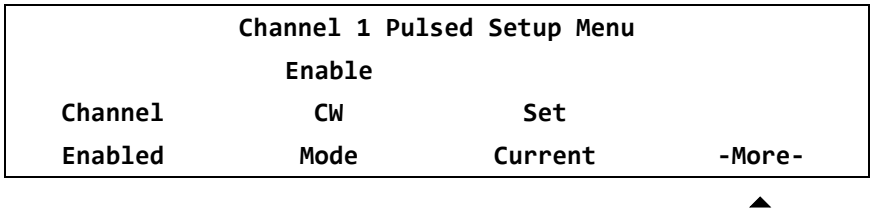
Select **Set Current** to set the channel current.



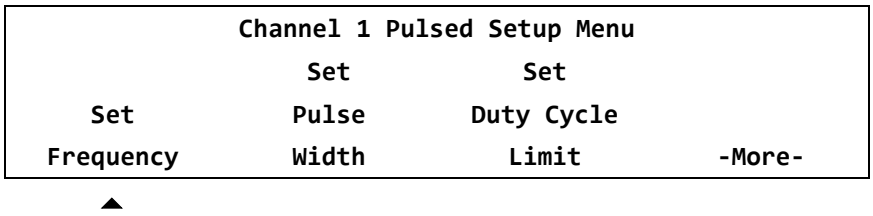
Use the selection knob to set the value. Select **Done** to enter the value.



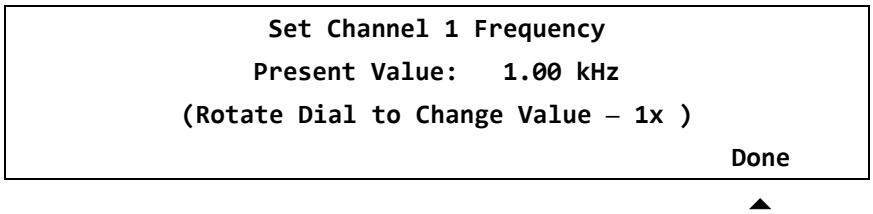
Select **-More-** to access additional options.



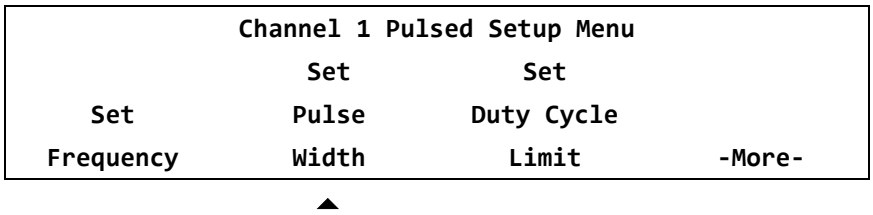
Select **Set Frequency** to set the PRF of the current pulse.



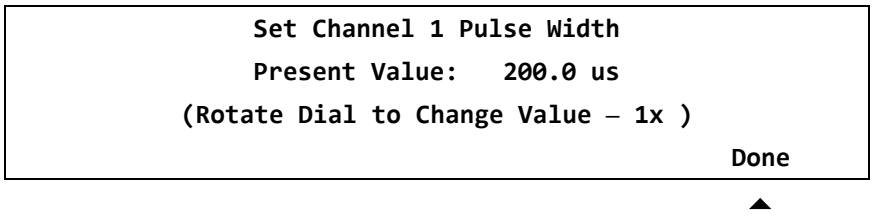
Use the selection knob to set the value. Select **Done** to enter the value.



Select **Set Pulse Width** to set the pulse width of the current pulse.

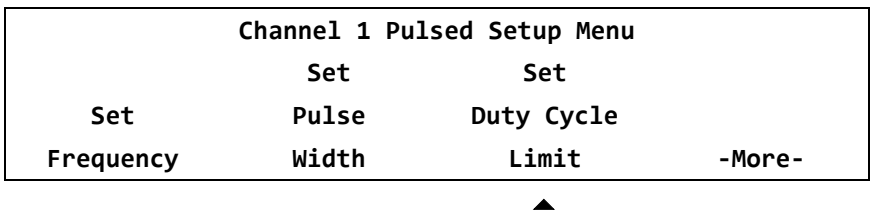


Use the selection knob to set the value. Select **Done** to enter the value.

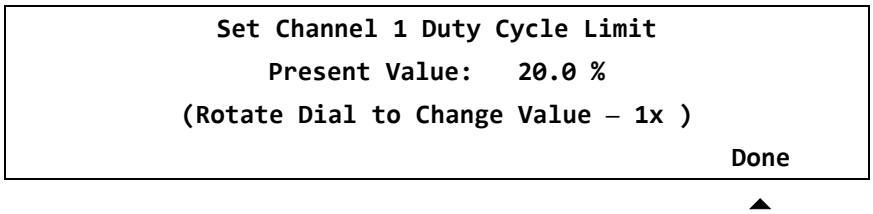


NG recommends the use of a current probe and current monitor output to verify the output pulse width matches the commanded value. Some difference is normal depending on the load. The current monitor output (BNC) is located on the back panel (see *Chapter 1: Getting Started*). Use the PW offset menu option to match the actual PW to the commanded value, if desired.

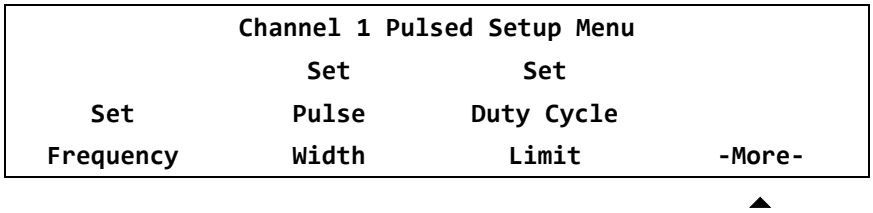
Select **Set Duty Cycle Limit** to set a limit on the duty cycle of the PRF of the current pulse. The duty cycle is the ratio of on-time to off-time of the pulse train.



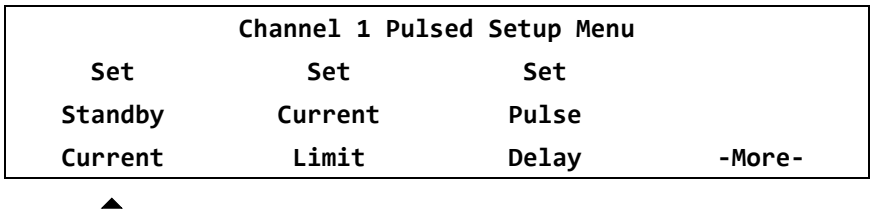
Use the selection knob to set the value. Select **Done** to enter the value.



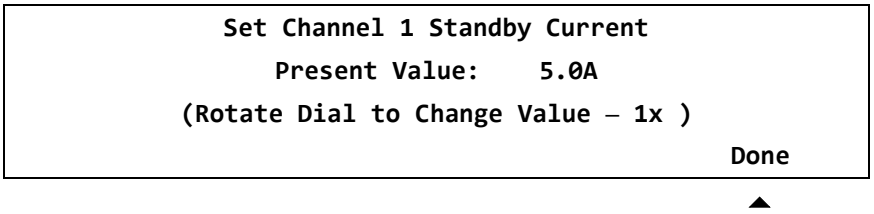
Select **-More-** to access additional options.



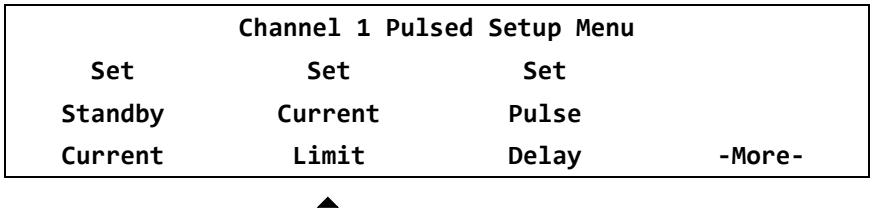
Select **Set Standby Current** to set the standby current.



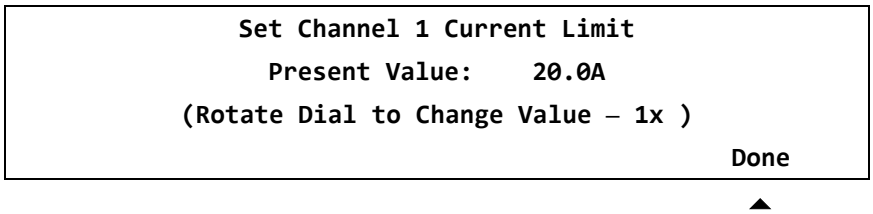
Use the selection knob to set the value. Select **Done** to enter the value.



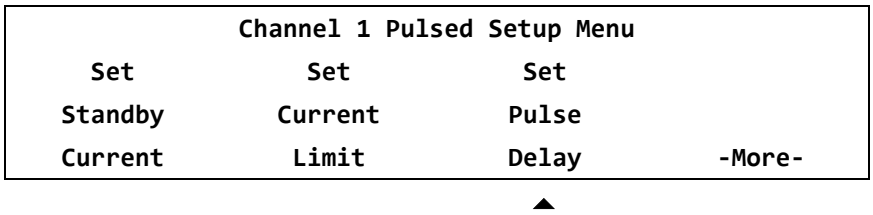
Select **Set Current Limit** to set the current limit value.



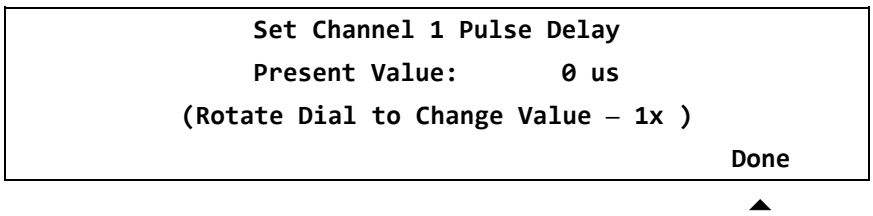
Use the selection knob to set the value. Select **Done** to enter the value.



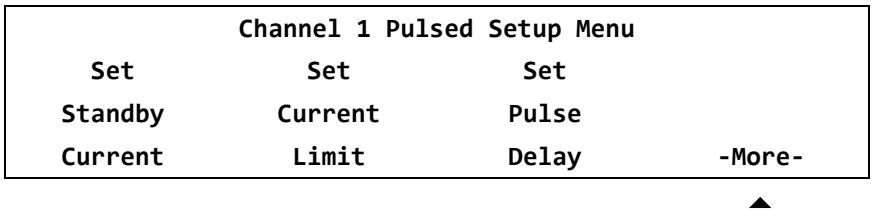
Select **Set Pulse Delay** to set the delay from the trigger to the pulse.



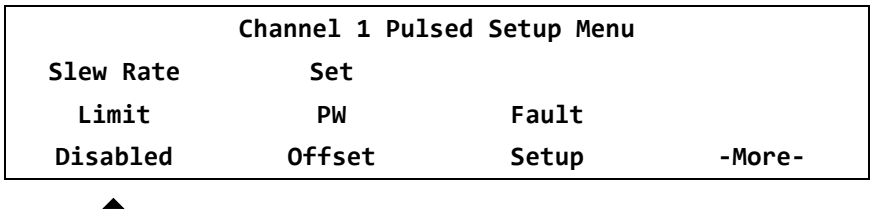
Use the selection knob to set the value. Select **Done** to enter the value.



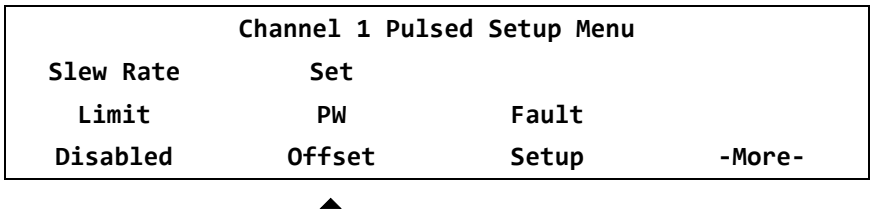
Select **-More-** to access additional options.



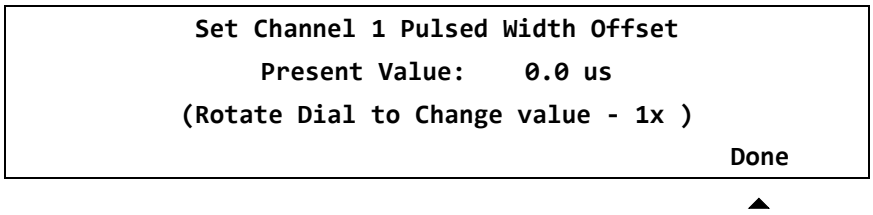
Select **Slew Rate Limit Disabled/Enabled** to toggle the slew rate limit function. Refer to *Chapter 3: Operating Basics* for a description of this function.



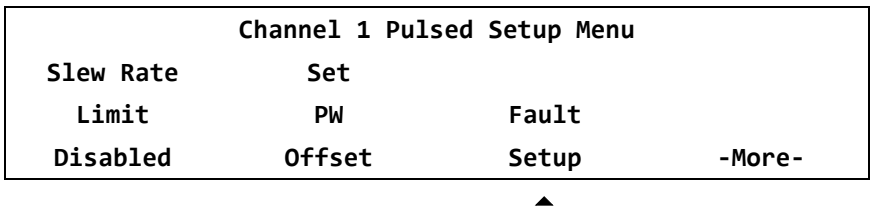
Select **Set Pw Offset** to set the pulse width offset.



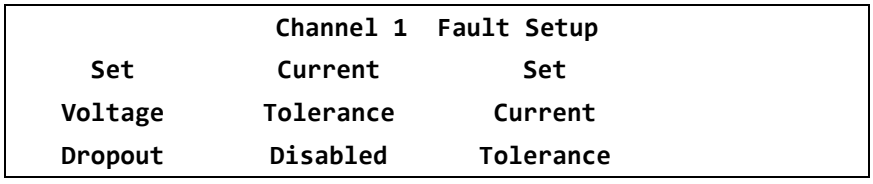
Use the selection knob to set the value. Select **Done** to enter the value.



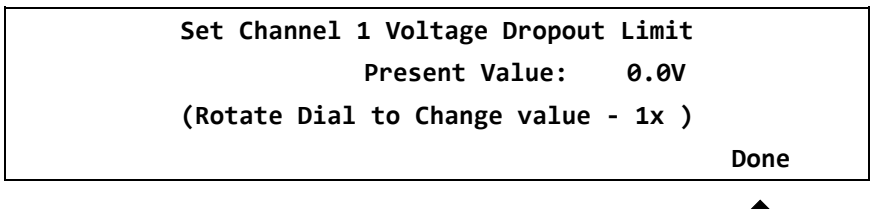
Select **Fault Setup** to set the pulse width offset.



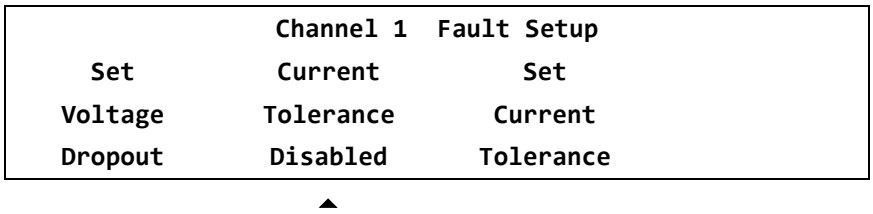
Select **Fault Setup** to set the pulse width offset.



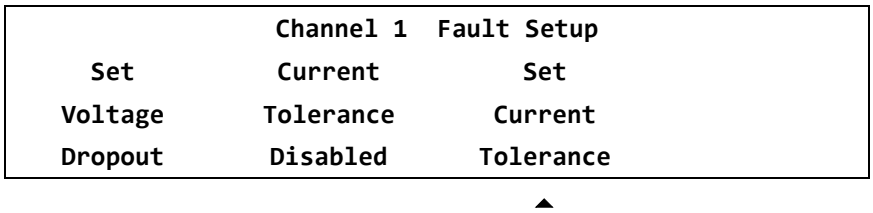
Use selection knob to set value. Select **Done** to enter value.



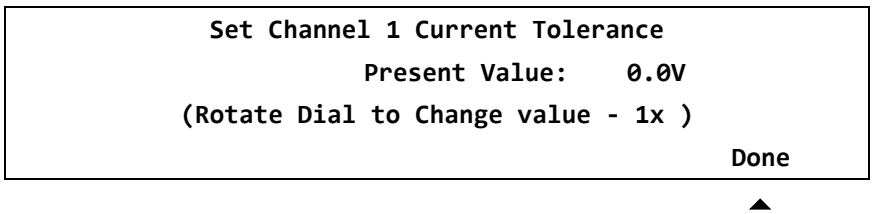
Select **Current Tolerance Enable** to toggle the current tolerance enable.



Select **Set Current Tolerance** to set the current tolerance.



Use selection knob to set value. Select **Done** to enter value.

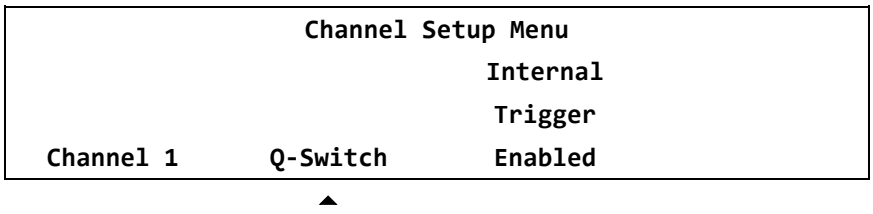


CW Q-Switch Setup Menu (eDrive)

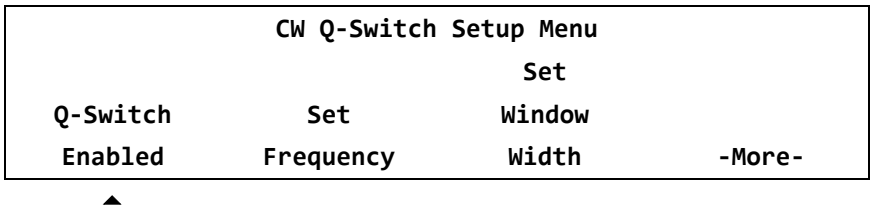
This menu supports configuration of the Q-switch operation.

NOTE: The Q-switch menu will display either CW or pulsed mode depending on the mode selected for Channel 1.

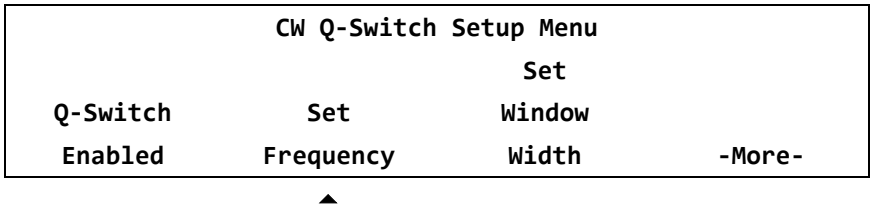
This is the channel setup menu. Select **Q-Switch** to select Q-Switch Setup Menu.



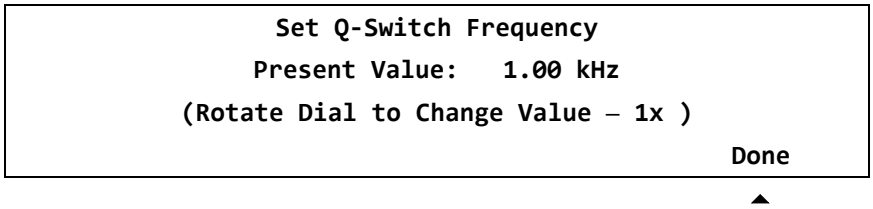
Select **Q-Switch Enabled** to toggle the Q-switch enabled. Make sure that it is enabled.



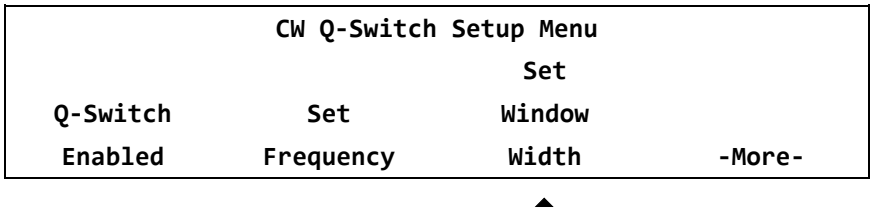
Select **Set Frequency** to set the Q-switch repetition frequency.



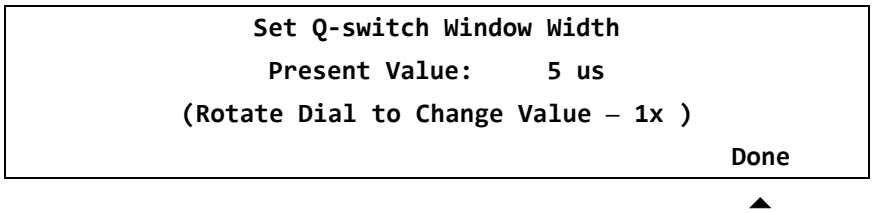
Use the selection knob to set the value. Select **Done** to enter the value.



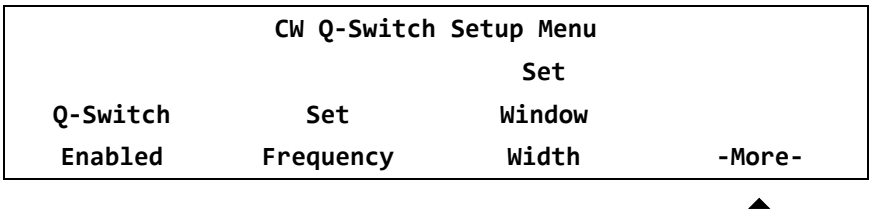
Select **Set Window Width** to set the Q-switch window width.



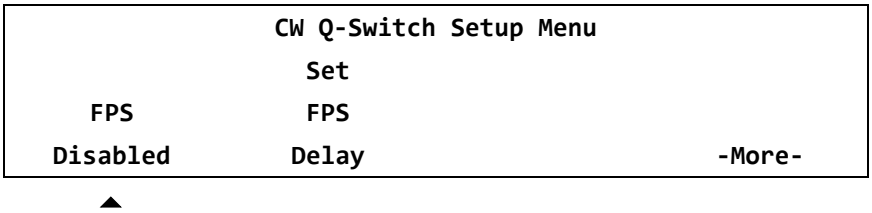
Use the selection knob to set the value. Select **Done** to enter the value.



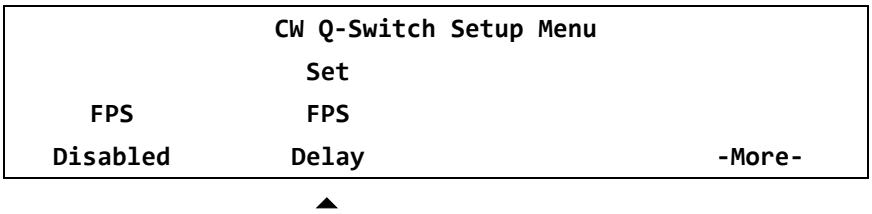
Select **-More-** to access more options.



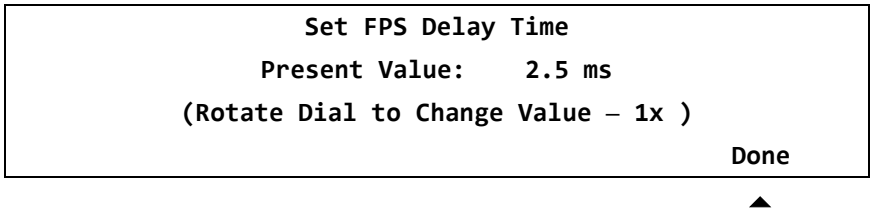
Select **FPS Disabled** to toggle the state of the first pulse suppression function. Set it to meet your laser system requirements.



Select **Set FPS Delay** to set the time limit required to activate a first pulse suppression.



Use the selection knob to set the value. Select **Done** to enter the value.

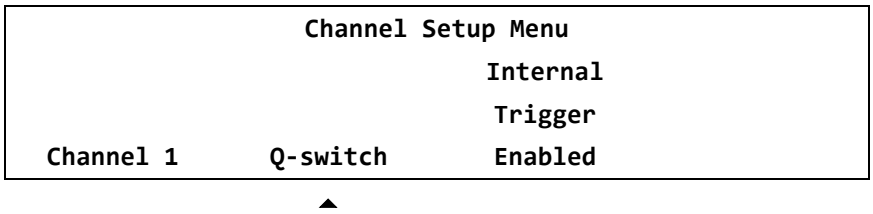


CW Q-Switch Setup Menu (eDrive Nitro and Aero)

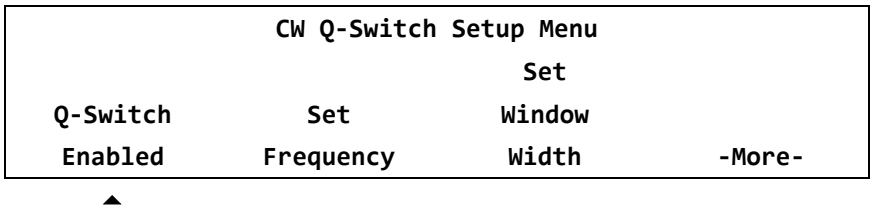
This menu supports configuration of the Q-switch operation.

NOTE: The Q-switch menu will display either CW or pulsed mode depending on the mode selected for Channel 1.

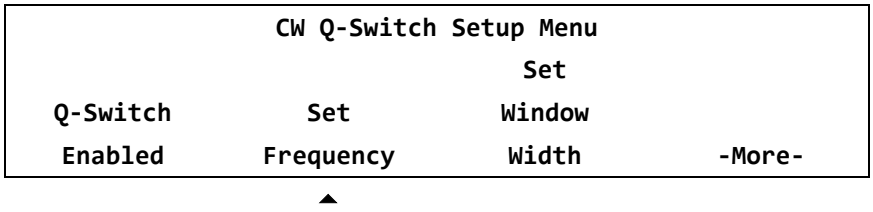
This is the channel setup menu. Select **Q-Switch** to select Q-Switch Setup Menu.



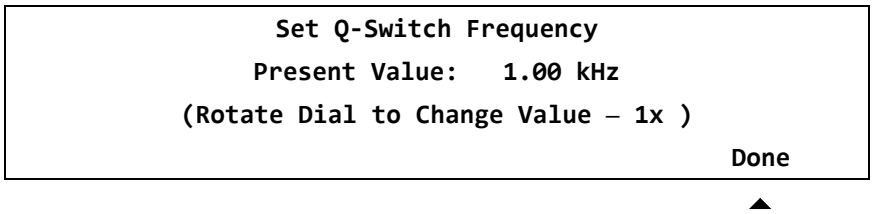
Select **Q-Switch Enabled** to toggle the Q-switch enabled. Make sure that it is enabled.



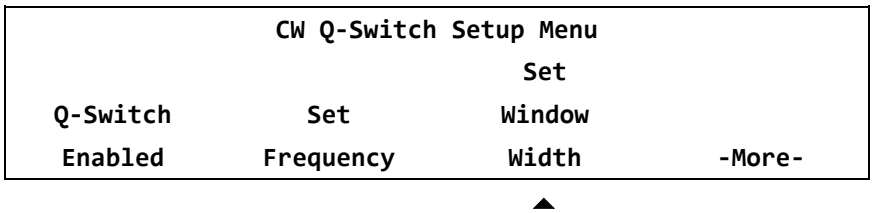
Select **Set Frequency** to set the Q-switch repetition frequency.



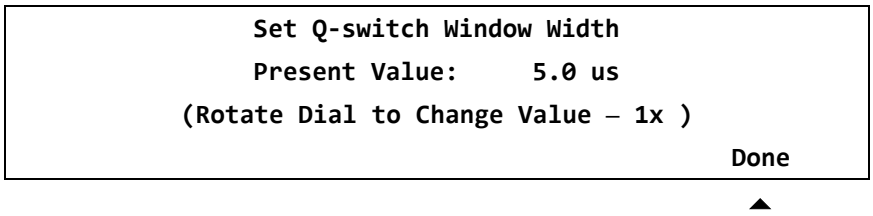
Use the selection knob to set the value. Select **Done** to enter the value.



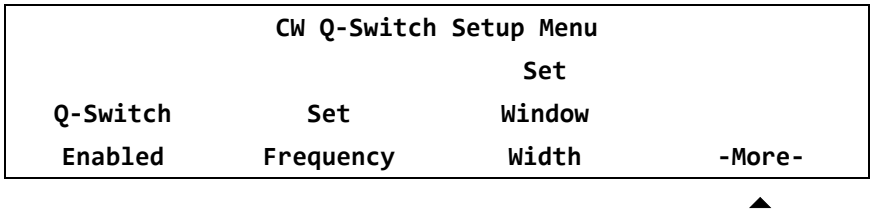
Select **SET WINDOW WIDTH** to set the Q-switch window width.



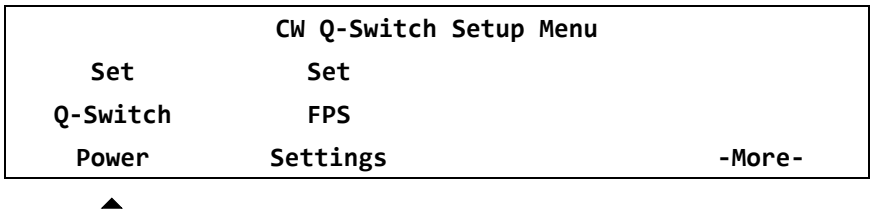
Use the selection knob to set the value. Select **Done** to enter the value.



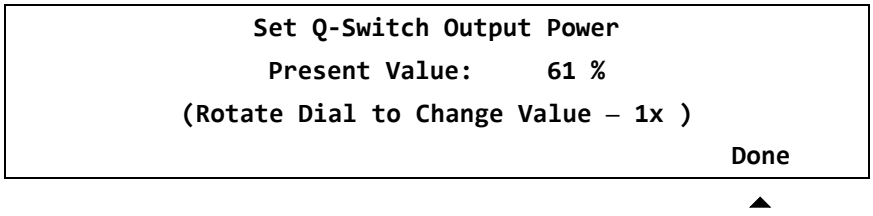
Select **-More-** to access additional options.



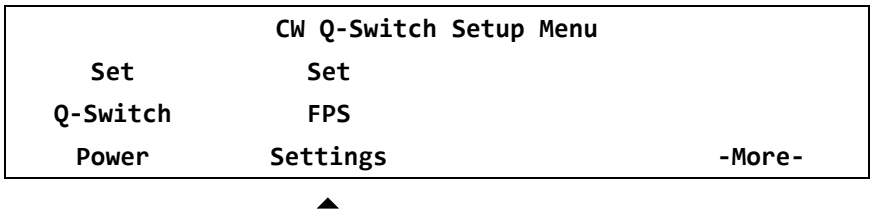
Select **Set Q-Switch Power** to access the Q-switch power modulation feature. Refer to *Chapter 3: Operating Basics* for a description of this feature.



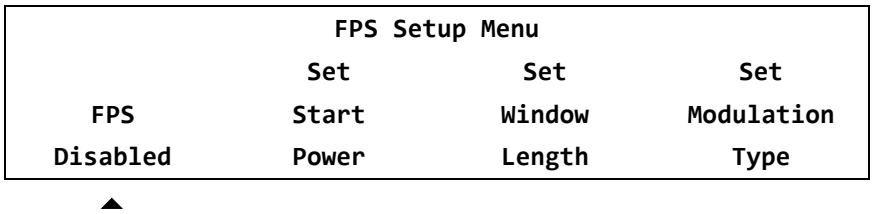
Use the selection knob to set the value. Select **Done** to enter the value.



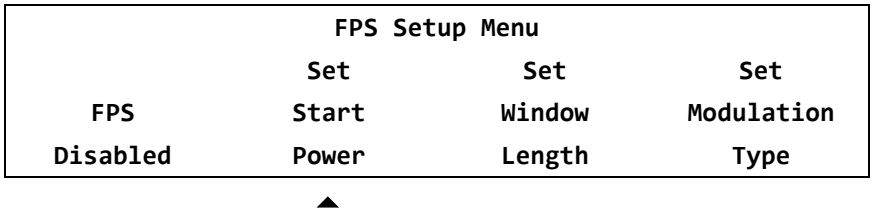
Select **Set FPS Settings** to access the Q-switch FPS feature. Refer to *Chapter 3: Operating Basics* for a description of these features.



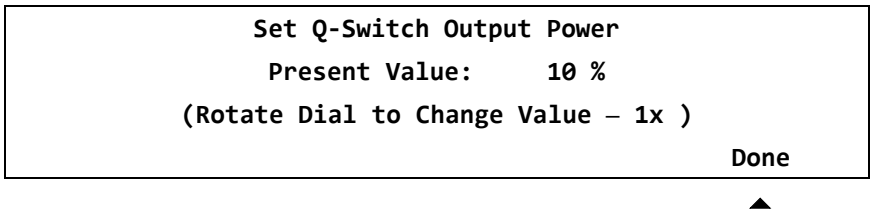
Select **FPS Disabled/Enabled** to toggle the state of the FPS function.



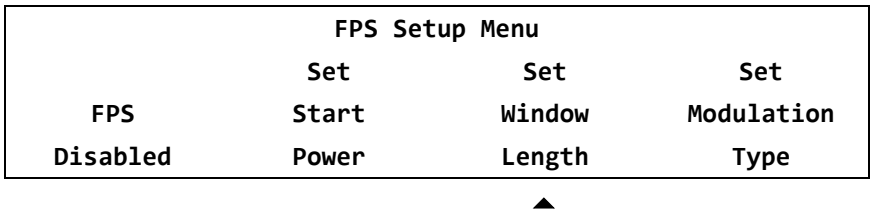
Select **Set Start Power** to adjust the starting power of the Q-switch driver output during FPR.



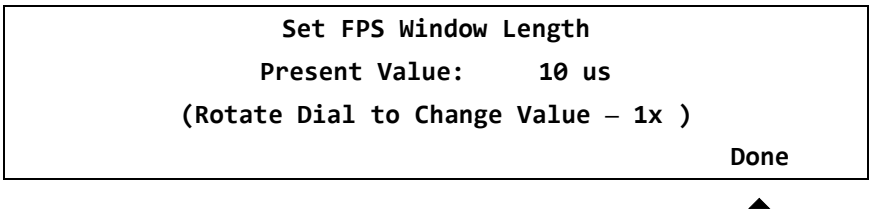
Use the selection knob to set the value. Select **Done** to enter the value.



Select **Set Window Length** to adjust the duration of the Q-switch FPS window.



Use the selection knob to set the value. Select **Done** to enter the value.



Select **Set Modulation Type** to adjust the type of modulation used in the Q-switch FPS window.

FPS Setup Menu			
FPS Disabled	Set Start Power	Set Window Length	Set Modulation Type

Use the selection knob to set the value to select **Linear**, **Exponential**, **Sine**, or **Sine^2**. Select **Done** to enter the value.

Set FPS Modulation Type			
Present Value: LINEAR			
(Rotate Dial to Select Function)			
			Done

Pulsed Q-switch Setup Menu (eDrive)

This menu supports configuration of the Q-switch operation in QCW (pulsed) mode.

NOTE: The Q-switch menu will display either CW or pulsed mode depending on the mode selected for Channel 1.

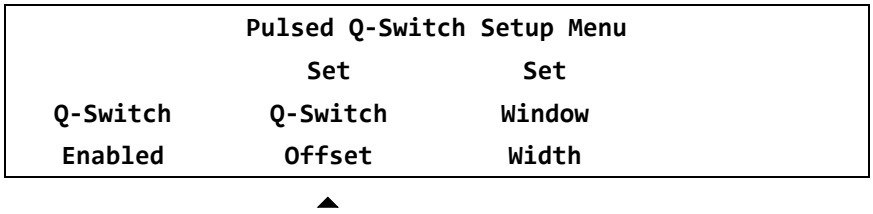
From the Channel Setup Menu, select **Q-Switch** to select Q-switch setup menus.

Channel Setup Menu			
			Internal Trigger
Channel 1	Q-switch	Enabled	

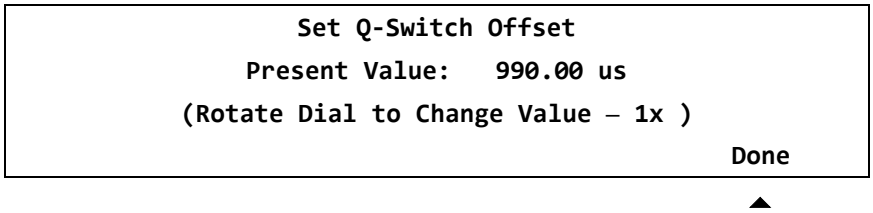
Select **Q-Switch Enabled** to toggle the Q-switch enable. Make sure that it is enabled.

Pulsed Q-Switch Setup Menu			
Q-Switch Enabled	Set Q-Switch Offset	Set Window Width	

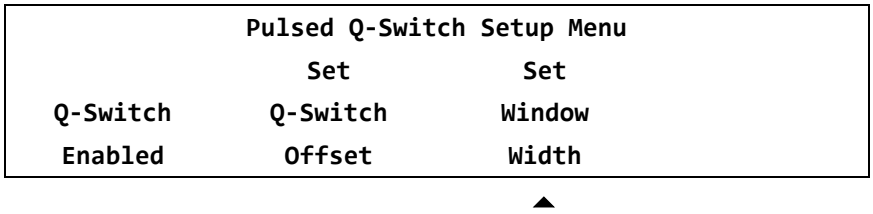
Select **Set Q-Switch Offset** to set the Q-switch offset relative to the end of the current pulse.



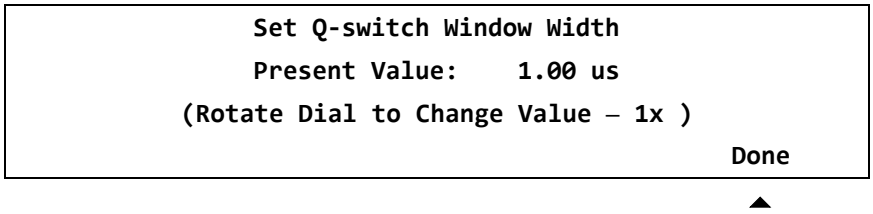
Use the selection knob to set the value. Select **Done** to enter the value.



Select **Set Window Width** to set the Q-switch window width.



Use the selection knob to set the value. Select **Done** to enter the value.

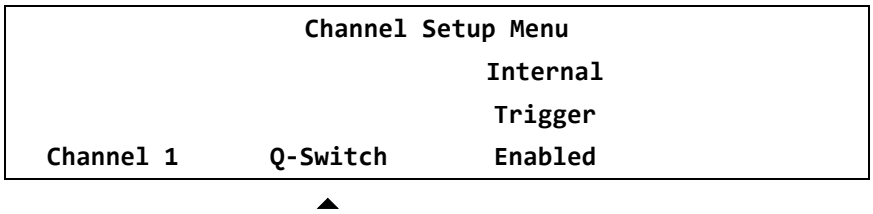


Pulsed Q-Switch Setup Menu (eDrive Nitro and Aero)

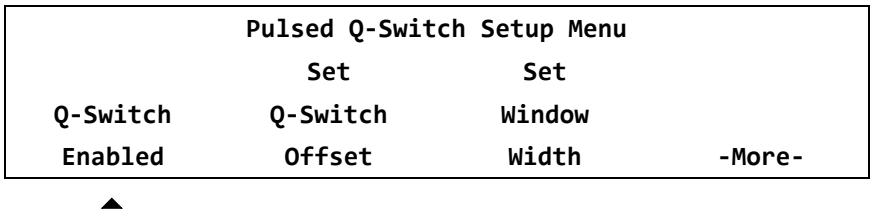
This menu supports configuration of the Q-switch operation in QCW (pulsed) mode.

NOTE: The Q-switch menu will display either CW or pulsed mode depending on the mode selected for Channel 1.

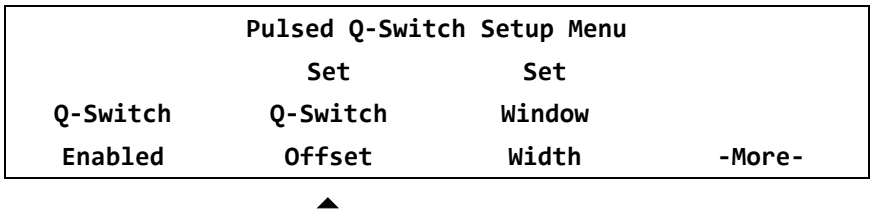
In the Channel Setup Menu press **Q-Switch** to select the Q-switch Setup Menu.



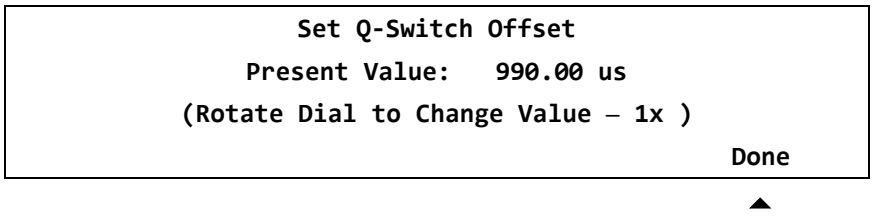
Select **Q-Switch Enabled** to toggle the Q-switch enable. Make sure that it is enabled.



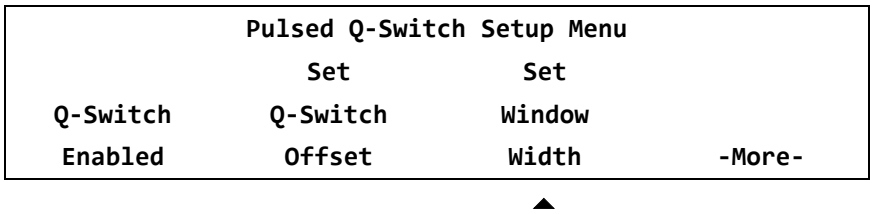
Select **Set Q-Switch Offset** to set the Q-switch offset relative to the end of the current pulse.



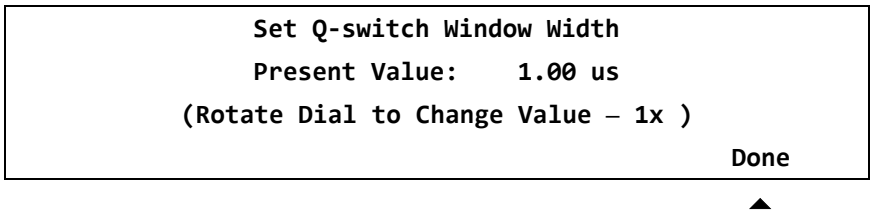
Use the selection knob to set the value. Select **Done** to enter the value.



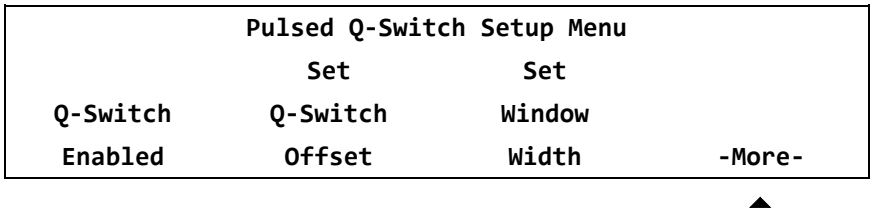
Select **Set Window Width** to set the width of the Q-switch window.



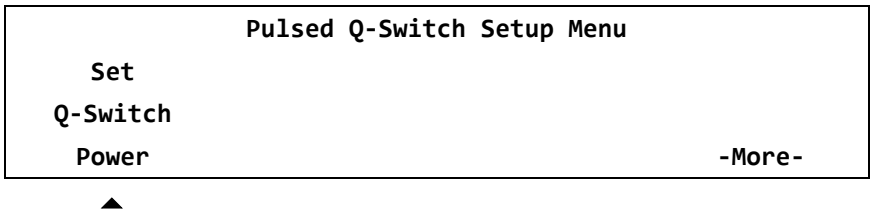
Use the selection knob to set the value. Select **Done** to enter the value.



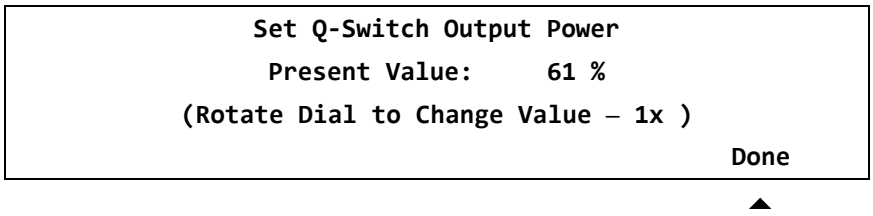
Select **-More-** to access additional options.



Select **Set Q-Switch Power** to access the Q-switch power modulation feature. Refer to *Chapter 3: Operating Basics* for a description of this feature.



Use the selection knob to set the value. Select **Done** to enter the value.



Internal TEC Controller Settings

The main function of the thermal electric controller (TEC) is to control the temperature of the second harmonic generator (SHG) crystal.

NOTE: The TEC Controller Settings shown in this section are for example only. For your application see the Data Summary Sheet supplied with your laser.

From the Main Menu select **Channel Setup**.

Main Menu			
Channel Setup	Comm Setup	Interface Setup	Utility Functions

From the Channel Setup Menu, select **TEC**.

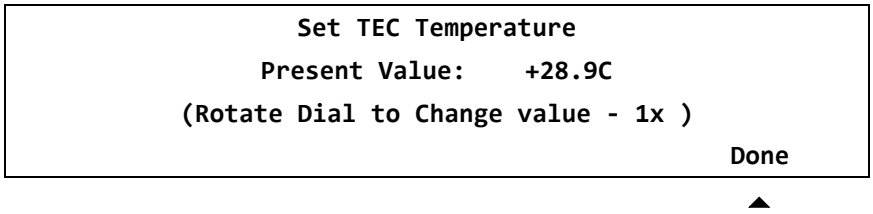
Channel Setup Menu			
Internal Trigger Enabled	Q-Switch	Channel 1	TEC

WARNING: From the TEC Setup Menu TEC must always be set to Enabled. Damage to the laser optics may occur if TEC is not set to Enabled.

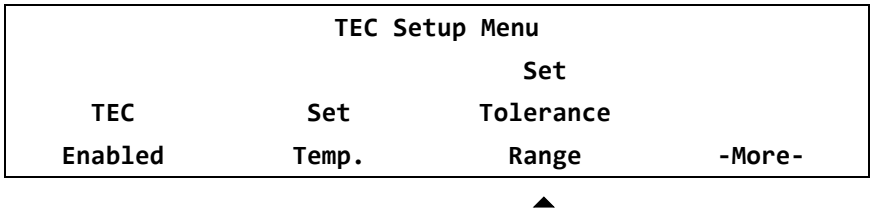
From the TEC Setup Menu select **Set Temp**.

TEC Setup Menu			
TEC Enabled	Set Temp.	Set Tolerance Range	-More-

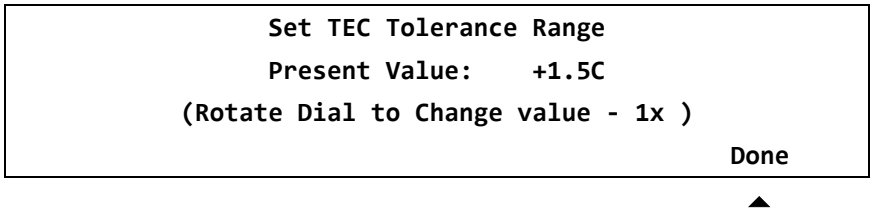
From Set TEC Temperature verify that the eDrive is set to the correct temperature. Adjust as needed using the rotary switch. Select **Done** when finished.



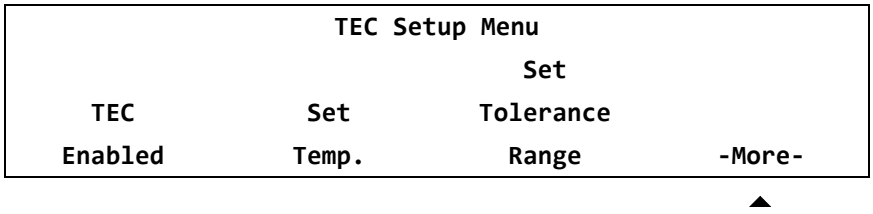
From the TEC Setup Menu, select **Set Tolerance Range**.



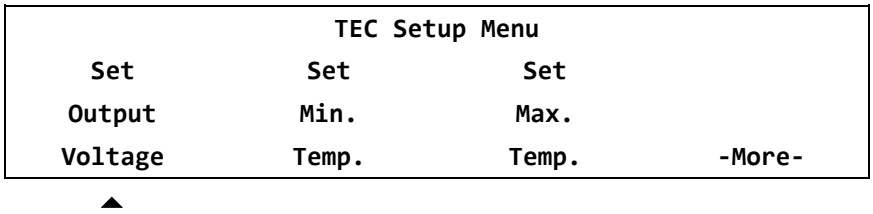
From the Set TEC Temperature menu verify that the eDrive is set to the correct Tolerance Range. Adjust as needed using the rotary switch. Select **Done** when finished.



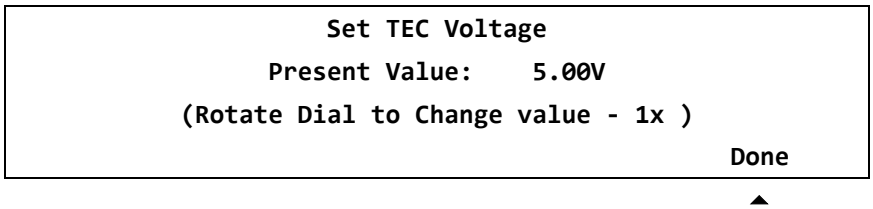
From the TEC Setup Menu, select **-More-**.



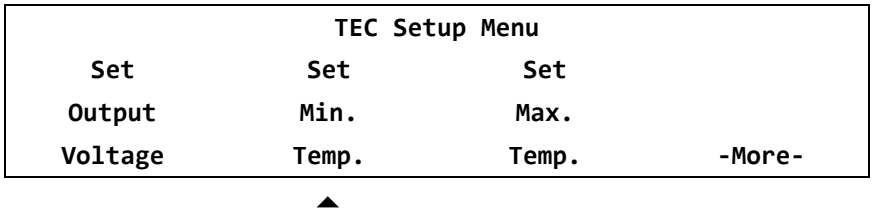
From the TEC Setup Menu, select **Set Output Voltage**.



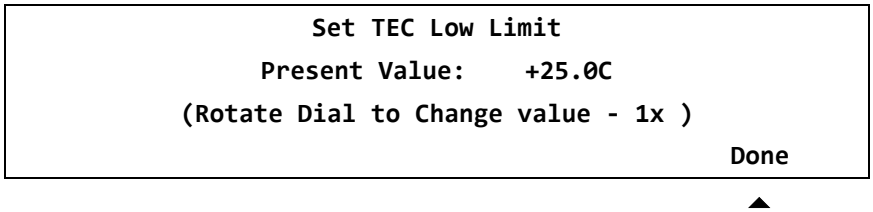
From Set TEC Voltage verify that the eDrive is set to the correct TEC voltage. Adjust as needed using the rotary switch. Select **Done** when finished.



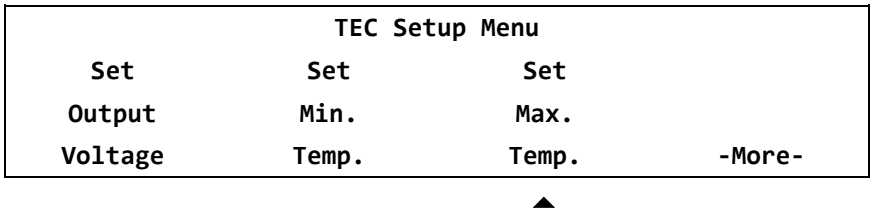
From the TEC Setup Menu, select **Set Min Temp**.



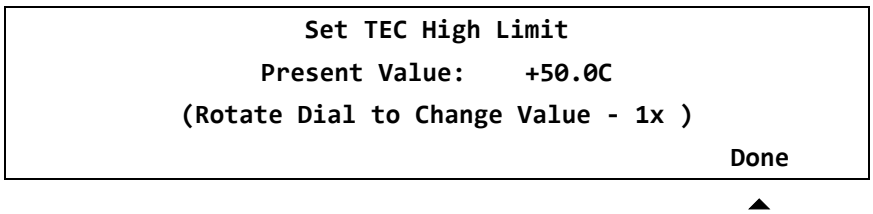
From Set TEC Low Limit verify that the eDrive is set to the correct TEC low temperature limit. Adjust as needed using the rotary switch. Select **Done** when finished.



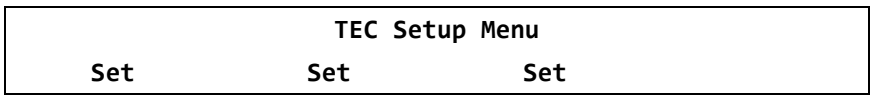
From the TEC Setup Menu, select **Set Max. Temp**.

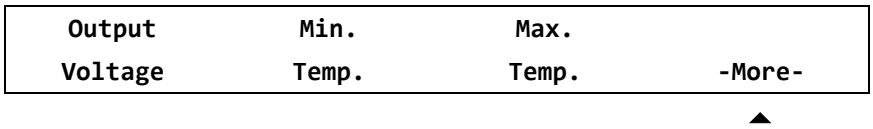


From Set TEC High Limit, verify that the eDrive is set to the correct TEC high temperature limit. Adjust as needed using the rotary switch. Select **Done** when finished.

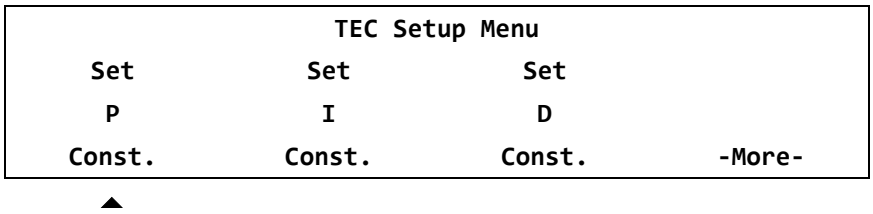


From the TEC Setup Menu, select **-More-.**

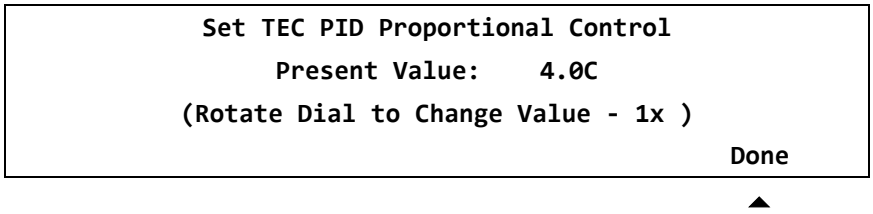




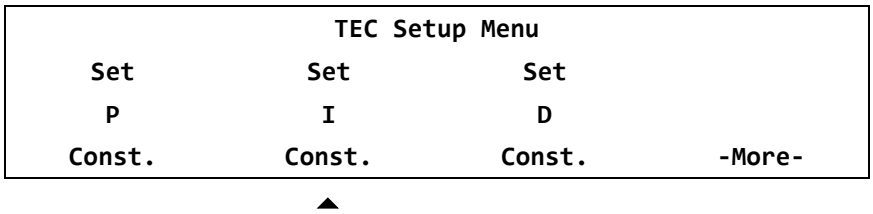
From the TEC Setup Menu, select **Set P Const**.



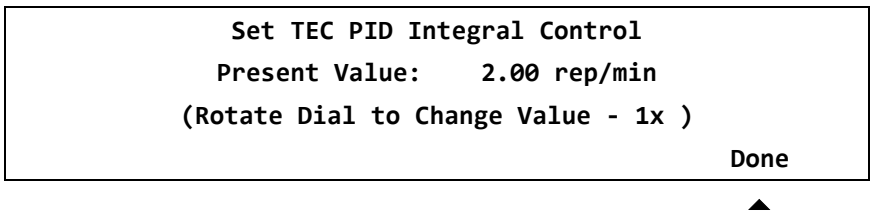
From Set TEC PID Proportional Control, verify that the eDrive is set to the correct TEC proportional control value. Adjust as needed using the rotary switch. Select **Done** when finished.



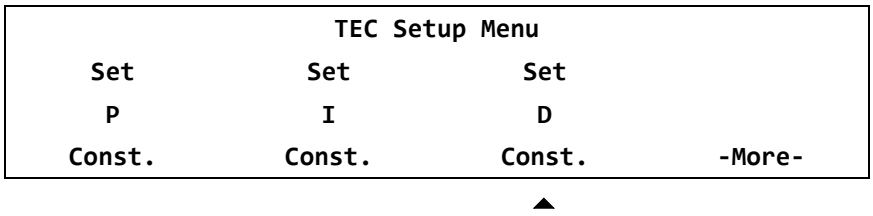
From the TEC Setup Menu, select **Set I Const**.



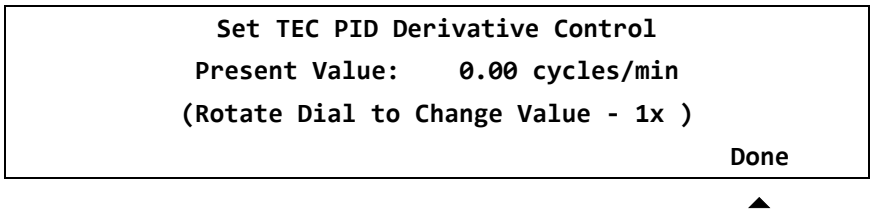
From Set TEC PID Integral Control, verify that the eDrive is set to the correct TEC integral control value. Adjust as needed using the rotary switch. Select **Done** when finished.



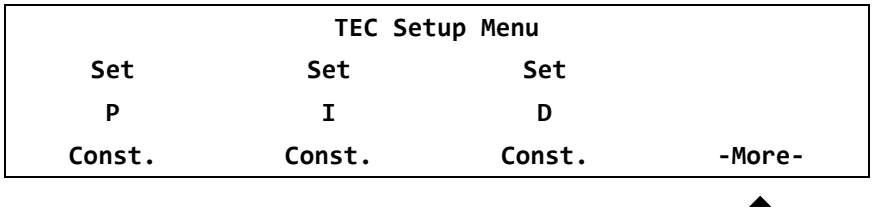
From the TEC Setup Menu, select **Set D Const**.



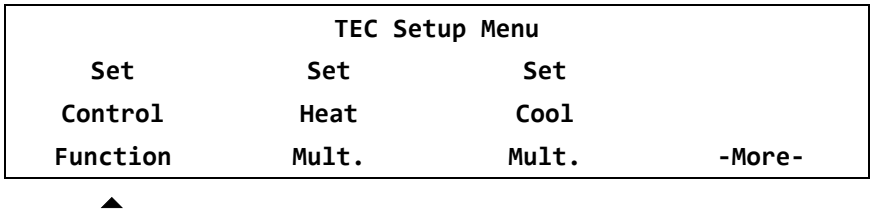
From Set TEC PID Derivative Control, verify that the eDrive is set to the correct TEC derivative control value. Adjust as needed using the rotary switch. Select **Done** when finished.



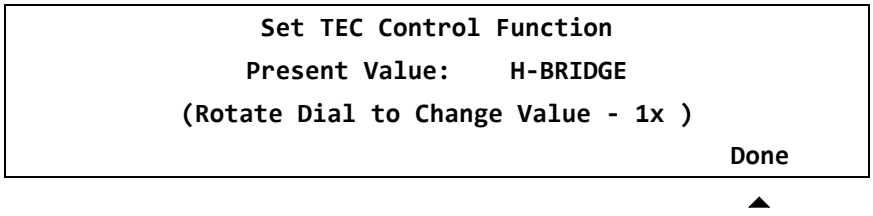
From the TEC Setup Menu, select -**More-.**



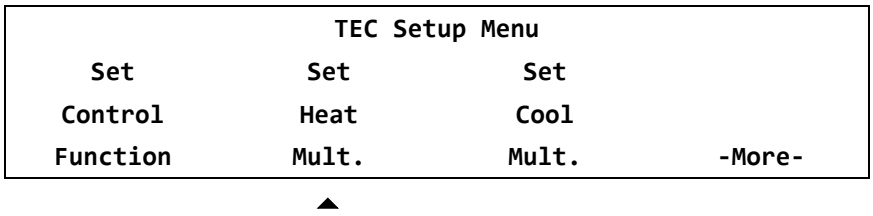
From the TEC Setup Menu, select **Set Control Function**.



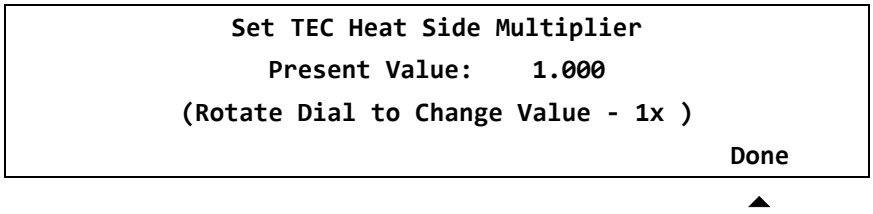
From Set TEC Control Function, verify that the eDrive is set to the correct TEC control function value. Adjust as needed using the rotary switch. Select **Done** when finished.



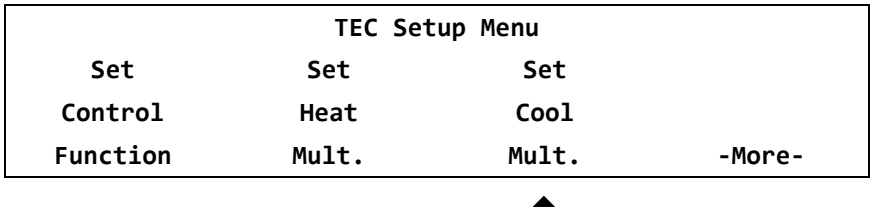
From the TEC Setup Menu, select **Set Heat Mult**.



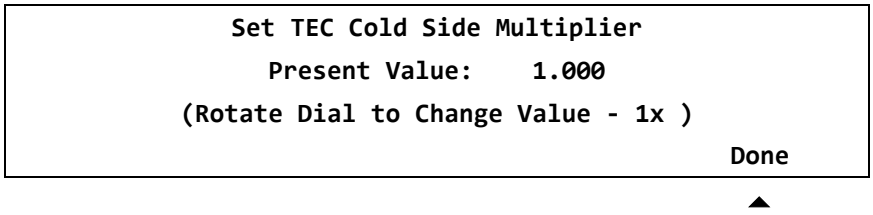
From Set TEC Heat Side Multiplier, verify that the eDrive is set to the correct TEC heat side multiplier value. Adjust as needed using the rotary switch. Select **Done** when finished.



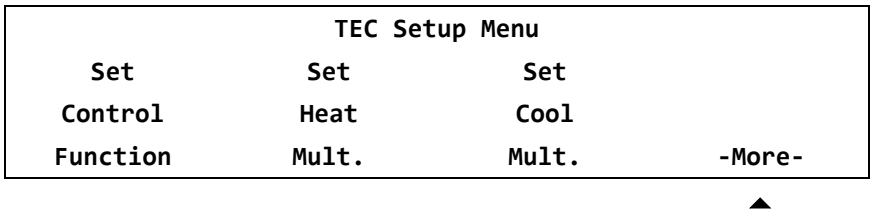
From the TEC Setup Menu, select **Set Cool Mult**.



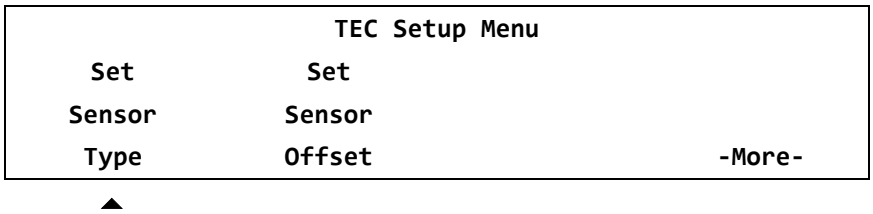
From Set TEC Cold Side Multiplier, verify that the eDrive is set to the correct TEC cold side multiplier value. Adjust as needed using the rotary switch. Select **Done** when finished.



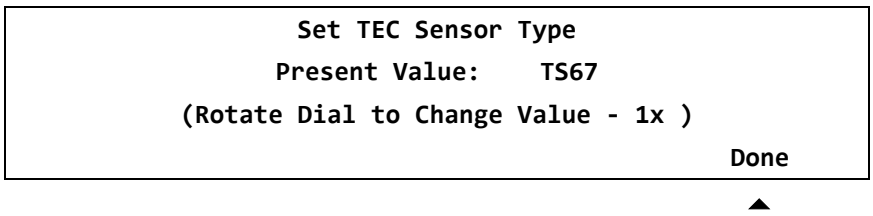
From the TEC Setup Menu, select -**More-.**



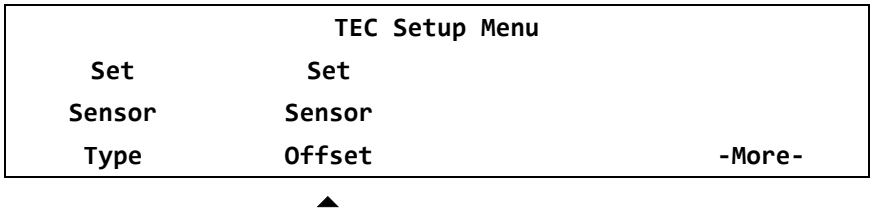
From the TEC Setup Menu, select **Set Sensor Type**.



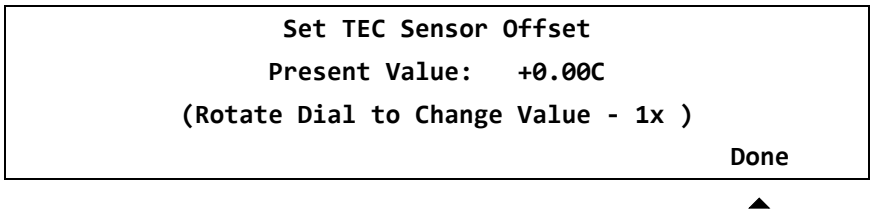
From Set TEC Sensor Type, verify that the eDrive is set to the correct TEC sensor type value. Adjust as needed using the rotary switch. Rotate the rotary switch one step and wait until the "busy" note clears. Select **Done** when finished.



From the TEC Setup Menu, select **Set Sensor Offset**.



From Set TEC Sensor Offset, verify that the eDrive is set to the correct TEC sensor offset value. Adjust as needed using the rotary switch. Rotate the rotary switch one step and wait until the "busy" note clears. Select **Done** when finished.



This completes the Internal TEC Control set up. Press the **MENU** button several times to return to the top level menu.

Triggering/Gating

Refer to *Chapter 2: Understanding Driver Functions* for an explanation of the various triggering and gating modes.

This is the channel setup menu. Press button 3 to select the various triggering/gating options. When the following display is shown, all trigger events are generated internally using the Timing Engine.

```
                  Channel Setup Menu
                                Internal
                                Trigger
Channel 1      Q-Switch         Enabled
```

When the following display is shown, all trigger events are generated externally using a signal input on the trigger/gate input connector.

```
                  Channel Setup Menu
                                External
                                Trigger
Channel 1      Q-Switch         Enabled
```

When the following display is shown, all trigger events are generated internally using the Timing Engine and may be interrupted using a signal input on the trigger/gate input connector.

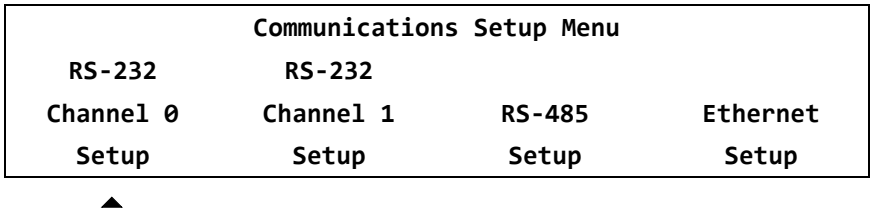
```
                  Channel Setup Menu
                                External
                                  Gate
Channel 1      Q-Switch         Enabled
```

Communications Setup

From the Main Menu display, select **Comm Setup** to select the communications setup menus.

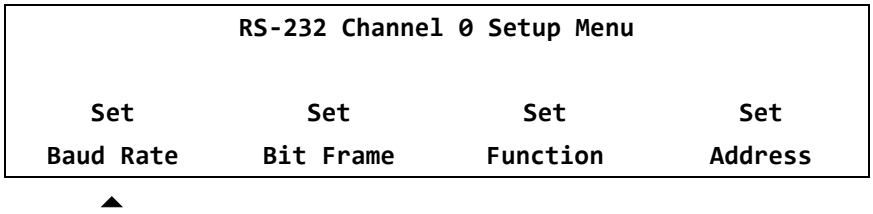
```
                        Main Menu

  Channel          Comm          Interface        Utility
   Setup           Setup           Setup         Functions
```

The Communications Setup Menu is used to configure the various serial interfaces in the eDrive. Select **RS-232 Channel 0 Setup** to configure the serial port for your application.

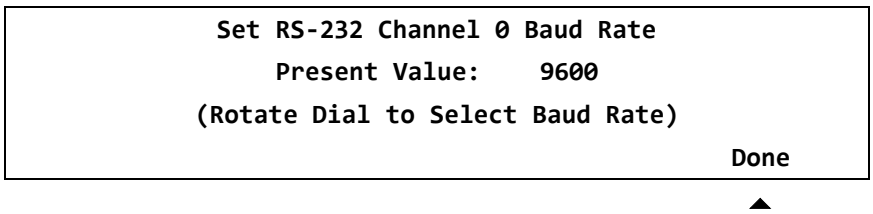


NOTE: Note that RS-232 Channel 1 and RS-485 setup are essentially identical and will not be described separately.

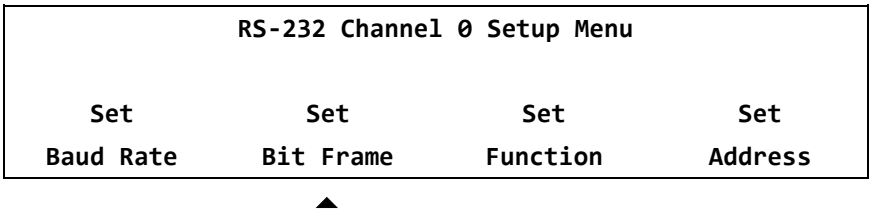
Select **Set Baud Rate**.



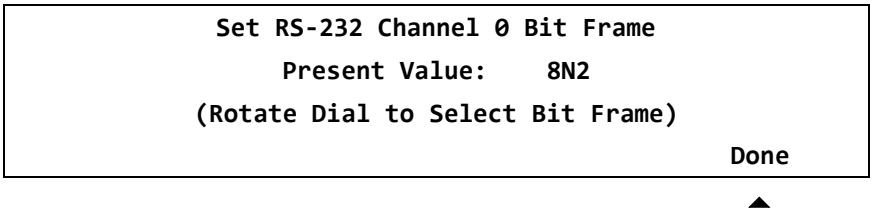
Use the selection knob to set the value. Select from **1200**, **2400**, **4800**, **9600**, **19200**, or **38400**. Select **Done** to enter the value.



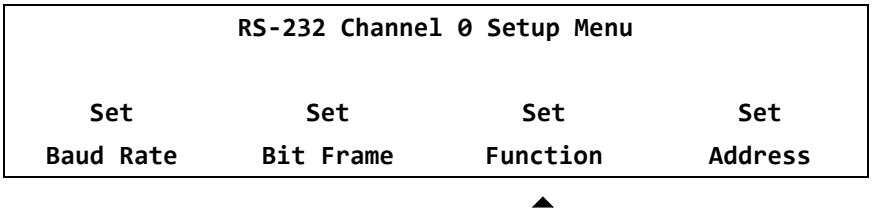
Select **Set Bit Frame**.



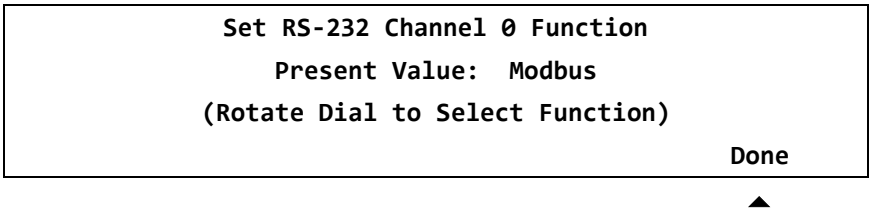
Use the selection knob to set the value. Select from **8N1**, **8O1**, **8E1**, or **8N2**. Refer to *Chapter 5: Communications* for details on bit frame. Select **Done** to enter the value.



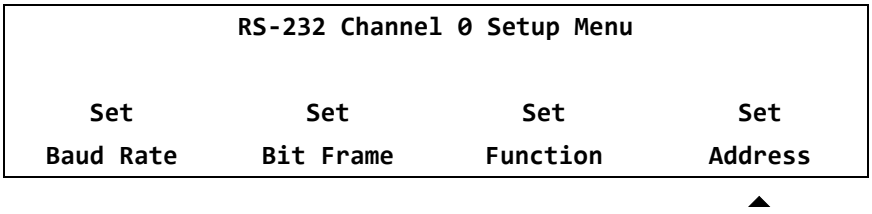
Select **Set Function**.



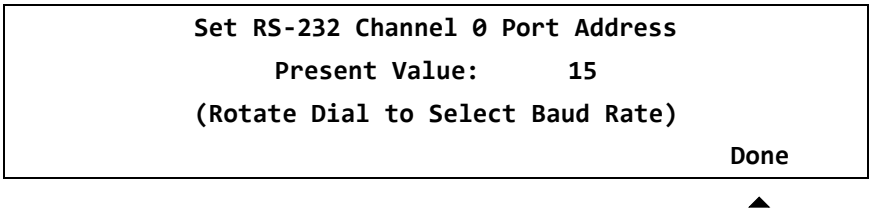
Use the selection knob to set the value. Select from **None**, **Modbus**, or **Loopback**. Select **Done** to enter the value.



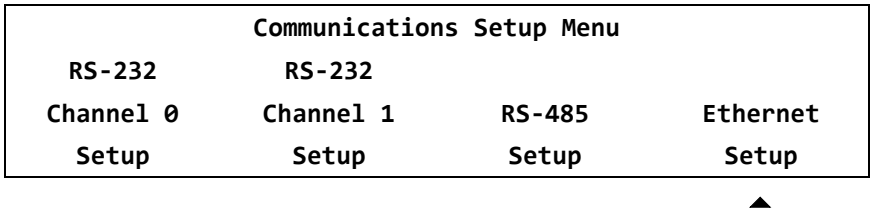
Select **Set Address**.



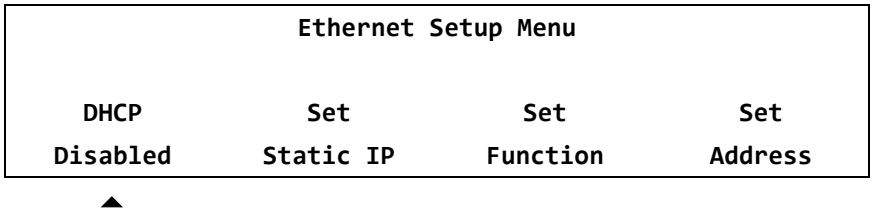
Use the selection knob to set the value. Refer to *Chapter 5: Communications* for details on port address. Select **Done** to enter the value.



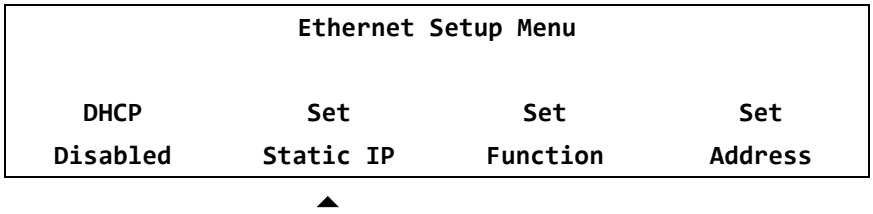
Select **Ethernet Setup** to configure the Ethernet interface parameters. Consult your network system administrator for help selecting these parameter values.



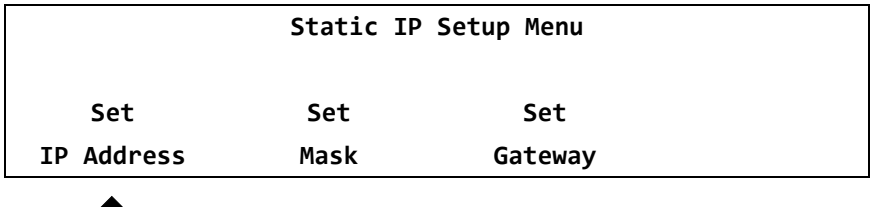
Select **DHCP Disabled** to toggle DHCP to the enabled state. When DHCP is enabled, the eDrive will obtain its Ethernet parameters from a DHCP server on the network.



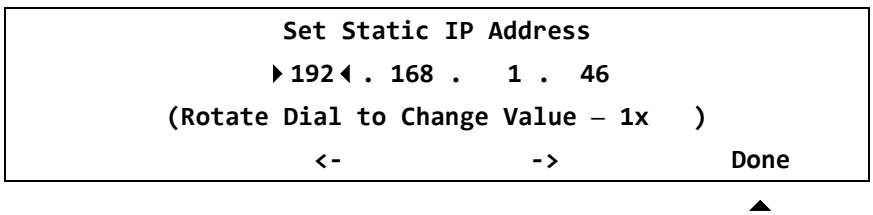
Select **Set Static IP** to set the static IP parameters.



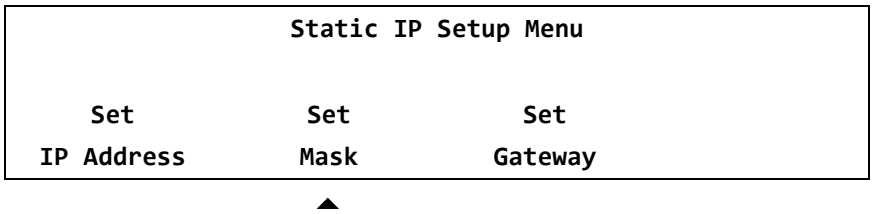
Select **Set IP Address** to set the IP address.



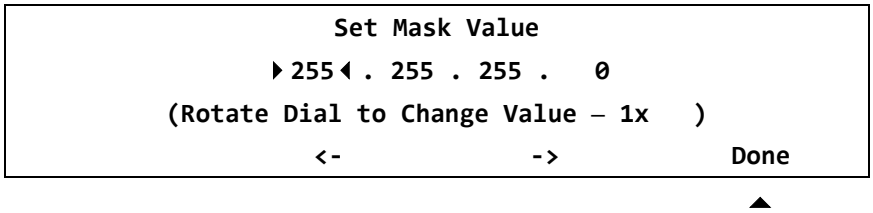
Use the selection knob to set each value. Press ← or → to switch between parameters. Select **Done** to enter the values.



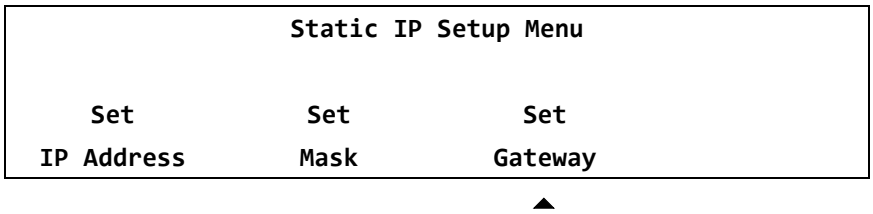
Select **Set Mask** to set the IP address mask.



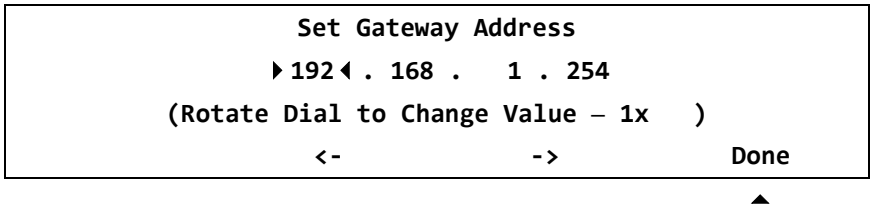
Use the selection knob to set each value. Press ← or → to switch between parameters. Select **Done** to enter the values.



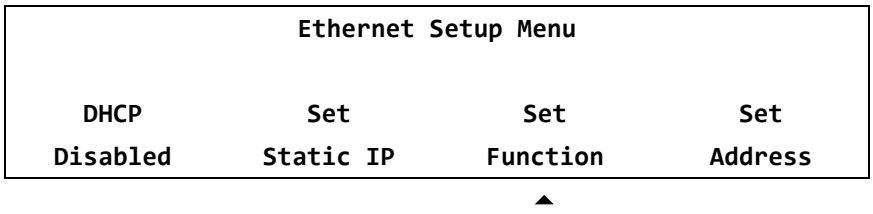
Select **Set Gateway** to set the gateway IP address.



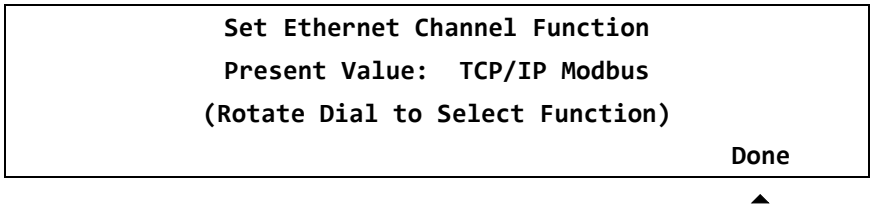
Use the selection knob to set each value. Press ← or → to switch between parameters. Select **Done** to enter the values.



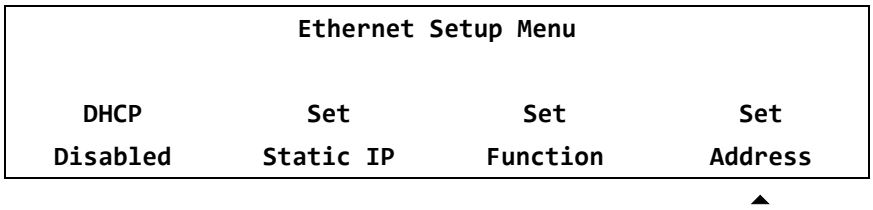
Select **Set Function** to set the function of the Ethernet interface.



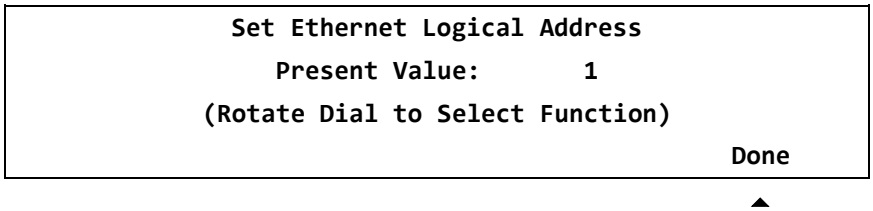
Use the selection knob to set the value. Select from **None** or **Modbus**. Select **Done** to enter the value.



Select **Set Address** to set the Modbus address of the Ethernet interface.

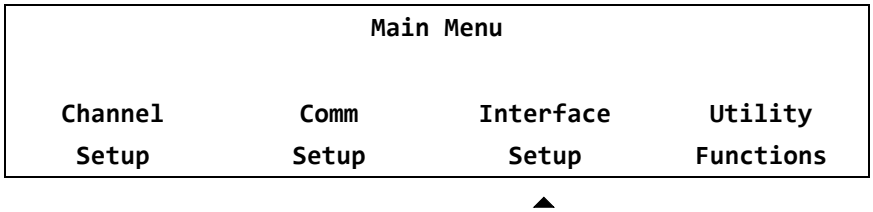


Use the selection knob to set the value. Select **Done** to enter the value.

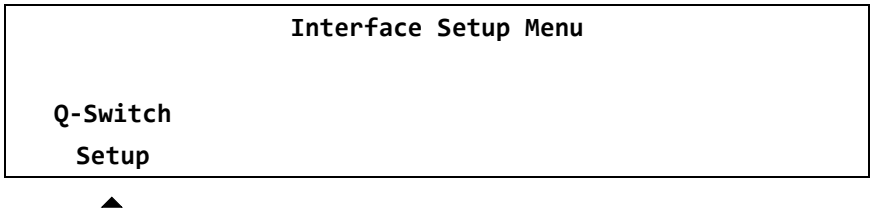


Interface Setup

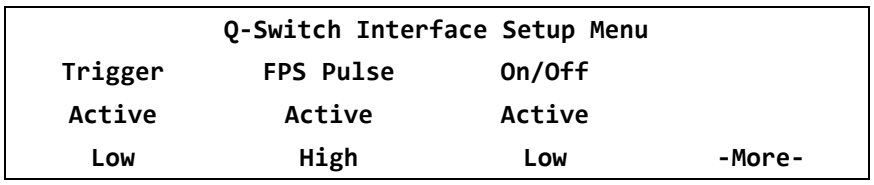
From the main menu, select **Interface Setup** to select the interface setup menus. Some eDrive-series products will have no additional interfaces to set up and this menu option will not be available.

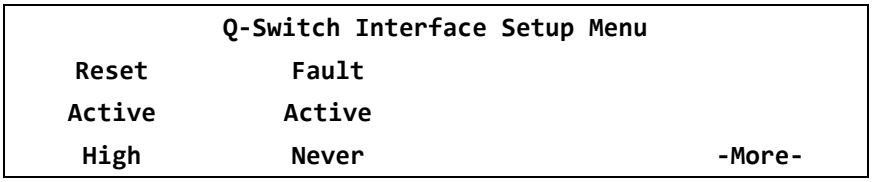


The Interface Setup Menu is used to configure the various miscellaneous interfaces in the eDrive other than serial ports. Select **Q-Switch Setup** (eDrive only).



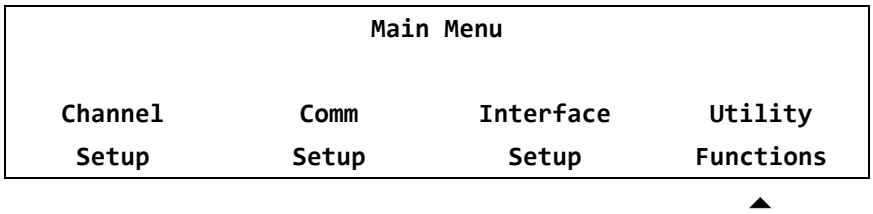
Set the logical sense of the various Q-switch interface signals using the signal options to match your Q-switch controller. Select **-More-** for additional options.



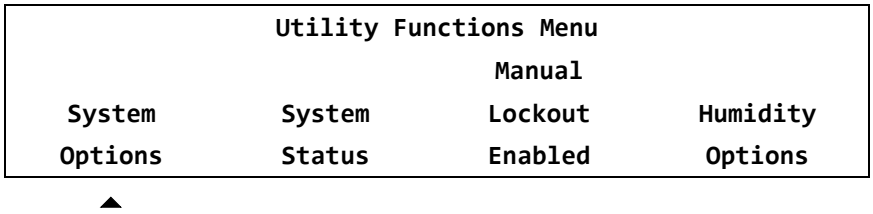


Utility Functions

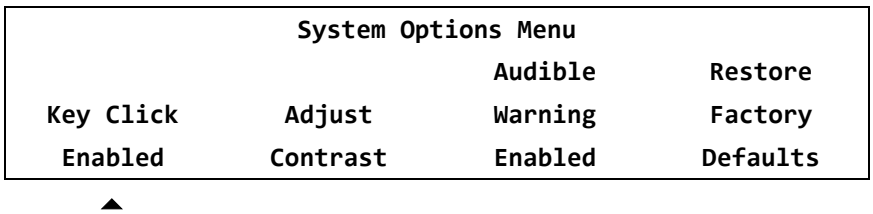
From the main menu display select **Utility Functions** to access the Utility Functions Menu.



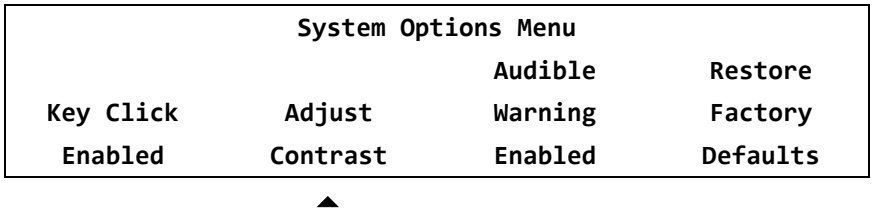
The Utility Functions Menu is used to set and read the various miscellaneous system-level parameters in the eDrive. Select **System Options**.



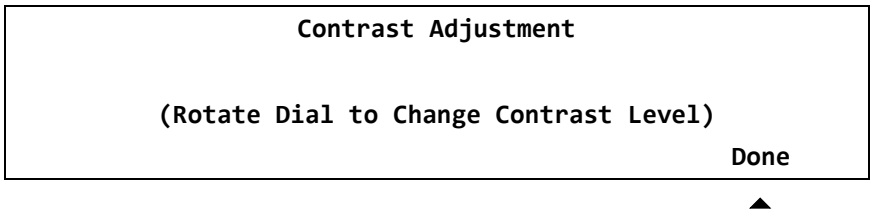
Select **Key Click Enabled** to cause the eDrive to produce an audible click when keys are pressed.



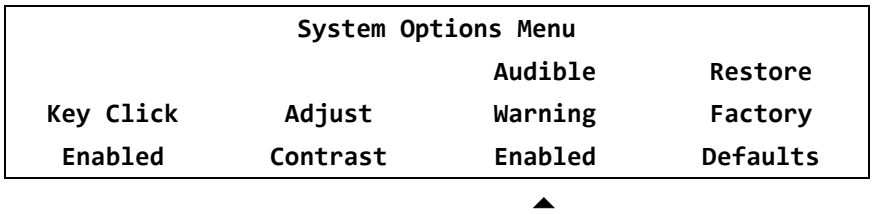
Select **Adjust Contrast** to adjust the LCD contrast based on your viewing angle.



When in contrast adjustment mode, use the rotary encoder to change the contrast and press any key to exit. Note that the system may prompt you to exit standby or active mode in order to enter contrast adjust mode. Select **Done** when adjustment is complete.



Select **Audible Warning Enabled** to cause the eDrive to produce a periodic audible beep when current is flowing to the laser as a safety reminder.



Select **Restore Factory Defaults** to return your eDrive to its factory configuration.

NOTE: Selecting this option will cause the eDrive to lose all of the setup parameters previously set. Be sure to record your configuration before restoring factory defaults.

```
                System Options Menu
                                    Audible      Restore
Key Click       Adjust              Warning      Factory
 Enabled        Contrast            Enabled      Defaults
                                                    ▲
```

Return to the Utility Functions Menu and select **System Status**.

```
                Utility Functions Menu
                                    Manual
System          System              Lockout      Humidity
Options         Status              Enabled      Options
                  ▲
```

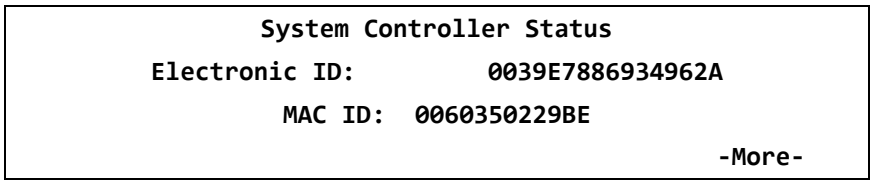
Select **Sys Ctrl**.

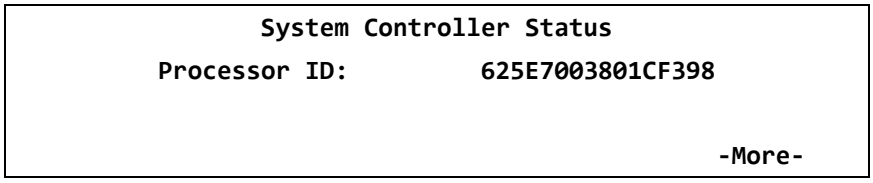
NOTE: Only eDrive Nitro drivers have expansion modules.

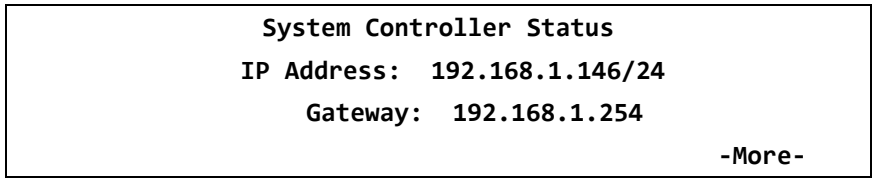
```
                System Status Menu


 Sys Ctrl       Expansion       Channel 1
    ▲
```

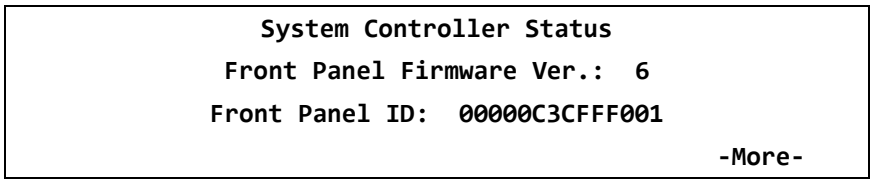
The eDrive will present consecutive screens of system information. Select **-More-** repeatedly.

```
              System Controller Status
               Firmware Version: 2.6.0
          Warranty Timer:        23 Hr 52 Min
                                                -More-
                                                   ▲
```





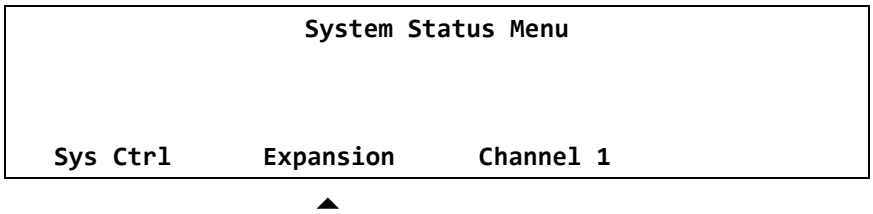




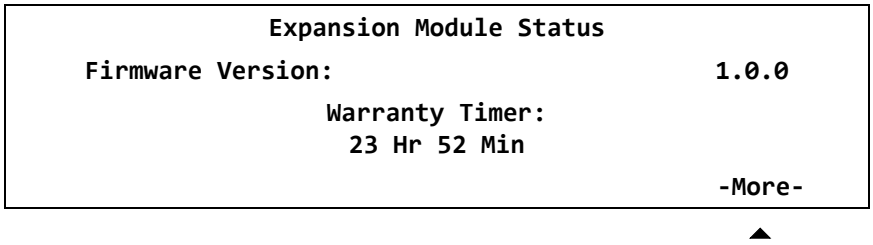
Press **MENU** to return to System Status Menu.

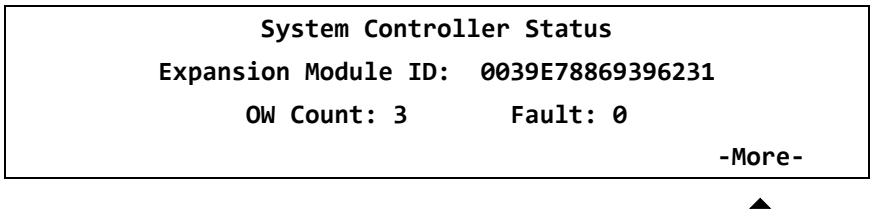
Select **Expansion**.

NOTE: Only eDrive Nitro drivers have expansion modules.

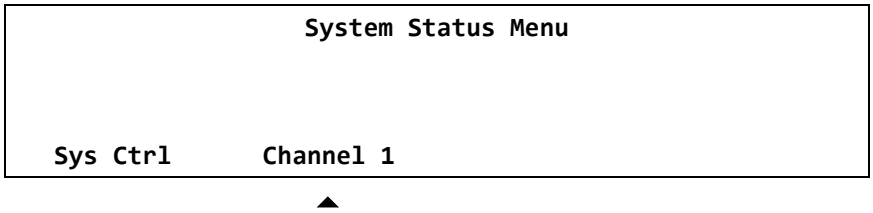


The eDrive will present consecutive screens of system information. Select **-More-** repeatedly.

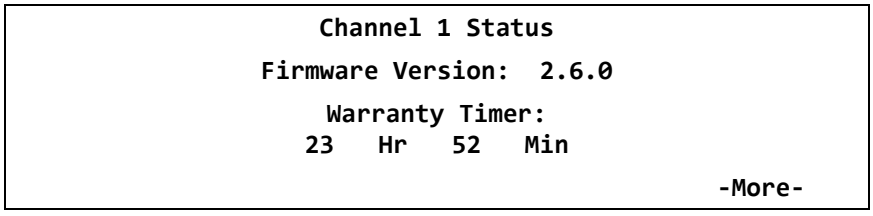


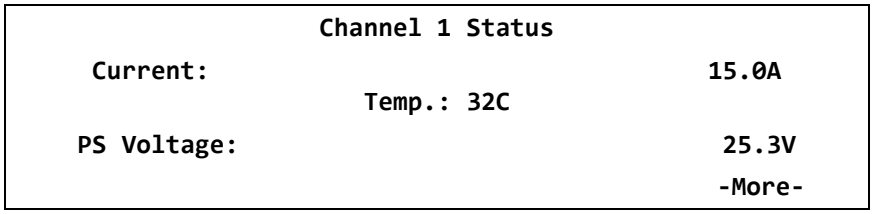


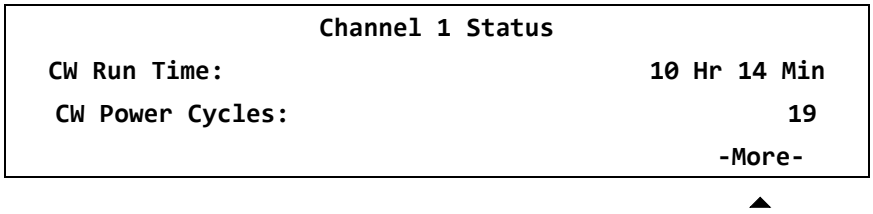
Select **Menu** to return to System Status Menu. Select **Channel 1**.

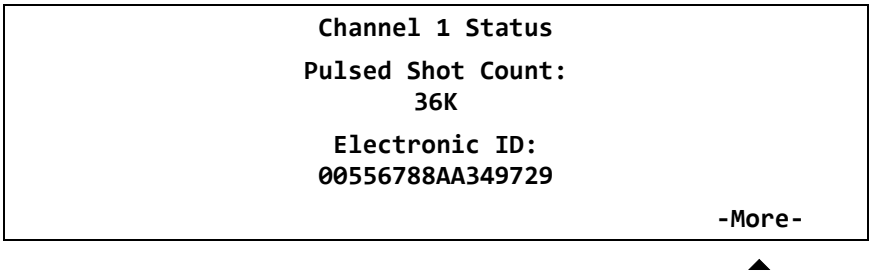


The eDrive will present consecutive screens of Channel 1 information. Select **-More-** repeatedly.

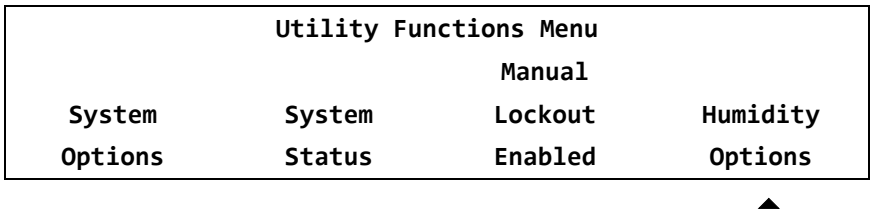




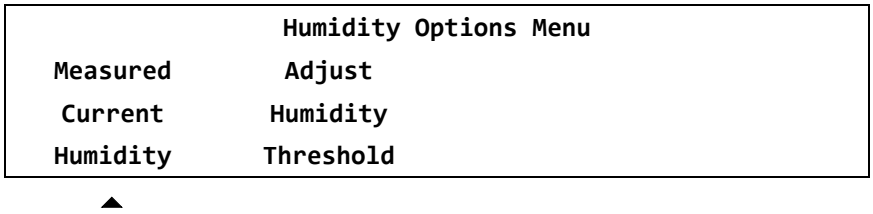




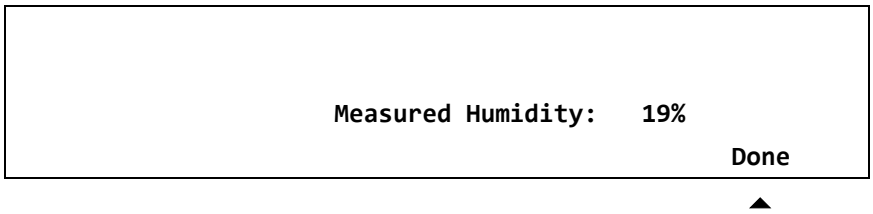
Return to the Utility Functions Menu and select **Humidity Options**.



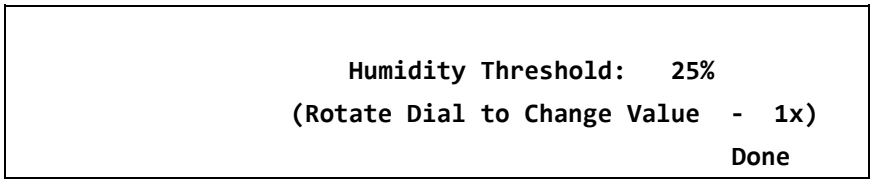
This is the Humidity Options Menu. Select **Measured Current Humidity**.



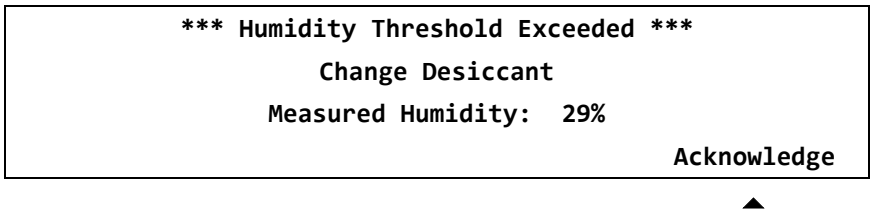
This menu will display the humidity level measured by the humidity sensor. Select **Done** to return to the Humidity Options Menu. Select **Adjust Humidity Threshold**.



When in adjust humidity threshold mode, use the rotary encoder to change the set point at which the user will be warned of excessive humidity. Select **Done** when adjustment is complete.



If the measured humidity level should exceed the humidity threshold set point, the eDrive will begin to beep and display the following menu. The warning will continue to display every 2 hours until the humidity level drops below the humidity threshold set point.



Select **Acknowledge** to return to the previous menu.

Quick Menus

The Quick Menus feature allows most of the functions to be disabled but provides access to the key features of the eDrive. To switch Quick Menus on and off, press and hold **MENU** for three seconds until the display changes.

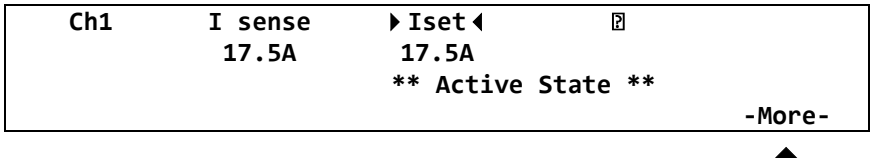
In Quick Menus, the configuration of the eDrive is not available. If the eDrive was configured for CW operation, then the CW Quick Menus will be displayed. If the eDrive was configured for QCW, or pulsed, operation, then the pulsed Quick Menus will be displayed.

In Quick Menus, the ▸ ◂ symbols indicate the parameter that will be modified with the selection knob. To switch between fine and course adjustment of the selected parameter, press and hold the selection knob until the selection symbols change. Fine adjustment is indicated by ▸ ◂ , coarse adjustment is indicated by ⏩ ⏪. (Some parameters may have three levels.)

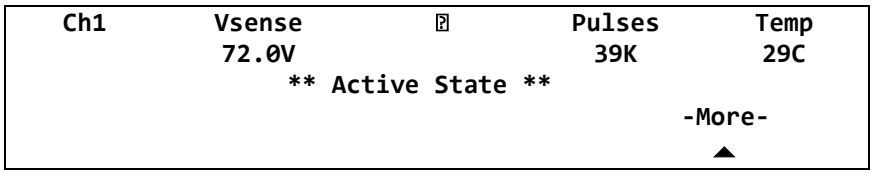
CW Quick Menus

On Display 1 of the CW-mode Quick Menu use the selection knob to adjust the current amplitude.

Press the selection knob to change adjustment sensitivity. Select **-More-** to switch to CW-mode Display 2.



There are no parameters that can be set in Display 2 of the CW-mode Quick Menus. Select **-More-** to switch to CW-mode Display 3.



The CW-mode Quick Menus Display 3 may not be present if the Q-switch has been disabled. Select ← or → to switch between parameters. Select **-More-** to switch to return to Display 1.

```
Q-Switch                 ▯          ▸Offset◂          PW
                                     +150.0us        50.00us
                        ** Active State **
                        <-             ->            -More-
                                                       ▲
```

Pulse-Mode Quick Menus

In Display 1 of the pulse-mode Quick Menus use the selection knob to adjust the current amplitude.

```
  Ch1        I sense       ▸Iset◂          Freq          PW
             17.5A          17.5A          500HZ        10.0us
                          ** Active State **
                            <-             ->           -More-
```

Press the selection knob to change adjustment sensitivity.

```
  Ch1        I sense      ⏩Iset⏪          Freq          PW
             17.5A          17.5A          500HZ        10.0us
                          ** Active State **
                            <-             ->           -More-
```

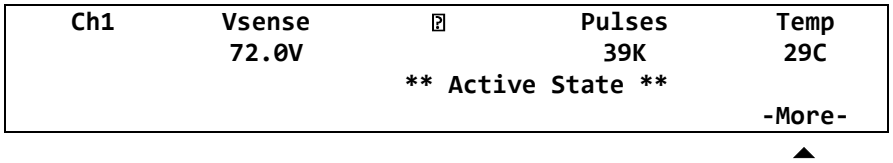
Select ← or → to switch between parameters.

```
  Ch1        I sense       Iset          ▸Freq◂          PW
             17.5A         17.5A          500HZ        10.0us
                          ** Active State **
                            <-             ->           -More-
                                                          ▲
```

Select **-More-** to switch to pulse-mode Display 2.

```
  Ch1        I sense       Iset          ▸Freq◂          PW
             17.5A         17.5A          500HZ        10.0us
                          ** Active State **
                            <-             ->           -More-
                                                          ▲
```

In Display 2 of the pulse-mode Quick Menus there are no parameters that can be set. Select **-More-** to switch to pulse-mode Display 3.

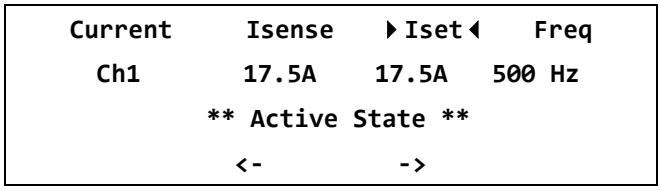


Display 3 of the pulse-mode Quick Menus may not be present if the Q-switch has been disabled. Select **-More-** to switch to return to Display 1.

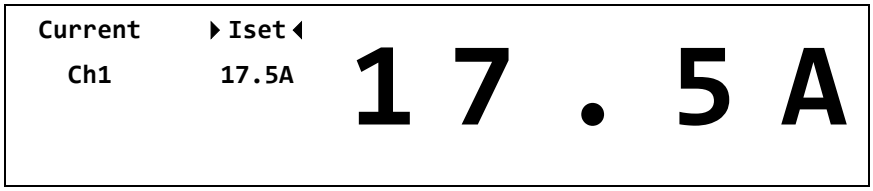
Current Monitor Menu

This convenient menu brings the quick access feature of the Quick Menus to the Standard Menus system. This mode is accessed by pressing **CURRENT** and is only accessible while in Standard Menus mode.

Refer to the *Quick Menus* section for operation of these menus.



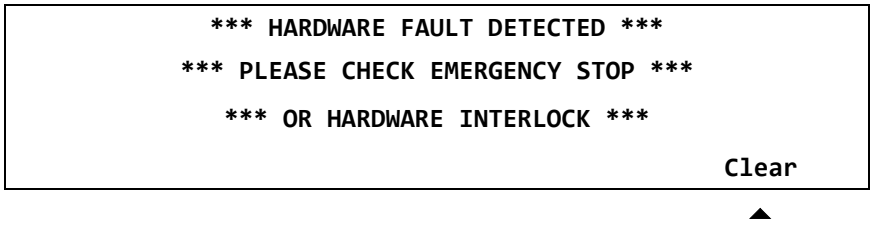
Press **MENU** to return to the Standard Menus or press **CURRENT** again to enter the large current display. This mode assists in viewing the driver current from a distance.



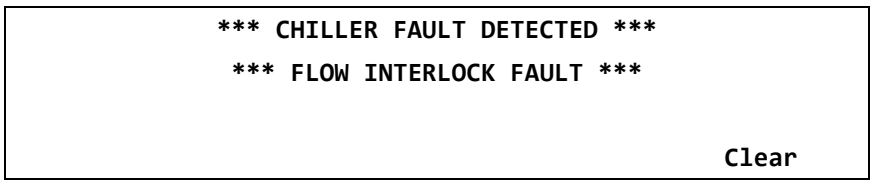
Error Displays

The eDrive will display error messages when a fault occurs.

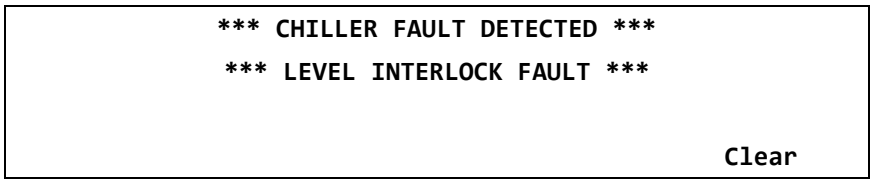
This display appears when the emergency stop switch or user interlock is activated. Correct the fault and then select **Clear**.



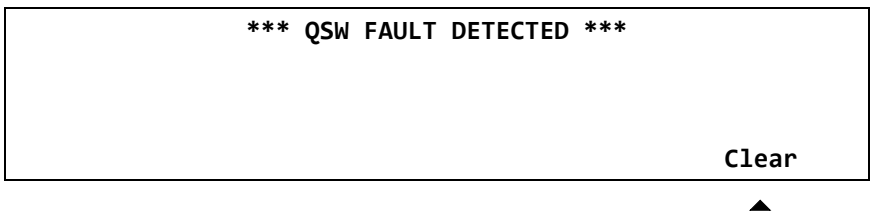
This display appears when the chiller interface connector coolant flow interlock faults. Correct the fault and then select **Clear**.



This display appears when the chiller interface connector coolant level interlock faults. Correct the fault and then select **Clear**.



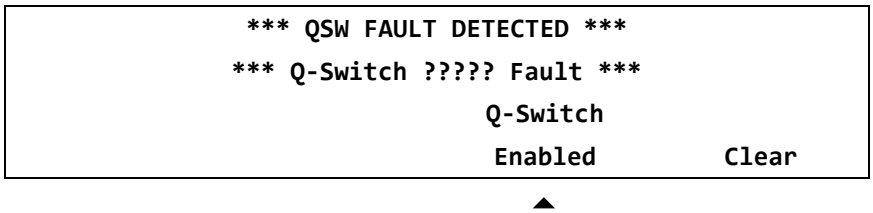
This display appears when the Q-switch interface connector fault signal is asserted (eDrive only). The state of the signal that triggers the fault is set by the menus. Correct the fault and then select **Clear**. If you cannot clear the fault at the connector interface, power the eDrive off and then on to restore normal operation.



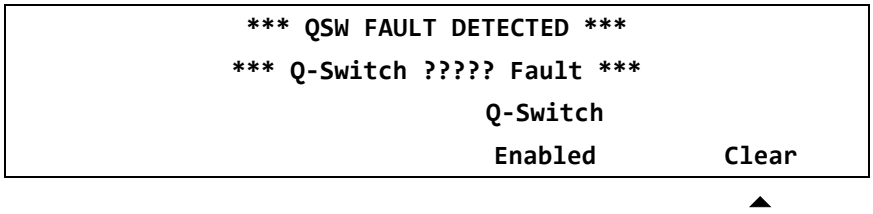
This display appears when one of the internal Q-switch fault signals is asserted (eDrive Nitro and Aero only). Correct the fault and then select **Clear**. If you cannot clear the fault at the connector interface, power the eDrive off and then on to restore normal operation.

NOTE: Note that the internal Q-switch driver has multiple fault modes. The specific fault will be identified in the fault window below where the ????? are shown. Refer to *Chapter 3: Operating Basics* for details on this feature.

Select **Q-Switch Enabled** to toggle the state of the RF driver to disabled if you wish to continue using the driver without correcting the fault.



Select **Clear** to clear the fault display after correcting the fault.



A

Appendix A: Specifications

This appendix provides the following information:

- Operational specifications
- Miscellaneous specifications
- Electrical specifications
- eDrive mechanical outline
- eDrive Nitro and Aero mechanical outline
- Model numbers

Operational Specifications

Table A-1 shows the operational specifications for air and water cooled eDrive 300A.

Table A-1. Operational Specifications for eDrive 300A

	Air Cooled 300A		Water Cooled 300A	
	CW	**QCW**	**CW**	**QCW**
Amplitude:				
Output Current	50 A	≤100.0% D.C. @ 50 A	70 A	≤100.0% D.C. @ 70 A
	-----	≤15.0% D.C. @ 140 A	-----	≤50.0% @1 00 A
	-----	≤12.5% D.C. @ 160 A	-----	≤15.0% D.C. @ 200 A
	-----	≤10.0% D.C. @ 190 A	-----	≤7.0% @ 300 A
	-----	≤7.5% D.C. @ 240 A	-----	-----
	-----	≤5.0% D.C. @ 270 A	-----	-----
	-----	≤4.0% D.C. @ 300 A	-----	-----
Display Resolution	100 mA	100 mA	100 mA	100 mA
Accuracy	2%	2%	2%	2%
Noise	<200 mA_{peak}	< 200 mA_{peak}	<200 mA_{peak}	< 200 mA_{peak}

Table A-2 shows the operational specifications for air cooled and water cooled eDrive 100A.

Table A-2. Operational Specifications for the eDrive 100A

	Air Cooled 100A		Water Cooled 100A	
	CW	**QCW**	**CW**	**QCW**
Amplitude:				
Output Current	50 A	≤30.0% D.C. @ 100 A	70 A	≤70.0% D.C. @ 100 A
Display Resolution	100 mA	100 mA	100 mA	100 mA
Accuracy	2%	2%	2%	2%
Noise	< 200 mA_{peak}	< 200 mA_{peak}	<200 mA_{peak}	< 200 mA_{peak}
Pulse Rate:				
Range (kHz)	-----	2 Hz – 50	-----	2 Hz – 50
Display Resolution				
(1 Hz)	-----	0 – 100 Hz	-----	0 – 100 Hz
(10 Hz)	-----	100 – 1 kHz	-----	100 – 1 kHz
(100 Hz)	-----	1 – 50 kHz	-----	1 – 50 kHz
Accuracy	-----	± 2%	-----	± 2%
Pulse Width:				
Range	-----	10 μs – 100 ms	-----	10 μs – 100 ms
Display Resolution	-----	100 ns	-----	100 ns
Transition Time	-----	5 μs (typ)	-----	5 μs (typ)
Trigger In:				
Type	-----	Positive edge triggered	-----	Positive edge triggered

	Air Cooled 100A		Water Cooled 100A	
	CW	**QCW**	**CW**	**QCW**
Signal Input	-----	TTL or 5 V CMOS	-----	TTL or 5 V CMOS
Minimum Width	-----	50 μs	-----	50 μs
Input Impedance	-----	50 Ω	-----	50 Ω
Voltage Compliance[2]	0 – 350 V	0 – 350 V	0 – 350 V	0 – 350 V
Display Resolution	0.1 V	0.1 V	0.1 V	0.1 V
Accuracy	± 2%	± 2%	± 2%	± 2%

Miscellaneous Specifications

Table A-3 illustrates specifications for CW and QCW, air cooled and water cooled eDrive.

Table A-3. Specifications for CW and QCW eDrive

	Air Cooled		Water Cooled	
	CW	**QCW**	**CW**	**QCW**
Operating Temperature:	0 – 40 °C	0 – 40 °C	0 – 40 °C	0 – 40 °C
Operating Humidity:	0-80% Non-Condensing	0-80% Non-Condensing	0-80% Non-Condensing	0-80% Non-Condensing
Pulse Width:				
Range	-----	10 μs – 500 ms	-----	10 μs – 500 ms
Display Resolution	-----	100 ns	-----	100 ns
Transition Time	-----	5 μs (typ)	-----	5 μs (typ)
Current Monitor:	**100A**			
Output Voltage (10 A/V)	0 – 10 V	0 – 10 V	0 – 10 V	0 – 10 V
Accuracy	± 2%	± 2%	± 2%	± 2%
Current Monitor:	**300A**			
Output Voltage (20 A/V)	0 – 15 V	0 – 15 V	0 – 15 V	0 – 15 V
Accuracy	± 2%	± 2%	± 2%	± 2%
Humidity Monitor:				
Humidity Range	0-100% RH	0-100% RH	0-100% RH	0-100% RH
Accuracy (1 - 20% RH @23 °C)	± 3% RH	± 3% RH	± 3% RH	± 3% RH
Water Cooling:				
Pressure Drop	-----	-----	0.5 PSI	0.5 PSI
Maximum Pressure	-----	-----	60 PSI	60 PSI
Minimum Coolant Flow Rate	-----	-----	1 GPM	1 GPM

[1] Compliance voltage is defined as the maximum voltage a current source will reach to source the programmed current. In the case of the eDrive, the compliance voltage is the maximum voltage that can be applied to the diode array in order to achieve the desired current flow.

[2] The eDrive has been tested to comply with the requirements for CE marking for compliance voltages up to 60 V. For compliance voltages in excess of 60 V, contact the factory for more information.

NOTE: User must minimize overload voltage. Refer to *Chapter 3: Operating Basics*.

Electrical Specifications

Table A-4. Input Power Specifications for the eDrive (Base)

AC Input		Frequency
100-240 VAC	4 A max.	50/60 Hz

Table A-5. Input Power Specifications for the eDrive Nitro, Aero

AC Input		Frequency	Fuse Ratings (F1, F2)
120V ±10%	15 A	50/60 Hz	T 15 A 250 V
240V ±10%	8 A	50/60 Hz	T 8 A 250 V
Fuse Dimensions: 0.25 inches x 1.25 inches			

eDrive Mechanical Outline

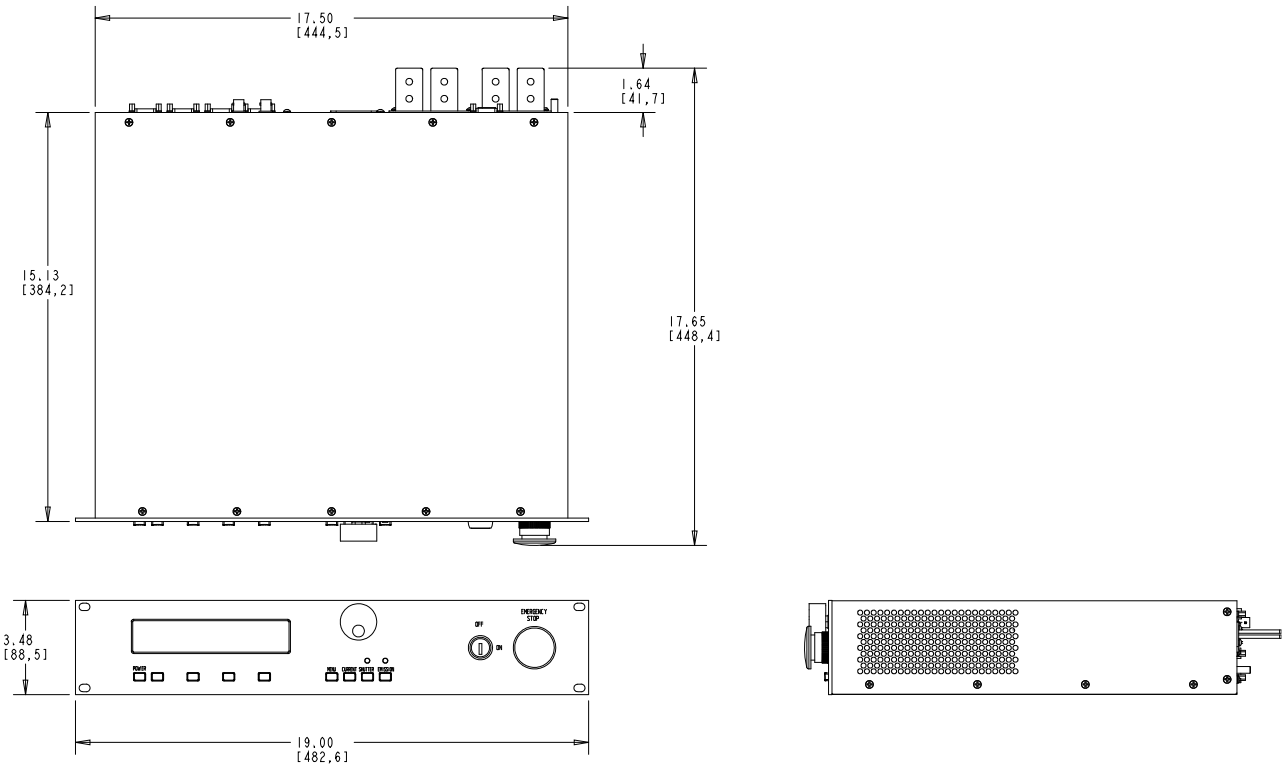


Figure A-1. eDrive Mechanical Outline

eDrive Nitro and Aero Mechanical Outline

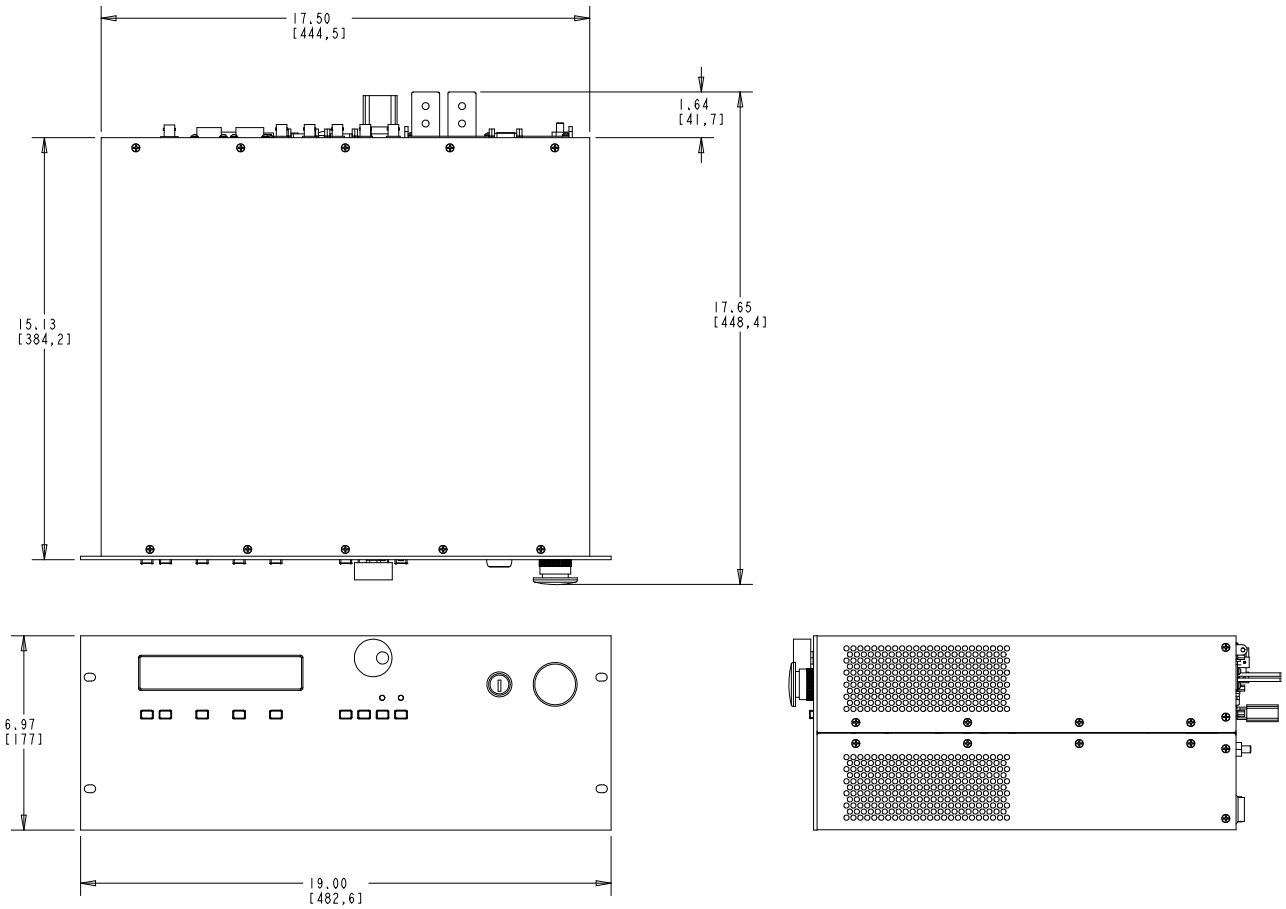


Figure A-2. Nitro and Aero Mechanical Outline

Model Numbers

eDrive Base Model Number

Build an eDrive model number using the following guide.

NOTE: This guideline may become outdated as new features are added.

Model[1..2]. These characters of the model number are always “ED” (indicates that this is an eDrive).

Model[3]. This character indicates the chassis size.
2: 2U
4: 4U

Model[4]. This character indicates the operational modes of the driver.
C: CW operation only
P: CW or QCW (pulsed) operation
L: fiber laser product (see Aero part number extension)

Model[5..7]. These characters are always “-AX” for the standard product.

Model[8]. This character indicates the cooling method used.
A: air-cooled
W: water-cooled

If the driver is an eDrive (2U), the model number ends at this point.

eDrive Nitro Model Number

If the driver is an eDrive Nitro, continue the base model number above with these characters.

Model[9]. This character is always a “-”.

Model[10..12]. These characters indicate the rated voltage of the internal power supply (in volts). The range of this field will typically be 3 to 25 volts above the expected output voltage depending on delivered current. If the value is less than 100, only two digits will be utilized.

Model[13..14]. These characters indicate the maximum rated current of the internal power supply (in amperes). The range of this field will typically be 20 to 100 A.

Model[15]. This character indicates the number of Q-switch radio frequency (RF) outputs provided.
N: a single-output RF output is provided (27 MHz, 50 W)
D: a dual-output RF output is provided (27 MHz, 100 W)
X: no RF driver is utilized

Model[16]. This character is always a "-".

Model[17..20]. These characters are for factory use only.

The model number ends at this point.

eDrive Aero Model Number

If the driver is an eDrive Aero, continue the base model number above with these characters.

Model[9]. This character is always a "-".

Model[10..12]. These characters indicate the rated optical power output in watts.

Model[13]. This character indicates the operational modes of the driver.
C: CW operation only
P: CW or QCW (pulsed) operation

Model[14..17]. These characters indicate the optical output target wavelength in nanometers.

Model[18]. This character is always a "-".

Model[19]. This character indicates the number of Q-switch RF outputs provided.
A: a single-output RF output is provided (80 MHz, 15 W)
B: a dual-output RF driver is provided (80 MHz, 30 W)
X: no RF driver is utilized

Model[20..22]. These characters indicate the diameter of the output fiber core in microns.

Model[23]. This character is always a "-".

Model[24..27]. These characters are for factory use only.

Model Number Examples

The part number:

ED4P-AXW-2037D-0010

indicates that this unit:

- is an eDrive in a 4U enclosure
- is capable of both CW and QCW operation
- is water-cooled
- has a power supply rated for 20V/37A
- has a dual-output RF Q-switch driver.

The part number:

ED4L-AXA-130C0808-A600-0010

indicates that this unit:

- is an eDrive in a 4U enclosure
- contains a fiber pump source (eDrive Aero)
- is air-cooled
- has a 130 W optical power output
- operates in CW mode only
- delivers output power at 808nm
- has a single 80 MHz, 15 W RF output
- delivers its output into a 600 micron fiber optic
- has a dual-output RF Q-switch driver

B

Appendix B: Connector Interfaces

This appendix contains information on the various connector interfaces present on the eDrive and eDrive Nitro. These connector interfaces include:

- RS-232 Channels 0, 1
- RS-232 Channel 2
- RS-485
- External sensors
- Chiller
- CAN bus
- Q-switch driver
- Trigger/Gate in
- Trigger out
- Current monitor
- Q-switch interlock
- Radio frequency (RF) Out 1, 2
- Interlock
- Interlock
- Laser interface
- Fiber optic output
- Ethernet
- Power supply input and array output lugs
- Array output connector
- AC power inlet

Table B-1. Key

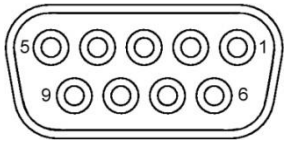
Type	Meaning
-	No connection
I	Input
O	Output
I/O	Input/Output (bidirectional)
P	Power
G	Ground/Signal Reference

RS-232 Channels 0, 1

This connector provides a general-purpose RS-232 serial port. It may be used for serial port remote control or in custom applications. Consult factory for options. For RS-232 communications with a standard PC serial port, use a straight-through, male-to-female serial cable. See *Appendix C: Accessories* for ordering information.

Connector type: 9-position D-sub receptacle.

Table B-2. RS-232 Channels 0,1



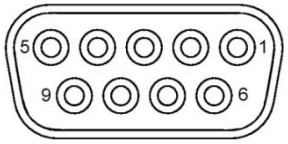
Pin	Name	Type	Function
1	No connection	-	-
2	Transmit Data	O	Serial data output
3	Receive Data	I	Serial data input
4	Data Terminal Ready	I	Reserved
5	Signal Ground	G	Signal reference
6	Data Set Ready	O	Reserved
7	No connection	-	-
8	No connection	-	-
9	No connection	-	-

RS-232 Channel 2

This connector provides a general-purpose RS-232 serial port but is supported for maintenance and custom applications only. Consult factory for options. For RS-232 communications with a standard PC serial port, use a straight-through, male-to-female serial cable. See *Appendix C: Accessories* for ordering information.

Connector type: 9-position D-sub receptacle.

Table B-3. RS-232 Channel 2



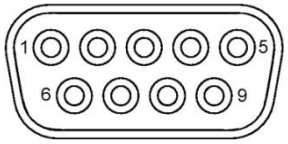
Pin	Name	Type	Function
1	No connection	-	-
2	Transmit Data	O	Serial data output
3	Receive Data	I	Serial data input
4	Reset	I	Reserved for factory test
5	Signal Ground	G	Signal reference
6	No connection	-	-
7	No connection	-	-
8	No connection	-	-
9	No connection	-	-

RS-485

This connector provides a general purpose RS-485 serial port. It may be used for serial port remote control or in custom applications. In addition to the serial port function, there are two trigger outputs that can be used to trigger external array interface modules (AIM). Consult factory for options.

Connector type: 9-position D-sub receptacle.

Table B-4. RS-485



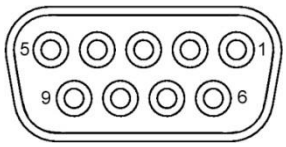
Pin	Name	Type	Function
1	Trigger 1	O	Trigger signal for an external AIM. Active high.
2	Trigger 2	O	Trigger signal for an external AIM. Active high.
3	No connection	-	-
4	Data (-)	I/O	Serial data bus
5	Signal Ground	G	Signal reference
6	Signal Ground	G	Signal reference
7	Signal Ground	G	Signal reference
8	Data (+)	I/O	Serial data bus
9	No connection	-	-

External Sensors (2U eDrive only)

This connector provides miscellaneous signals that are used in typical laser systems and that may be employed in custom applications. Consult factory for options.

Connector type: 9-position D-sub receptacle

Table B-5. External Sensors



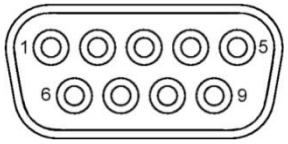
Pin	Name	Type	Function
1	Fused 5 V	P	Provides 5V out up to 1 A for external sensors, controls, etc.
2	Ground	G	Signal reference
3	Sensor Bus (+)	I/O	This serial communications bus supports optional sensor and control accessories useful in laser systems.
4	Sensor Bus (-)	G	
5	Laser On Light	O	This ground/open signal is capable of sinking up to 1 A and is used to activate a Laser On safety light. This signal mimics the function of the front panel Emission light. Active low. See *Chapter 4: Application Examples*.
6	Debug Transmit Data	O	Reserved for factory use.
7	Debug Receive Data	I	Reserved for factory use.
8	Ground	G	Signal reference
9	Shutter Control Output	O	This ground/open signal is capable of sinking up to 1A and is used to activate a shutter control circuit. This output is controlled with the front panel **SHUTTER** switch. Active low. See *Chapter 4: Application Examples*.

Chiller

This connector provides a chiller control interface. Chillers purchased with the eDrive may be connected to this interface for integrated control. The dedicated RS-485 interface provides a communications channel for temperature control. Power control and operational interlocks are also available. Consult factory for options.

Connector type: 9-position D-sub receptacle.

Table B-6. Chiller



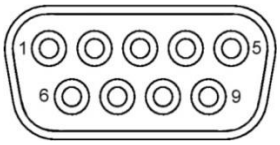
Pin	Name	Type	Function
1	Chiller Flow Interlock	I	This ground/open input indicates to the eDrive that the there is a coolant flow fault. Short to ground for normal operation.
2	Ground	G	Signal reference
3	Chiller Power Control 1	O	This signal, along with Chiller Power Control 2, is used to control the power of the external chiller. This signal along with Power Control 2 provides a dry contact relay output. Max current is 1 A. Applied voltage should not exceed 28 VDC.
4	Ground	G	Signal reference
5	Chiller Power Control 2	O	This signal, along with Chiller Power Control 1, is used to control the power of the external chiller. This signal along with Power Control 1 provides a dry contact relay output. Max current is 1 A. Applied voltage should not exceed 28 VDC.
6	Data (-)	I/O	Serial data bus for chiller communications.
7	Data (+)	I/O	
8	Chiller Level Interlock	I	This ground/open input indicates to the eDrive that the there is a coolant level fault on the chiller. Short to ground for normal operation.
9	Ground	G	Signal reference

CAN Bus

This connector provides a general-purpose CAN bus serial port but is supported for custom applications only. Consult factory for options.

Connector type: 9-position D-sub receptacle.

Table B-7. CAN Bus



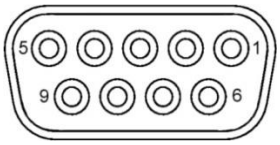
Pin	Name	Type	Function
1	No connection	-	-
2	Data (-)	I/O	Serial data bus
3	Signal Ground	G	Signal reference
4	No connection	-	-
5	No connection	-	-
6	Signal Ground	G	Signal reference
7	Data (+)	I/O	Serial data bus
8	No connection	-	-
9	Fused 5 V	O	Provides 5 V out up to 1 A

Q-Switch Driver (2U eDrive only)

This connector provides an interface to support an external Q-switch RF driver module.

Connector type: 9-position D-sub receptacle.

Table B-8. Q-Switch Driver



Pin	Name	Type	Function
1	Trigger	O	This signal triggers/enables the external RF module to inhibit its RF output to allow light to pass through the Q-switch. Active high or low (set by menu).
2	Enable	O	This signal enables external RF module operation. Active high or low (set by menu).
3	First Pulse Suppression	O	This signal triggers the RF driver to begin an amplitude-modulated ramp function to reduce the effective power of the first pulses of a new firing sequence. Active high or low (set by menu).
4	Fault	I	This signal indicates to the eDrive that there is an operational fault with the external RF driver module or Q-switch. Active high or low (set by menu).
5	Q-switch Reset	O	This signal is used to reset Q-switch RF driver fault conditions. Active high or low (set by menu).
6	Ground	G	Signal reference
7	Ground	G	Signal reference
8	Ground	G	Signal reference
9	Ground	G	Signal reference

Trigger/Gate In

This connector provides an interface to support an external pulse trigger input function or gate input function. Refer to *Chapter 2: Understanding Driver Functions* for information about using this connector. This signal is active high.

Connector type: BNC
Input impedance: 50Ω

Trigger Out

This connector provides an interface to support an external pulse trigger output function. Refer to *Chapter 2: Understanding Driver Functions* for information about using this connector. This signal is active high.

Connector type: BNC

Current Monitor

This connector provides an interface to facilitate measuring the amplitude of the current output. Refer to *Chapter 2: Understanding Driver Functions* for information about using this connector. Scale factor for this signal is 10 A per volt for 100A eDrives and 20 A per volt for 300A eDrives.

Connector type: BNC

To monitor the current pulse characteristics, connect an external clamp-on current probe to the eDrive output or connect a BNC cable to the **CURRENT MONITOR** output shown in **Figure B-1**.

Figure B-1. Current Monitor Connector

Connect either the current probe or cable to an oscilloscope (See **CAUTION** below if connecting BNC cable to **CURRENT MONITOR**). Follow the procedures outlined in the *Setting the Array Power Supply section* for setting the power supply.

CAUTION: If using an oscilloscope to measure the current monitor voltage, the oscilloscope should be floating (using a ground isolator on the oscilloscope power cord). If the scope is grounded, the diode current can pass through a ground loop (shown in **Figure B-2**) and burn the current monitor negative wire (**Figure B-3**). The presence of a ground loop bypassing the FET could potentially also result in damage to the hardware being controlled by the eDrive.

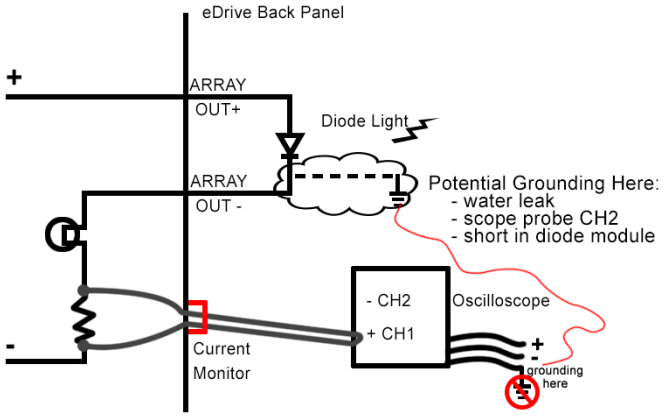


Figure B-2. Current Monitor Ground Loop

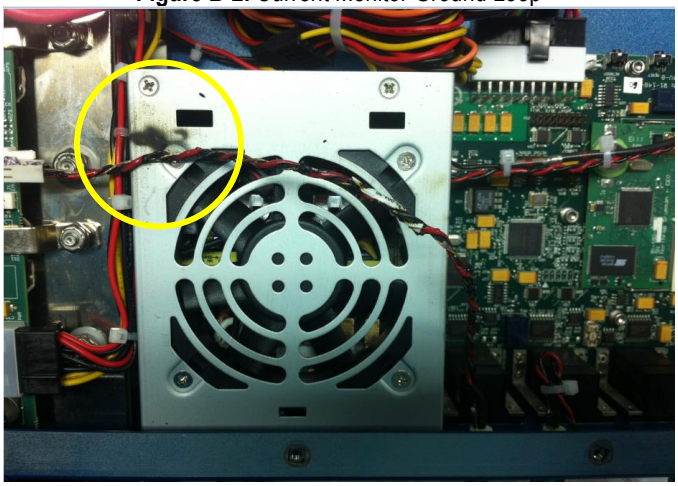


Figure B-3. Burned Current Monitor Negative Wire

Q-Switch Interlock (4U eDrive Nitro/Aero only)

This connector provides an interface to thermally interlock the Q-switch crystal with the eDrive. Refer to *Chapter 2: Understanding Driver Functions* for information about using this connector. The pin and shell must be shorted together for the RF driver to operate.

Connector type: BNC

RF Out 1, 2 (4U eDrive Nitro/Aero only)

These connectors provide RF modulated outputs to the Q-switch crystal(s) inside the laser. Refer to *Chapter 2: Understanding Driver Functions* for information about using this connector.

Connector type: BNC

Interlock (BNC)

This connector provides an interface to interlock the laser system or facility with the eDrive. Refer to *Chapter C: Understanding Driver Functions* for information about using this connector. The pin and shell must be shorted together for the RF driver to operate.

Connector type: BNC

Interlock (Plastic Housing, 4U eDrive Nitro/Aero only)

This connector provides an interface to interlock the laser system or facility with the eDrive. Refer to *Chapter 2: Understanding Driver Functions* for information about using this connector. The two pins must be shorted together for the RF driver to operate.

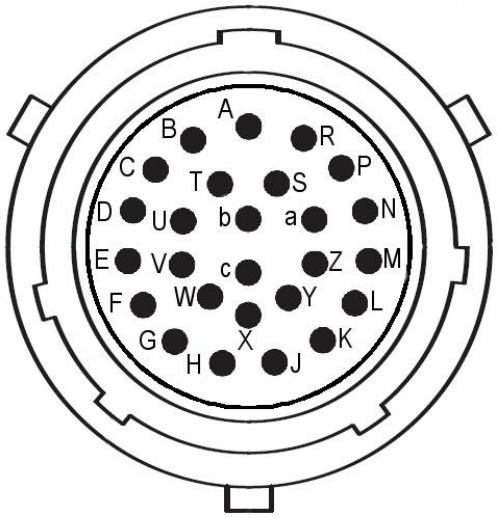
Connector type: AMP part 350778-1 (use mating AMP part 350777-1 and contacts 350689-1)

Laser Interface (eDrive Nitro/Aero only)

This connector provides an interface to connect the laser system control and monitor signals to the eDrive. Refer to *Chapter 2: Understanding Driver Functions* for information about using this connector.

Connector type: MS3472L16-26S. (Use mating connector MS3476L16-26P.)

Table B-9. Laser Interface



Pin	Name	Type	Function
A	Laser On Lamp (+)	O	This signal is used to drive an external laser on lamp on the laser housing. Output is 24 V. Keep isolated from other circuits. See *Chapter 2: Application Examples.*
B	Laser On Lamp (-)	O	
C	Shutter (+)	O	This signal is used to drive an external shutter solenoid in the laser. Output is 24 V, pulse width modulated to an average of 12 V. It is intended to drive a 12 V to 15 V actuator. Output is 24 V for a brief energize period and drops to 12 V_{avg} for continuous duty. See *Chapter 2: Application Examples.*

Pin	Name	Type	Function
D	Shutter (-)	O	
E	+5Vdc Return	G	Signal reference for Pins P and V
F	RS-485 Data (+)	I/O	Serial data bus. Consult factory for details.
G	RS-485 Data (-)	I/O	
H	Cover Interlock	I	This ground/open signal is used to indicate to the eDrive that the laser enclosure has been opened. Short to ground for normal operation. See *Chapter 2: Application Examples*.
J	Coolant Interlock	I	This ground/open signal is used to indicate to the eDrive that the coolant flow inside the laser system is insufficient to continue safe operation. Short to ground for normal operation. See *Chapter 2: Application Examples*.
K	Q-switch Thermal Interlock	I	This ground/open signal is used to indicate to the eDrive that the Q-switch crystal is too hot to continue operation. Short to ground for normal operation. See *Chapter 2: Application Examples.*
L	1-Wire Interface	I/O	Manufacturing use only
M	TEC-A	O	TEC output. Positive in heating mode. TEC output. Negative in cooling mode.
N	TEC-B	O	TEC output. Negative in heating mode. TEC output. Positive in cooling mode.
P	Relative Humidity	I	This signal is used for measuring relative humidity within the laser housing. Requires appropriate sensor located within laser.

R	Coolant Interlock Return	G	Signal reference for Pin J.
Pin	**Name**	**Type**	**Function**
S	+24Vdc Return	G	Power supply return for Pin T.
T	+24V	P	+24 V power supply output. This signal can supply up to 2 A per contact.
U	Laser Power	I	Reserved for laser power sensor input.
V	+5Vdc	P	+5 V DC power supply output. Supplies up to 2 A. Powers relative humidity sensor if present.
W	Cover Interlock Return	G	Signal reference for Pin H.
X	Q-Switch Thermal Interlock Return	G	Signal reference for Pin K.
Y	+15V		+15 V power supply output. This signal can supply up to 100 mA.
Z	-15V		-15 V power supply output. This signal can supply up to 100 mA.
a	±15Vdc Return	G	Power supply return for Pins Y, Z, and U.
b	Thermistor Input	I	TEC thermistor input.
c	Thermistor Input	I	TEC thermistor input.

Fiber Laser Output (4U eDrive Aero only)

This connector provides the output from the fiber pump source. A fiber optic cable should be connected from this Fiber SMA to your laser module.

Connector type: Fiber SMA

WARNING. Do not attempt to place the eDrive Aero into active emission with no fiber optic cable attached to this connector. Personal injury or damage to equipment may result.

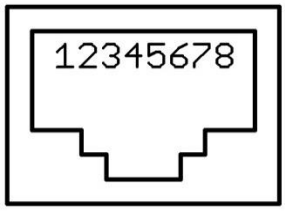
DANGER. This connector emits visible and invisible laser radiation. Avoid direct, indirect, or scattered exposure to eyes or skin. Damage to equipment or personnel may result. This is a Class IV laser product.

Ethernet

This connector provides an Ethernet interface to connect the eDrive to a network. This interface is only supported when the network support option is purchased. Use a standard straight-through Ethernet cable (EIA/TIA-568A) for connection to a hub or a standard cross-over cable (EIA-TIA-568B) for connection directly to a PC.

Connector type: RJ-45.

Table B-10. Ethernet



Pin	Name	Type
1	Transmit Data (+)	I/O
2	Transmit Data (-)	I/O
3	Receive Data (+)	I/O
4	Unused	-
5	Unused	-
6	Receive Data (-)	I/O
7	Unused	-
8	Unused	-

Power Supply Input and Array Output Lugs (select models only)

The power lugs are used to connect the eDrive to the external power supply and the laser diode array. To connect leads to these lugs, use 0.25 inch mounting hardware with either ring tongue terminals or two-hole compression lugs. See *Chapter 1: Getting Started* for tips on using the array power connections.

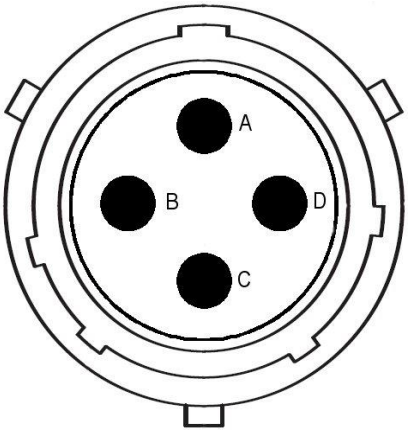
CAUTION. Electrical shock hazard. These power lugs can expose dangerous levels of electrical power. Do not touch these terminals unless the eDrive is removed from its power source. Damage to personnel may result, including death. Damage to equipment may result.

Array Output Connector (select models only)

The eDrive may be ordered with an optional circular array power output connector. This connector provides an alternate means of connecting lower power laser systems to the eDrive without using the power output lugs described above.

Connector type: MS3472L14-4S. (Use mating connector MS3476L14-4P.)

Table B-11. Array Output Connector



Pin	Name	Type	Function
A	Array Output (+)	O	These contacts provide array power output up to 20 A per pin.
B	Array Output (+)	O	
C	Array Output (-)	O	
D	Array Output (-)	O	

AC Power Inlet

This connector provides AC input power to the eDrive. See *Chapter 1: Getting Started* for input power requirements. For 220V/240V operation, the neutral (N) contact becomes a second line contact.

Connector Type: IEC 60320, C14.

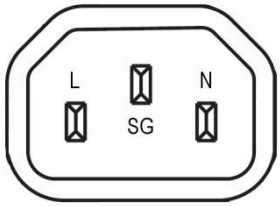


Figure B-1. AC Power Inlet

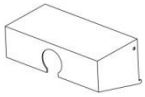
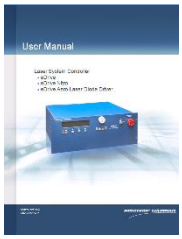
Appendix C: Accessories

This appendix describes the standard accessories available for the eDrive. All accessories are available by contacting your local NG sales office.

Standard Accessories

Some accessories come standard with your eDrive.

Table C-1. Standard Accessories

Picture	Item Number	Description
	88-003-10	AC Power Kit. North American (NEMA 5-15). 120 V, 15 A, 60 Hz. Includes fuses for both 120 V and 240 V operation.
	88-013-10	Bypass Connector Kit. Use to bypass unused interface connectors and interlocks. Includes three BNC shorting connectors, one interlock shorting connector, and one chiller bypass connector.
	88-023-10	Terminal Shroud. Use to safely cover the output lugs of the eDrive and to terminate the umbilical conduit from the laser system. Includes mounting hardware.
	CEO-UMAN-0001	User Manual.
	CEO-UMAN-0013	CD-ROM. The CD-ROM includes the User Manual and LabVIEW drivers. Additional documentation will be added as it is released.
	88-015-10	Keys. These keys are required to power on the eDrive.

Appendix D: Maintenance

This appendix describes general care and cleaning for your eDrive.

General Care

Do not store or leave the instrument where it will be exposed to direct sunlight for long periods of time.

CAUTION. To avoid damage to the instrument, do not expose the driver to sprays, liquids, or solvents.

Cleaning

Inspect the instrument as often as operating conditions require. To clean the exterior surfaces, perform the following steps:

1. Turn the system off and disconnect power.
2. Remove loose dust or dirt on the outside of the instrument with a lint-free cloth. Use care to avoid scratching the clear plastic display cover.
3. Disconnect power to the equipment, and clean the exterior of the equipment as needed. Use a soft cloth dampened with water to clean the instrument. Use an aqueous solution of 75 percent isopropyl alcohol for more efficient cleaning.

CAUTION. To avoid damage to the surface of the instrument, do not use any abrasive or chemical cleaning agents.

E

Appendix E: Cyclical Redundancy Check Calculations

This appendix explains the use of a cyclical redundancy check (CRC) in the serial protocol to ensure the integrity of the transmitted data. To help implement this feature in your control software, the following has been provided:

- Overview
- Procedural Description
- Code Example

Overview

The CRC value is calculated by the master, which appends the CRC to the message. The eDrive recalculates a CRC when a message is received and compares the calculated value to the value it received from the master. If the two values are not equal, an error is generated.

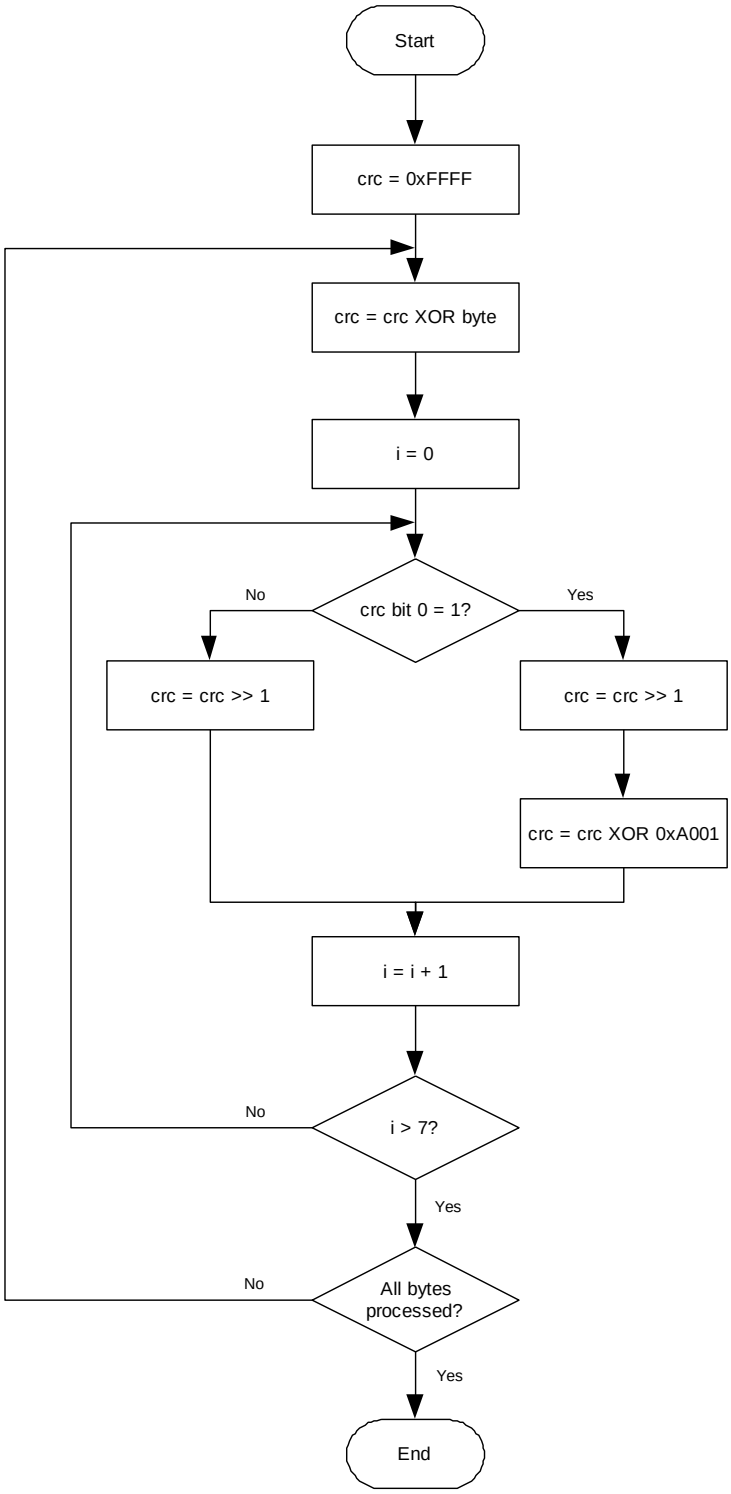
Procedural Description

A procedure for generating a CRC follows:

1. Load a 16-bit register with hex value 0xFFFF (0b1111 1111 1111 1111). Call this the CRC register.
2. Exclusive-OR the first 8-bit byte of the message with the low-order byte of the 16-bit CRC register, putting the result in the CRC register.
3. Check the LSB of the CRC register.
    a. If the LSB is 0, shift the CRC register one bit to the right, filling the now empty most significant bit (MSB) with 0.
    b. If the LSB is 1, shift the CRC register one bit to the right, filling the now empty MSB with 0. Now exclusive-OR the CRC register with the polynomial hex value 0xA001 (0b1010 0000 0000 0001).
4. Repeat step 3 until eight shifts have been performed. When this is done, a complete 8-bit byte will have been processed.
5. Repeat steps 2 through 4 for the next 8-bit byte of the message until all bytes have been processed.
6. The final contents of the CRC register is the CRC value

Flowchart

Figure E-1. Flowchart for CRC Algorithm



Code Example

The following code example demonstrates the implementation of the algorithm. The code is written in Python. The variable, “string”, is an example string for testing the calculation. The proper result for this string is “3A8C”.

```
string = '\x01\x05\x00\x00\xff\x00'
# initialize the crc and the poly.
crc = 0xFFFF
p16 = 0xA001

for char in string:
     # XOR the next byte with the lower 8 bits of the CRC.
     crc = crc ^ ord(char)

     for bit in range(8):
        if (crc & 0x0001):
           # if the LSB is 1, shift one to the right
           # and XOR 0xA001 with the crc.
           crc = crc >> 1
           crc = crc ^ p16
        else:
            # if the LSB is zero, just shift one to the
            right.
            crc = crc >> 1

print '%X' % crc

#klc
```

Appendix F: Acronyms

This appendix defines commonly used acronyms and abbreviations.

Table F-1. Acronyms

Acronym	Description
A	Ampere
AIM	Array Interface Modules
AO	Acousto-Optic
AWG	American Wire Gauge
CRC	Cyclical Redundancy Check
CW	Continuous Wave
DPSS	Diode-Pumped Solid State
EM	Expansion Module
FPS	First Pulse Suppression
HVSWR	High Voltage Standing Wave Ratio
IP	Internet Protocol
LSB	Least Significant Byte
mA	Milli-ampere
µs	Microsecond
ms	Millisecond
MBAP	Modbus Application Protocol Header
MOSFET	Metal Oxide Semiconductor Field Effect Transistor
MSB	Most Significant Byte
ns	Nanosecond
PID	Proportional-Integral-Derivative

Acronym	Description
PPK	Pre-Pulse Kill
PRF	Pulse Rate Frequency
PSI	Pounds per Square Inch
QCW	Quasi-Continuous Wave
RF	Radio Frequency
RMS	Root Mean Square
RoHS EU	Restriction of Hazardous Substances in the European Union
RTD	Resistance Temperature Detector
s	Second
SHG	Second Harmonic Generator
TEC	Thermal Electric Cooler
V	Volt
Va	Array Voltage
Vps	Power Supply Voltage
W	Watt
WEEE	Waste Electrical and Electronic Equipment

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