



# PCX-6425

Pulsed Current Source

## Operation Manual



Directed Energy, Inc.  
1609 Oakridge Dr., Suite 100, Fort Collins, CO 80525  
(970) 493-1901  
[sales@ixyscolorado.com](mailto:sales@ixyscolorado.com)  
[www.ixyscolorado.com](http://www.ixyscolorado.com)

Manual Document 7650-0020 Rev. A01



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# Safety

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- Always refer to the safe operating section of the manual for your model of the PCX-6425 system.
- Do not open the cover of the PCX-6425. There are no user-serviceable parts inside. Opening the cover exposes you to shock and voids the factory warranty.
- Do not install, handle, or remove the output cables or laser diode while the PCX-6425 is operating. Allow at least 10 minutes after powering down before handling the output cable or laser diode.
- Do not use this device in a manner not specified by the manufacturer.
- Allow sufficient space around this device for air circulation. Cooling air enters the left side of the chassis and exits the right of the chassis, as facing the chassis from the front.
- Do not use where liquids are present or in corrosive environments. Clean this instrument by wiping with a dry or damp cloth.

## **WARNING**

**Risk of lethal electric shock. Do not open the cabinet of this device. Do not touch the output or laser diode while it is operating. This device produces LETHAL levels of electric current, both inside its cabinet and at its output.**

DO NOT OPERATE THIS DEVICE UNLESS ANOTHER PERSON, CAPABLE OF RENDERING FIRST AID OR RESUSCITATION, IS PRESENT.

SAFE AND PROPER OPERATION OF THIS DEVICE IS THE RESPONSIBILITY OF THE USER.

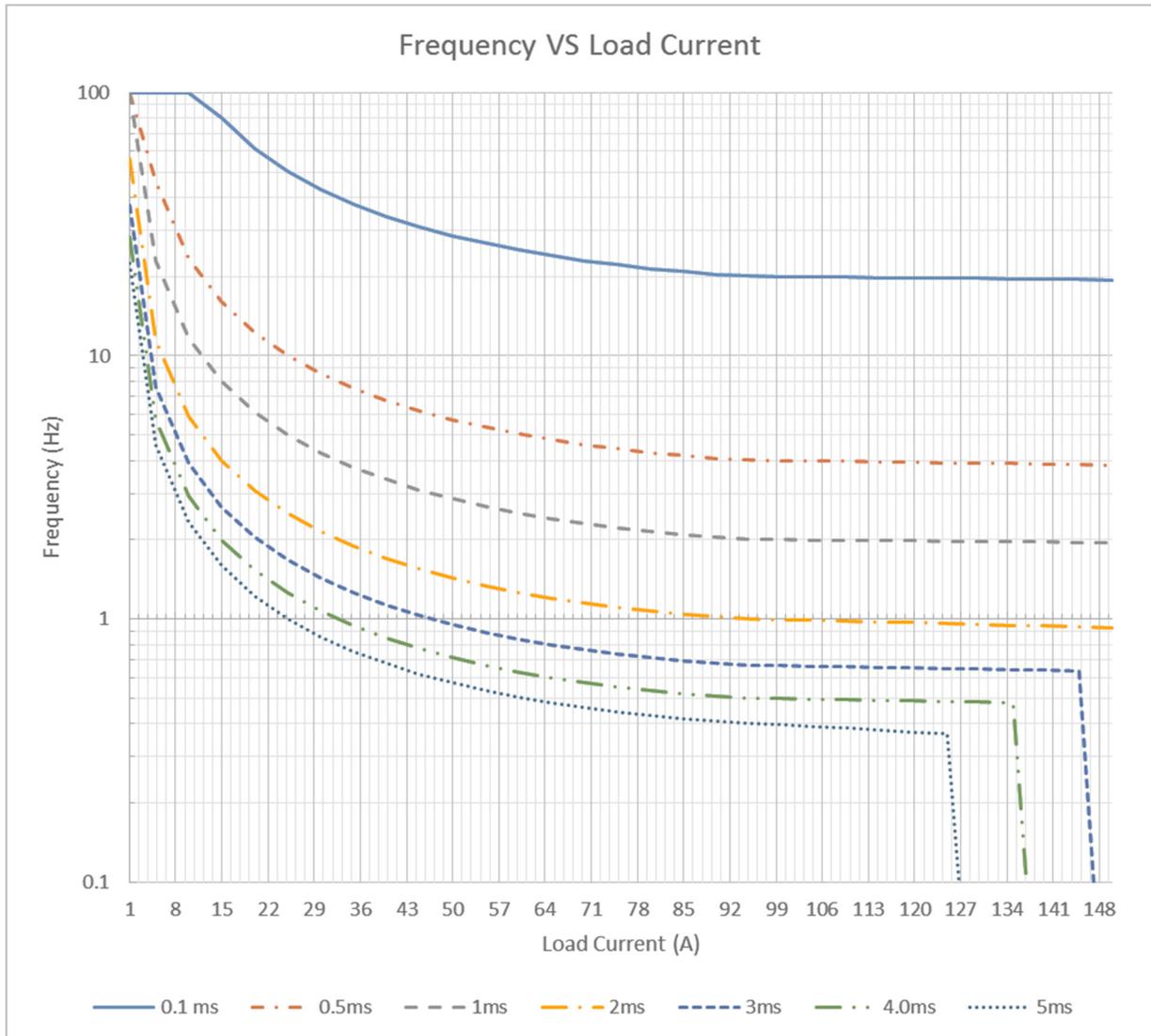
Directed Energy, Inc. (DEI) provides information on its products and associated hazards, but it assumes no responsibility for the after-sale operation and safety practices.

# Safe Operating Area

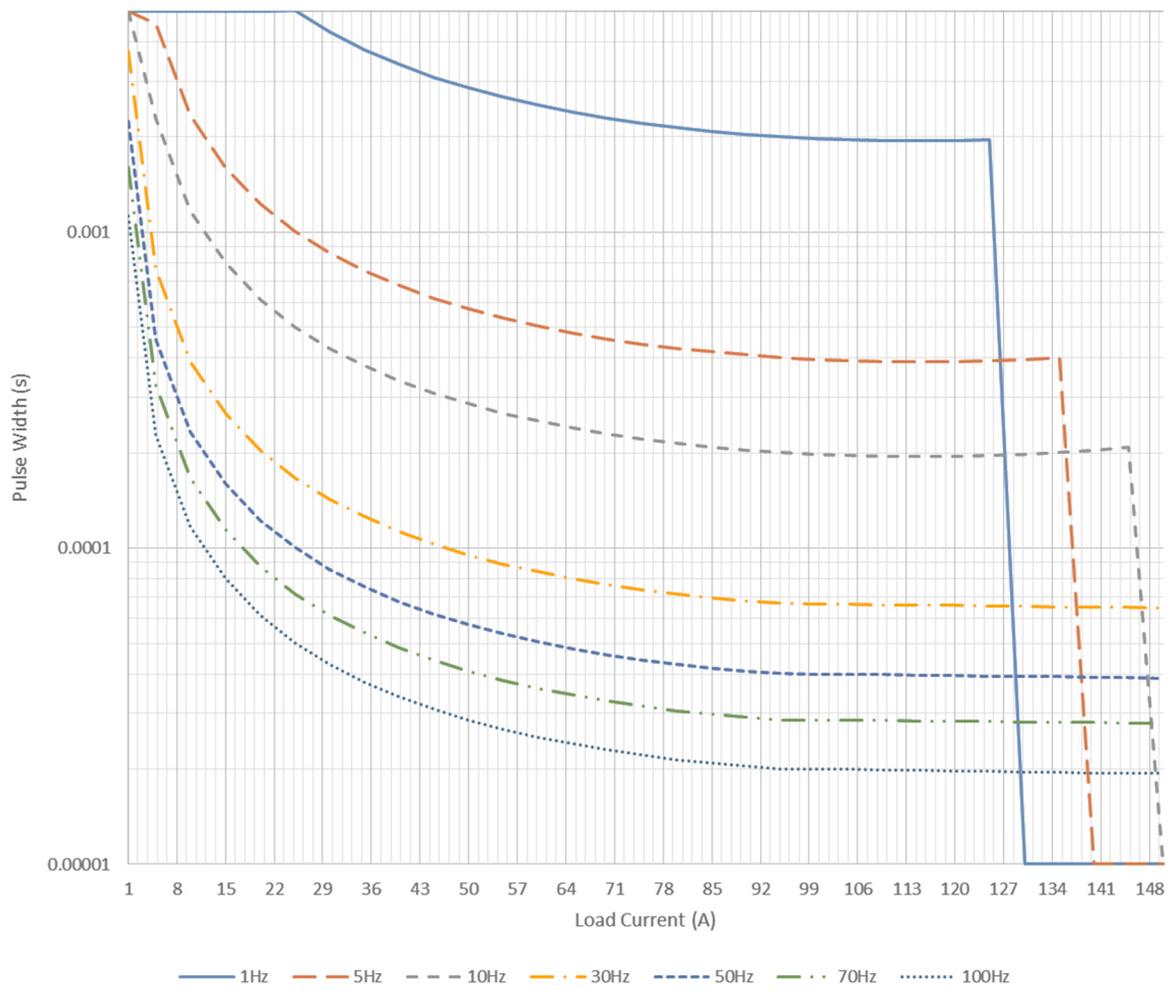
This section contains Safe Operating Area (SOA) graphs for all PCX-6425 models.

**IMPORTANT: Do not operate the instrument outside of the Safe Operating Area!**

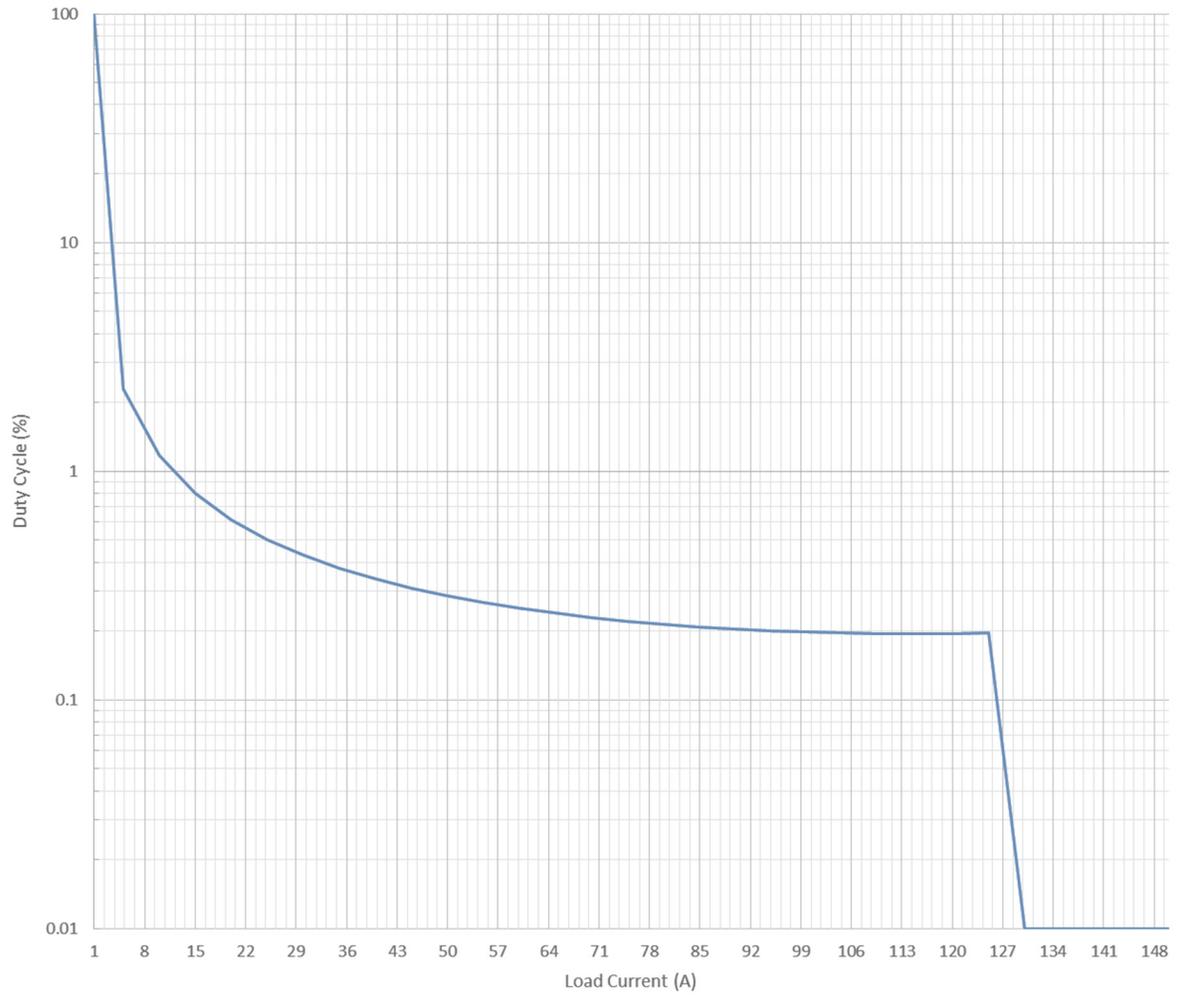
Although the PCX-6425's external triggering system allow it to operate outside the Safe Operating Area, such operation will result in permanent damage to the PCX-6425, the laser diode, or both.



Pulse Width VS Load Current



%Duty-Cycle VS Load Current



# Introduction

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## ❖ Description

The PCX-6425 is an air-cooled, high-power current source designed to drive laser diodes, bars, and arrays. The output current can be set from 1 A to 150 A. The load voltage can be set from 0 V to 120 V. The pulse width is adjustable from 100  $\mu$ s to 5,000  $\mu$ s with a frequency range from single shot to 100 Hz.

The PCX-6425 may be operated through its intuitive front panel controls. The controls allow the user to set the current and voltage. The display provides immediate visual confirmation of all operating parameters, including pulsed current setpoints, and error/fault messages.

For automated applications, complete control of the instrument is provided through RS-232, or USB computer interfaces. These communications are located at the rear panel of the PCX-6425 system.

The laser diode is connected to the front panel of the PCX-6425 through a low-impedance twisted pair cable designed to preserve the fidelity of high-speed current pulses.

Conveniently-located front panel BNC connector allow the PCX-6425 to be externally triggered. The impedance of the trigger input is 50  $\Omega$ . The current monitor and voltage monitor are also located on the front panel utilizing a BNC connector for each.

## ❖ Front Panel Features



### Display Screen

The display screen provides a user interface to review the settings of the PCX-6425. The display guides the user to adjust all functions of the PCX-6425, current set-point, current limit, voltage set-point, voltage limit and to view the firmware versions of the system.

### Encoder Knob

Turn the encoder knob to change a value for functions of the PCX-6425. Push it to cycle through the resolutions (increments of value change).

### Home Button

Pressing the **HOME** button returns the PCX-6425 to front panel home screen from settings screens or from any parameter screen.

### Enable Button

The **ENABLE** button selects whether the PCX-6425 output current is enabled or disabled. The **ENABLE** button is lit green when the unit is enabled. The unit can only be enabled when the key switch is in the ON position.

### Gate

This BNC connector accepts trigger pulses from an external source. The input impedance is 50  $\Omega$ .

### Current Monitor (IMon)

This BNC connector provides a connection to an oscilloscope. The signal is a voltage representation of the output current at the output current connector.

### Voltage Monitor (VMon)

This BNC connector provides a connection to an oscilloscope. The signal is a voltage representation of the output voltage at the output current connector.

### Keyswitch

The keyswitch ON position allows the PCX-6425 output current to be enabled. In the keyswitch OFF position, the PCX-6425 is disabled.

### Current Output

This socket accepts the factory-supplied output cable and is the connection for the system-generated current pulses. DO NOT TOUCH any part of this cable while the PCX-6425 is powered up. Please review the Safety section.

## ❖ Rear Panel Features



### **USB Connector**

Use this connector to communicate with an external computer with a USB cable.

### **RS232 Connector**

Use this connector to communicate with an external computer via a RS-232 cable.

### **Power Cord Connector**

The power cord connector accepts type IEC 320 C-19 to NEMA 5-20P grounding equipment power cord.

### **On-Off Power Switch**

This switches powers the PCX-6425 on and off.

## ❖ Accessories Included

### **AC Power Cord**

Factory-supplied power cord, type IEC 320-C-19 to NEMA L5-20 grounding equipment power cord.

### **Output Twisted Pair Cable**

This factory-supplied cable provides output current pulses to external devices. A 16 pin male Molex connector fits the socket on the front panel of the PCX-6425; a 16 pin male Molex connector is on the user end.

### **Keyswitch Keys**

The keys access the front panel on-off keyswitch. The output is enabled when the keyswitch is in the ON position.

# Interfacing Load to the Output Cable

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The output of the PCX-6425 uses a 16 pin Molex connector that is connected to a stripline cable. One of these output cables is included with every system. The user may order additional output cables if there is a need for more than one cable.

To interface to your load, you may design a simple two-layer interface board for your laser. The interface board must have very low resistance, and more importantly, very low inductance in order to ensure that the droop and overshoot specifications are met. In order to reduce the inductance, there should be very wide copper planes on the top and bottom of the board and no copper inner planes. PCBs thinner than 0.070 inches perform best in reducing inductance. Copper thickness should be 2 ounces or more to reduce resistance.

DEI recommends soldering your laser directly to the interface PCB without any additional cables or wire. If wires are absolutely necessary, they should be as short as possible and twisted if longer than 3 cm. Wires and cabling from an interface board to the laser will increase inductance which increases overshoot. DEI can design a custom interface board for you at a nominal cost; please contact customer support for a quotation.

## Why are we trying so hard to reduce resistance?

Resistance in the output path turns electrical energy into unnecessary heat. Designers spend a lot time and effort removing as much heat as possible from their systems, thus resistance is an unwanted parameter.

## Why are we trying so hard to reduce inductance?

Inductance in the output path can cause voltage overshoot on the rising and falling edges of the output pulse. The overshoot voltage is defined by the following fundamental equation:

$$V = L * di / dt$$

Assume we wish to generate a 450 A pulse with a 1  $\mu$ s rise time and a voltage overshoot of less than 10 volts. What is the maximum allowable inductance in the output path?

$$L = V / (di/dt) = 10 \text{ V} / (450 \text{ A} / 0.000001 \text{ s}) = 22 \text{ nH}$$

It is easily seen that with high currents and fast rise times, voltages can increase rapidly if inductance is not kept as low as possible. While we are more concerned about current overshoot than voltage overshoot, the overall result is that the current pulse can be affected by undesirable inductance in the output path.

# Quick Start Guide

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## ❖ Safety

Follow the safety guidelines. DO NOT PROCEED WITHOUT UNDERSTANDING AND OBSERVING THESE GUIDELINES.

## ❖ Requirements

Make sure the PCX-6425:

- Is connected with the proper cables and termination impedance
- Is powered up
- Has all faults cleared
- Has the keyswitch enabled

## ❖ Controlling the PCX-6425 from the front panel

### 1. Disable the PCX-6425

- The **Enable** button on the front panel glows green if the PCX-6425 is enabled. Press the button to disable.

### 2. Set the output current

1. Rotate the encoder knob until the **Output Current** is displayed on the screen.
2. Press the encoder knob to set the output current. The screen will provide a message indicating to change the current. Press the encoder knob to change the resolution to x0.1, x1.0, or x10.0.
3. Turn the encoder knob to set the output current from 1.0 A to 150.0 A.
4. Press the **Home** button once the output current value is on the display.

### 3. Set the output voltage

1. Rotate the encoder knob until the **Output Voltage** is displayed on the screen.
2. Press the encoder knob to set the output voltage. The screen will provide a message indicating to change the voltage. Press the encoder knob to change the resolution to x1, or x10.
3. Turn the encoder knob to set the output voltage from 10 V to 120 V.
4. Press the **Home** button once the output voltage value is on the display.

### 4. Set the current trip point

1. Rotate the encoder knob until the **Current trip point** is displayed on the screen.
2. Press the encoder knob to set the current trip point. The screen will provide a message indicating to change the trip point current. Press the encoder knob to change the resolution to x1, or x10.
3. Turn the encoder knob to set the current trip point from 10 V to 150 V.

4. Press the **Home** button once the current trip point value is on the display.
5. **Set the voltage trip point**
  1. Rotate the encoder knob until the **Voltage trip point** is displayed on the screen.
  2. Press the encoder knob to set the voltage trip point. The screen will provide a message indicating to change the trip point voltage. Press the encoder knob to change the resolution to x1, or x10.
  3. Turn the encoder knob to set the voltage trip point from 10 V to 120 V.
  4. Press the **Home** button once the voltage trip point value is on the display.
6. **Enable the PCX-6425**
  - Press the **Enable** button on the front panel. The button lights green.

## ❖ Controlling the PCX-6425 from a computer

1. **Disable the PCX-6425**
  - Send the command "OUTPUT:DISABLE".
2. **Set the trigger to internal or external**
  - Send the command "TRIG:INTERNAL" or "TRIG:EXTERNAL".
3. **Set the internal pulse trigger frequency**
  - Send the command "TRIG:INT:FREQ n", where n = [8 to 10000].
  - Units are hertz.
4. **Set the pulse width**
  - Send the command "TRIG:INT:PULSEWIDTH nnnn", where n = [4000 to 5000000]. Pulse width is dependent on the frequency.
  - Units are nanoseconds.
5. **Set the output current**
  - Send the command "SETPOINT:CURRENT n", where n = [10 to 450.0].
  - Units are amperes.
6. **Enable the PCX-6425**
  - Send the command "OUTPUT:ENABLE".

# Operation

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## ❖ Setup

**NOTE:** Any change to a command adjustment typically requires less than 200 ms to complete.

1. Make sure the PCX-6425 has been OFF for at least ten minutes when connecting or disconnecting the current output connector.
2. Make sure the laser diode is connected with the correct polarity. If necessary, review the output cable for polarity specifications.
3. Make the other connections as necessary: External Trigger, Current monitor, Voltage monitor, or the connection to the computer.
4. Connect the power cable.

## ❖ Power Up

1. Turn on the power switch. The instrument powers up in about 3 seconds.
2. After a few seconds, the PCX-6425 displays the **Home** screen. The Home screen lists the output current, output voltage, current trip point, and voltage trip point.

## ❖ Set the Output Current

SETPOINT:CURRENT:?  
SETPOINT:CURRENT: n (in A)

1. Rotate the encoder knob until the **Output Current** is displayed on the screen.
2. Press the encoder knob to set the output current. The screen will provide a message indicating to change the current. Press the encoder knob to change the resolution to x0.1, x1.0, or x10.0.
3. Turn the encoder knob to set the output current from 1.0 A to 150.0 A.
4. Press the **Home** button once the output current value is on the display.

## ❖ Set the Output Voltage

SETPOINT:VOLTAGE:?  
SETPOINT: VOLTAGE: n (in V)

1. Rotate the encoder knob until the **Output Voltage** is displayed on the screen.
2. Press the encoder knob to set the output voltage. The screen will provide a message indicating to change the voltage. Press the encoder knob to change the resolution, x1.0, or x10.0.
3. Turn the encoder knob to set the output voltage from 10.0 V to 120.0 V.
4. Press the **Home** button once the output voltage value is on the display.

## ❖ Set the Current trip point

SETPOINT:CURRENT:?  
SETPOINT:CURRENT: n (in A)

5. Rotate the encoder knob until the **Current trip point** is displayed on the screen.
6. Press the encoder knob to set the current trip point. The screen will provide a message indicating to change the current trip point. Press the encoder knob to change the resolution to x0.1, x1.0, or x10.0.
7. Turn the encoder knob to set the current trip point from 1.0 A to 150.0 A.
8. Press the **Home** button once the current trip point value is on the display.

## ❖ Set the Voltage trip point

SETPOINT:VOLTAGE:?  
SETPOINT:VOLTAGE: n (in V)

9. Rotate the encoder knob until the **Voltage trip point** is displayed on the screen.
10. Press the encoder knob to set the voltage trip point. The screen will provide a message indicating to change the voltage trip point. Press the encoder knob to change the resolution to x1.0, or x10.0.
11. Turn the encoder knob to set the voltage trip point from 1.0 A to 120.0 A.
12. Press the **Home** button once the voltage trip point value is on the display.

## ❖ View the Communication Settings

1. On the **Home** screen, rotate the encoder knob until the screen lists the communication settings.
2. This screen is for information only the communication settings cannot be changed on this PCX-6425 system.
3. Press the **Home** to return to the **PCX-6425 Home** screen.

## ❖ Power Down

### OUTPUT:DISABLE

1. Disable the unit by pressing the **Enable** button the Enable LED is only green when the system is enabled.
2. Turn the **Keyswitch OFF**.
3. Turn the power **OFF** by using the power switch on the rear of the instrument.

# Command Set

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The Command Set consists of all the commands and queries that the PCX-6425 supports via remote computer control. Commands and queries must be in all capital letters. Commands and queries that require data, denoted as *n*, must have a space between the command and the data.

The PCX-6425 expects “\n” to be the end line character of commands and queries. The responses to the user’s computer are also terminated with “\n”. For every command sent to the PCX-6425, a response will be sent back to the user from the PCX-6425. The user’s software must wait for a response before sending another command to avoid an overflow of the PCX-6425 receive buffer.

**NOTE:** Any change to a command adjustment typically requires less than 200 ms to complete.

In the examples, the command or query is in black; the response is in blue italics.

## \*LIST?

Lists all commands and queries supported by the PCX-6425. Example:

```
*LIST?  
*IDN?  
*LIST?  
OUTPUT?  
OUTPUT:ENABLE  
OUTPUT:DISABLE  
SETPOINT:CURRENT?  
SETPOINT:CURRENT n           :: n=[10 ... 450] Amp  
FAULT?  
FAULT:CLEAR:ALL  
STATUS:KEYSWITCH?
```

## \*IDN?

Abbreviation for identity; returns the manufacturer’s name, unit model number, serial number, firmware revision, and manufacture date. Example:

```
*IDN?  
DEI Scientific, PCX-6425-110, 6425-121131, Q01C01T01P01, 11-25-2012
```

## OUTPUT?

Returns the state of the output (Enabled or Disabled). Example:

```
OUTPUT?  
Disabled
```

## OUTPUT:ENABLE

Enables the output. Performs the same function as pressing the front-panel ENABLE icon. Example:

OUTPUT:ENABLE  
*OUTPUT:ENABLE*

### **OUTPUT:DISABLE**

Disables the output. Performs the same function as pressing the front-panel ENABLE icon. Example:

OUTPUT:DISABLE  
*OUTPUT:DISABLE*

### **SETPOINT:CURRENT?**

Returns the Output Current in amperes. Example:

SETPOINT:CURRENT?  
*100.2 Amps*

### **SETPOINT:CURRENT n**

Sets the Output Current in amperes. The value of n must be from 10.0 A to 450.0 A. Example:

SETPOINT:CURRENT 100  
*SETPOINT:CURRENT 100.0*

### **FAULT?**

Returns the fault codes. Example:

FAULT?  
*(0, 0, 0, 0, 0, 0, 0, 0, 0, 0)*

Each digit represents a failure or multiple failures (which are bitwise or'd together). The first digit is the failure that is the most recent failure and the last digit is the oldest failure. On power up, the default codes are 1,2,4,8,16,32,64,128,256,512.

The error codes are as follows:

<u>Code</u>	<u>Error</u>	<u>Description</u>
0:	no error	
1:	keyswitch error	keyswitch changed from on to off while pulses were enabled
4:	temperature error.	instrument's temperature exceeded expected range.
8:	open load	load is open or the required voltage exceeds instrument range
16:	24V error	internal 24V is outside of normal range
32:	Cap voltage error	< NOT USED >
64:	over current error	Either the PCX-6425 or the load failed. Contact DEI
128:	Under_Current_Error	< NOT USED >
256:	Power_Up_Error	< NOT USED >
512:	RS485_Error	< NOT USED >
1024:	HS_Error	Contact DEI, internal hardware issue.
2048:	CB_Error	Contact DEI, internal hardware issue.

4096: LS\_Error                   Contact DEI, internal hardware issue.  
8192: Trigger\_RS485\_Error    Contact DEI, internal hardware issue.  
16384: Enable\_Disable\_Error   Contact DEI, internal hardware issue.

**FAULT:CLEAR:ALL**

Clears the fault codes. Example:

FAULT:CLEAR:ALL  
*FAULT:CLEAR:ALL*

**STATUS:KEYSWITCH?**

Returns the state of the keyswitch (Enabled or Disabled). Example:

STATUS:KEYSWITCH?  
*ENABLED*

# Warranty and Service

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## ❖ Warranty

Directed Energy, Inc. (DEI) warrants equipment it manufactures to be free from defects in materials and factory workmanship under conditions of normal use, and agrees to repair or replace any standard product that fails to perform as specified within one year after date of shipment to the original owner. OEM, modified, and custom products are warranted, as stated above, for ninety (90) days from date of shipment to original owner. This Warranty shall not apply to any product that has been:

- I. Repaired, worked on, or altered by persons unauthorized by DEI in such a manner as to injure, in DEI's sole judgment, the performance, stability, or reliability of the product;
- II. Subjected the product to misuse, neglect, or accident; or
- III. Connected, installed, adjusted, or used otherwise than in accordance with instructions furnished by DEI.

DEI reserves the right to make any changes in the design or construction of its products at any time, without incurring any obligation to make any change whatever in units previously delivered.

DEI's sole obligation, and buyer's sole remedies, under this agreement shall be limited to a refund of the purchase price, or at DEI's sole discretion, to the repair or replacement of products in kind that prove, to DEI's satisfaction, to be defective, when returned to the DEI factory, transportation prepaid by the buyer, within the warranty period. DEI shall in no way be liable for damages consequential or incidental to defects in its products, for failure of delivery in whole or in part, for injuries resulting from its use, or for any other cause.

Returns must be preauthorized and accompanied by a DEI return authorization number.

The foregoing states the entire warranty extended by DEI, and is given and accepted in lieu of 1) any and all other warranties, expressed or implied, including but not limited to the implied warranties of merchantability and fitness for any particular purpose and 2) any obligation, liability, right, claim or remedy in contract or tort.

## ❖ **Factory Service and Support**

For more information about your instrument or for an operation problem, please contact the factory:

Directed Energy, Inc.  
1609 Oakridge Dr., Suite 100  
Fort Collins, Colorado 80525  
(970) 493-1901, ext. 24

[sales@ixyscolorado.com](mailto:sales@ixyscolorado.com)

[techsupport@ixyscolorado.com](mailto:techsupport@ixyscolorado.com)

<http://ixyscolorado.com/>

# Notes

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