PCM-7510

Pulsed Current Source

Operation Manual

Contents

Safety

> **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.

- Do not open the cover of PCM-7510. There are no user-serviceable parts inside. Opening the cover exposes you to lethal shock and voids the factory warranty.

- Do not install, handle, or remove the output cable or laser diode while the PCM-7510 is operating.

- The PCM-7510 can be triggered randomly by spurious transients. Always assume it is possible to get an unexpected pulse at the output.

- Allow at least 10 minutes after power-down before handling the output cable or laser diode.

- Operate the PCM-7510 ONLY in the safe operating areas as shown in the graphs on Page 8.

- 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 front of the chassis and exits the back of the chassis.

- Take normal precautions to protect this device against liquid entry or corrosive environments.

- Clean this device by wiping with a dry or damp cloth.

Quick Start Guide

■ Safety

Personal Safety
Follow the safety guidelines on Page 1. DO NOT PROCEED WITHOUT UNDERSTANDING AND OBSERVING THESE GUIDELINES.

Equipment Safety
Operate the PCM-7510 ONLY in the safe operating area and within the maximum power according to the graphs on page 8. Exceeding these limits can cause serious damage the PCM-7510 or the laser diode.

■ Requirements

Make sure the PCM-7510:
- Is properly connected to the system
- Is powered up
- Has all faults cleared
- Has the rear enable and keyswitch enabled. Their icons and LEDs should be green.

■ Controlling the PCM-7510 From a Computer

1. **Disable the PCM-7510.**
   Send the command "OUTPUT:DISABLE".

2. **Set the trigger to internal or external as needed**.
   Send the command "TRIG:INTERNAL" or "TRIG:EXTERNAL".

3. **Set the output current.**
   Send the command "SETPOINT:CURRENT xxx".
   xxx = [0–275]. Units are in Amperes.

4. **Set the internal trigger frequency.**
   Send the command "TRIG:INT:FREQ yyyy".
   yyyy = [40–6000]. Units are in Hertz.

5. **Set the internal pulse width.**
   Send the command "TRIG:INT:PULSEWIDTH n"
   n = [5000–5,000,000]. Units are in nanoseconds.

6. **Enable the PCM-7510.**
   Send the command "OUTPUT:ENABLE".

■ Controlling the PCM-7510 From the Front Panel

1. **Disable the PCM-7510.**
   If the ENABLE button on the front panel is lit green, press the button to disable the unit. The button should be unlit.

2. **Set the trigger to internal or external as needed**.
   Press the Trigger button on the touch screen.
   Press the Internal or External button to select the trigger.

3. **Set the output current.**
   Press the Output button on the touch screen.
   Press the encoder knob to set the resolution.
   Turn the encoder knob to set the output current.
   Press the Done button.

4. **Set the frequency.**
   Press the Frequency button on the touch screen.
   Press the encoder knob to set the resolution.
   Turn the encoder knob to set the frequency.
   Press the Done button.

5. **Set the pulse width.**
   Press the Pulse Width button on the touch screen.
   Press the encoder knob to set the resolution.
   Turn the encoder knob to set the pulse width.
   Press the Done button.

6. **Enable the PCM-7510.**
   Press the ENABLE button on the front panel. The button lights green.

Introduction

■ Description

The PCM-7510 is a high-power pulsed current source for driving laser diodes, bars, and arrays. It delivers current pulses variable from 50 to 250 amperes with up to 1250 watts of total output power. Pulse widths are variable from 5 μsec to 5 msec, with rise and fall times of 2 μsec to 8 μsec. An internal trigger provides pulse repetition frequencies from 40 to 6000 Hz.

The PCM-7510 can be operated from a touch screen on the front panel or from a computer with an RS232 interface.

The PCM-7510 can use its internal trigger or can be externally triggered and synchronized with other devices via BNC connectors on the front panel. The input impedance of the external trigger is selectable for 50 or 10,000 Ohms. The synchronization output is triggered by the leading edge of the output current pulse and is active independent of the trigger source.

The PCM-7510 requires two user-supplied power supplies: a 24 VDC supply which connects at the front panel, and a high-voltage power supply of 50 to 135 VDC which connects at the rear panel.
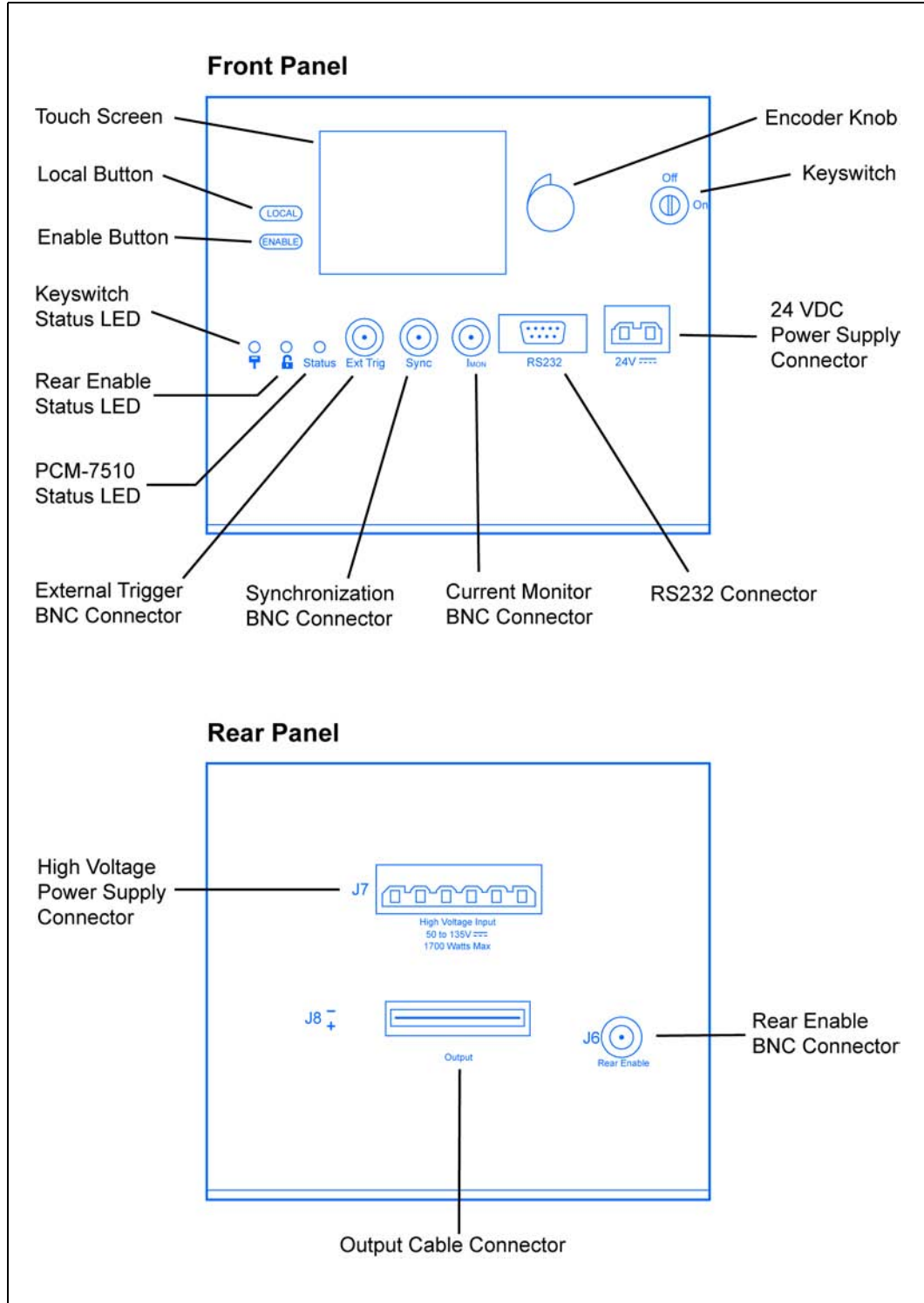
■ Unpacking

Inspect the unit. Contact the carrier if there is any damage.
Perform electrical installation. Contact the factory for any repair issues.

■ Accessories Included
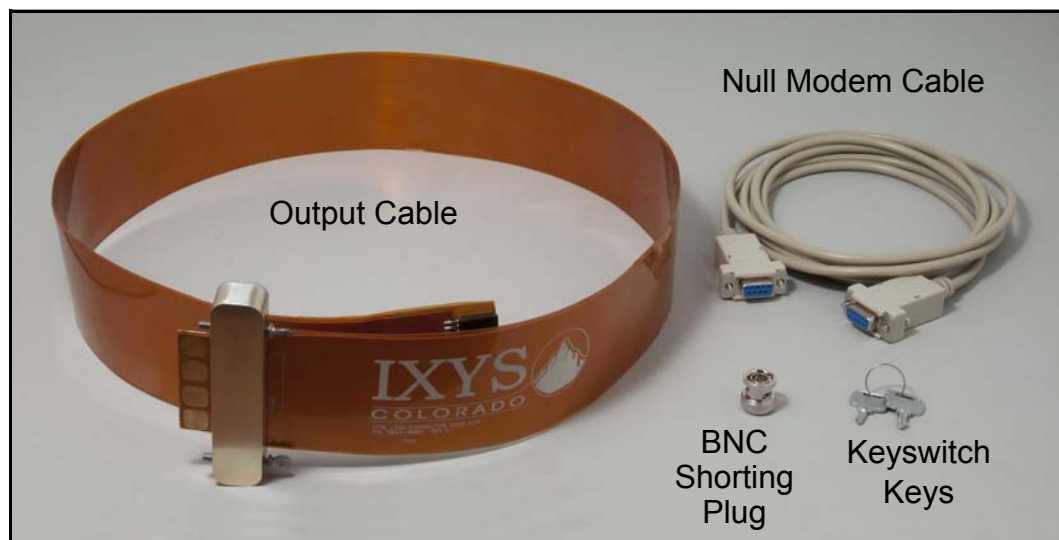
■ Panel Layout

All features of the front and rear panel are labeled. Their functions are covered in the next section.

■ Front Panel Features

Keyswitch
On enables the PCM-7510. Off disables the PCM-7510.

Encoder Knob
Turn to change a value. Push to cycle through the resolutions (increments of value change).

Touch Screen
Provides a graphic user interface and front-panel touch control for most of the functions of the PCM-7510.

LOCAL Button
Returns the PCM-7510 to front-panel control during computer control. Lights red during power-up initialization. Flashes red during a fault.

ENABLE Button
Toggles the PCM-7510 between enabled and disabled. Lights green when the unit is enabled. Lights green, then flashes green during power-up initialization.

Keyswitch LED (under key symbol)
Lights green if the keyswitch is on, red if the keyswitch is off.

Rear Enable LED (under padlock symbol)
Lights green if the rear enable contacts are closed or the shorting BNC connector is in place (enabled). Lights red if the rear enable contacts are open or the shorting BNC connector is removed (disabled).

Status LED
Lights green when the unit is enabled; is unlit when the unit is disabled. Flashes red briefly during a fault.

Ext Trig Input
A BNC connector that accepts trigger pulses from an external source. Its input impedance can be set to either 50 Ohms or 10K Ohms.

Sync Output
A BNC connector that provides synchronization pulses to external devices. The sync pulse is triggered by the leading edge of the output current pulse.

Ext Trig Input
A BNC connector that accepts input signals for external triggering.

I_{MON} Output
A BNC connector that provides a connection to an oscilloscope.

RS232 Connector
Communicates with an external computer through an RS232 null cable.

24V Connector
Accepts 24 Volts DC from a user-supplied power supply.

■ Rear Panel Features

High Voltage Input (J7)
A socket that accepts 50 to 135 Volts DC from a customer-supplied power supply.

Output (J8)
A socket that accepts the factory-supplied output cable and provides the generated high-current pulses. DO NOT TOUCH IF THE UNIT IS ON.

Rear Enable (J6)
A BNC connector that accepts either external dry-contact closure or the factory-supplied shorting BNC plug. Closed contacts or use of the shorting plug enables the PCM-7510. Open contacts or removal of the shorting plug disables the PCM-7510.

■ Cables

Output Cable
A factory-supplied cable that provides high current pulses to external devices. Minus is on top; plus is on the bottom. Contact the factory for information about terminating the cable.

RS232 Computer Control Cable
A factory-supplied cable with DB9 female connectors on each end. It is also known as a null modem cable, with the following pinout:

Computer DB9 female connector	**PCM-7510** DB9 female connector
2 Receive Data	3 Transmit Data
3 Transmit Data	2 Receive Data
5 Signal Ground	5 Signal Ground

24-Volt and High-Voltage Supply Cables
User-supplied. Connector and pin part numbers are in the Specifications section of this manual.

BNC Test Cables
50 ohm RG-8U or equivalent. User-supplied.

Operation

■ Safe Operating Area and Maximum Power

CAUTION
Risk of severe damage to the PCM-7510 and/or the diode under test.
Do not exceed the Safe Operating Area or the Maximum Power.

Make sure the voltage of the high-voltage power supply (HVPS) is in the safe operating area (SOA) and results in power less than or equal to the maximum power according to the graphs below.
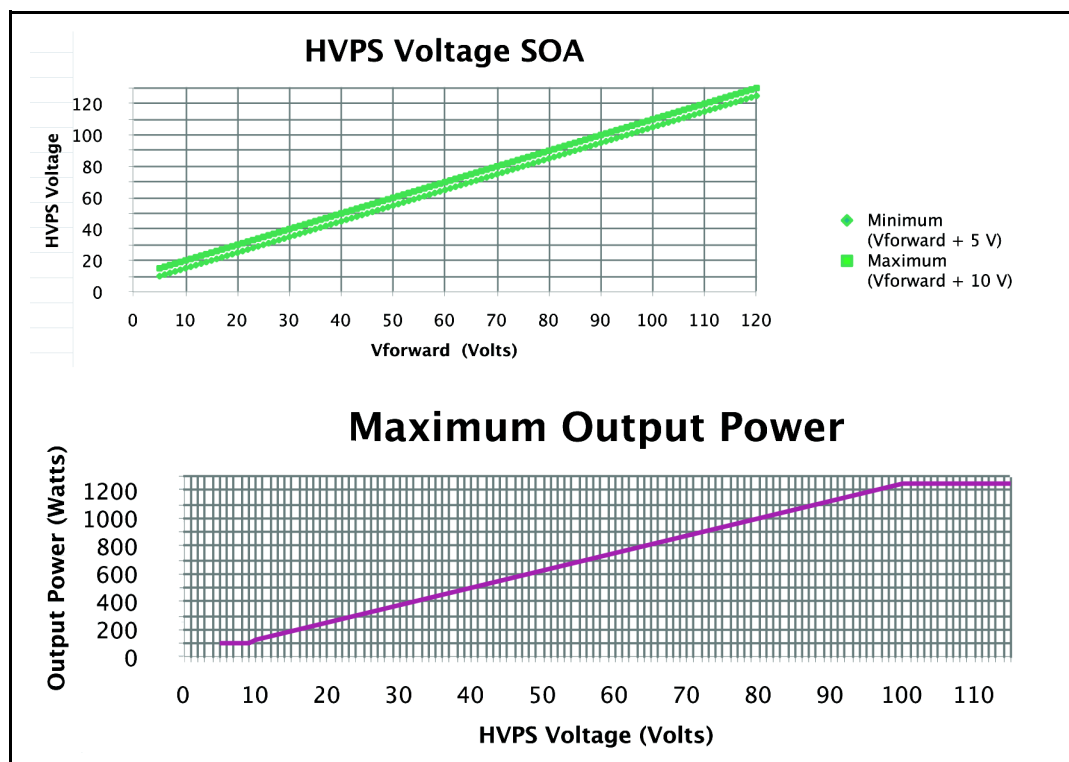
■ Setup

1. Make sure the PCM-7510 has been OFF for at least ten minutes.

2. Connect the output cable to the diode under test. Plus (+) goes to the anode and minus (–) goes to the cathode.

3. Make the other connections as necessary: Ext Trig, Sync, I_{MON}, Rear Enable, and RS232.

4. Connect the high-voltage power supply.

5. Connect the 24-volt power supply.

■ Power Up

CAUTION
ALWAYS follow this procedure to power up the PCM-7510.

1. Make sure the keyswitch is off.

2. Turn on the 24-volt power supply.

3. Wait at least 10 seconds.

All the PCM-7510 front panel lights turn on, the unit plays a tune, and the DEI logo screen appears.The ENABLE button flashes green as the unit initializes.

The PCM-7510 powers up in Internal Trigger mode and the Home screen appears. The main features of the Home screen are shown below.
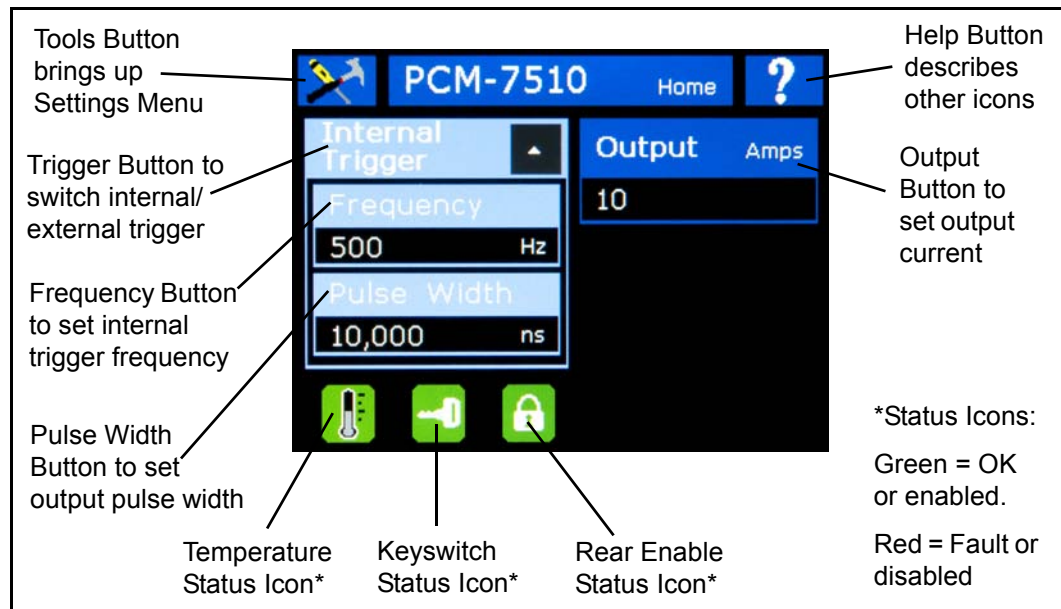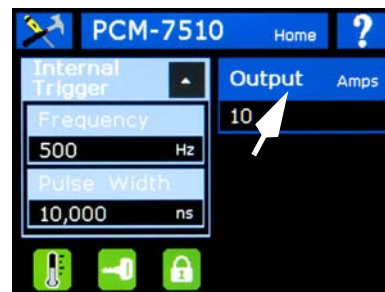

4. Turn on the high-voltage power supply.

5. Wait at least 30 seconds.

6. Turn the keyswitch on.

7. Operate the unit manually or via computer command.
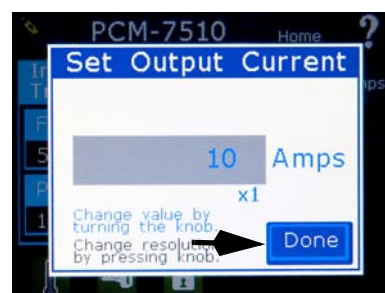
■ Set the Output Current

SETPOINT:CURRENT?
SETPOINT:CURRENT n

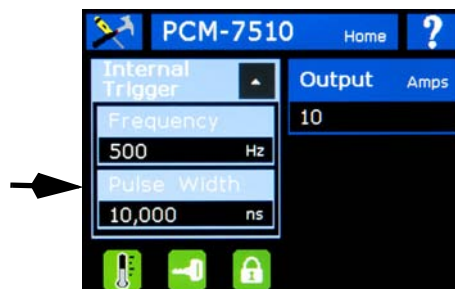**1.** On the Home screen, press the Output button.

2. The Set Output Current screen appears. Press the encoder knob to select a resolution: x1, x5, x10, or x25.

3. Turn the encoder knob to change the output current: 10–275 Amperes.

4. On the screen, press the Done button.
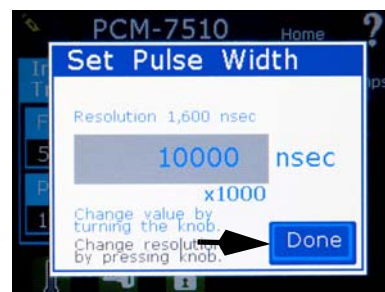
■ Set the Pulse Width

TRIG:INT:PULSEWIDTH?
TRIG:INT:PULSEWIDTH n

1. On the Home screen, press the Pulse Width button.

2. The Set Pulse Width screen appears. Press the encoder knob to select a resolution: x25, x100, x1000, or x10,000.

3. Turn the encoder knob to change the pulse width: 5000–5,000,000 nsec (5 μsec to 5 msec).

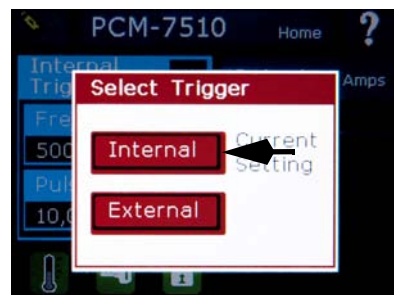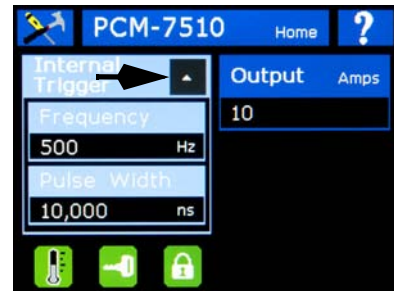**4.** On the screen, press the Done button.

■ Set the Trigger

Set the Source

TRIG:INTERNAL
TRIG:EXTERNAL

NOTE:
If you have just powered up the PCM-7510, the unit is in Internal Trigger mode.

1. On the Home screen, press the gray Trigger button.

2. The Select Trigger screen appears. Press the button for the desired trigger mode.

Set the Frequency

TRIG:INT:FREQ?
TRIG:INT:FREQ n

3. If you have selected Internal Trigger, the Set Frequency screen appears. Press the encoder knob to select a resolution: x100, x500, x1000, or x5000.
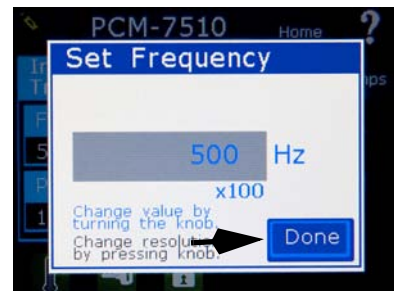
**4.** Turn the encoder knob to change the trigger frequency: 40–6000 Hz.

5. On the screen, press the Done button. The Home screen reappears.

OR
Set the Termination

TRIG:EXT:TERM?
TRIG:EXT:TERM n

3. If you have selected External Trigger, the External Trigger Home screen appears. Press a Termination button to set the termination of the external trigger input to 50 Ohms or 10K Ohms.

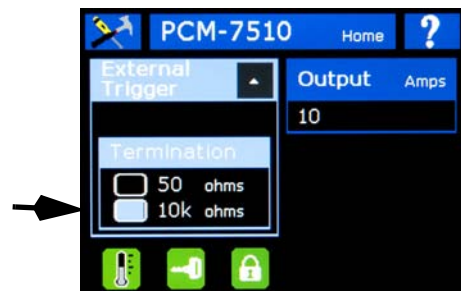
■ Save Settings

*SAVE n

1. On the Home screen, press the tools button.
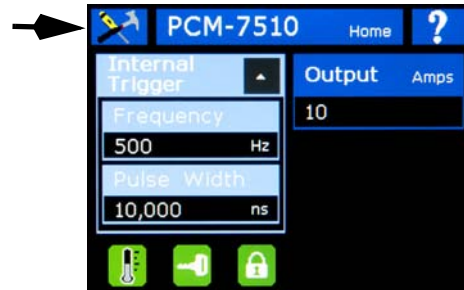
2. The Settings screen appears. Press the Save Settings button.
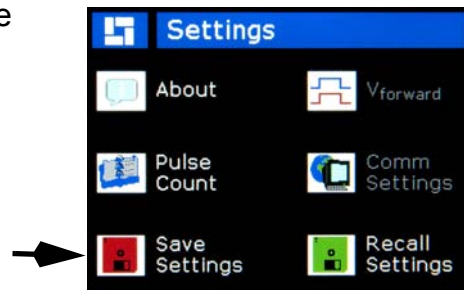
3. The Save screen appears. Press the button for one of the four locations to which you want to save the settings.

   NOTE
   Saving to a location overwrites any data at that location.

4. A progress indicator appears. When it is finished, press the upper left icon button to return to the Home screen.

■ Recall Settings

*RECALL n

1. On the Home screen, press the tools button.

2. The Settings screen appears. Press the Recall Settings button.
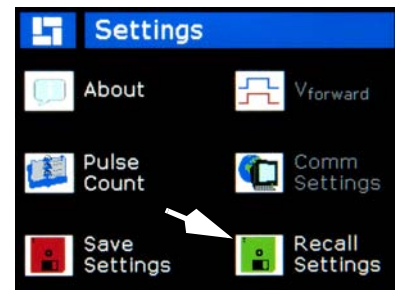
3. The Recall screen appears. Press the button for one of the four locations from which you want to recall the settings.

4. A progress indicator appears. When it is finished, press the upper left icon button to return to the Home screen.
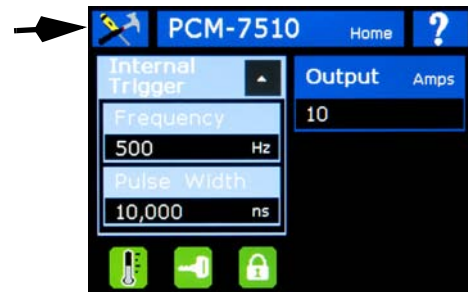
■ View the Pulse Count

PULSE:COUNT?
PULSE:COUNT n

1. On the Home screen, press the tools button.
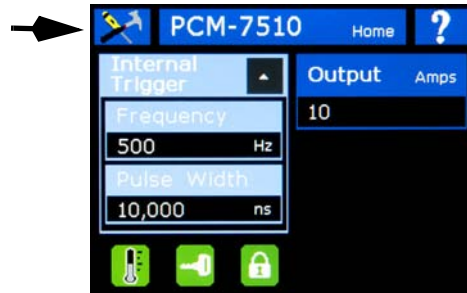
2. The Settings screen appears. Press the Pulse Count button.

3. The Pulse Count screen appears

4. Press the upper left icon button to return to the Home screen.

■ View Information About the PCM-7510

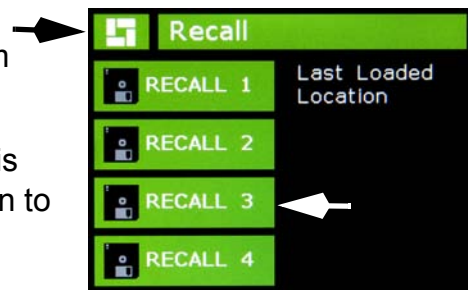*IDN?

1. On the Home screen, press the tools button.

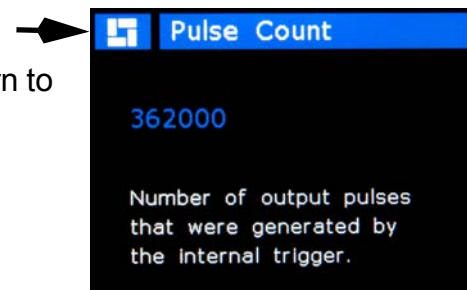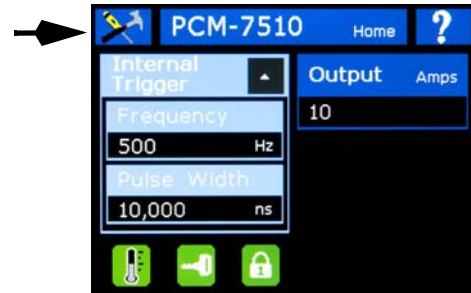**2.** The Settings screen appears. Press the About button.
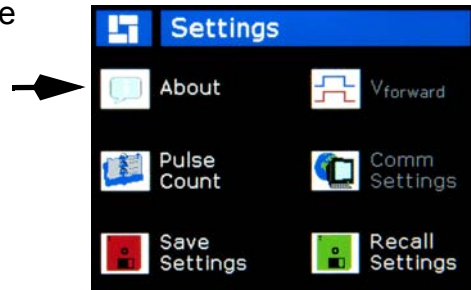
3. The About screen appears. View the model number, serial number, manufacture date, and firmware revision level.

4. Press the upper left icon button to return to the Home screen.
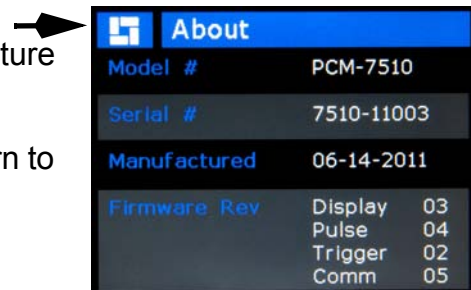
■ Warnings and Faults

All faults disable the PCM-7510. To continue after clearing a fault, you must send an "OUTPUT:ENABLE" command from the computer or press the ENABLE button on the front panel.

Red Keyswitch Status Icon

STATUS:KEYSWITCH?

The keyswitch was off at power-up, or it was turned off during disabled operation.

This is also the display after clearing a keyswitch hardware warning or a keyswitch fault.

Turn the keyswitch on to continue.

Keyswitch Hardware Warning

FAULT:CLEAR:ALL

The user attempted to enable the PCM-7510 while the keyswitch was off.

On the screen, press the Clear Warning button.

The Home screen appears with a red keyswitch status icon.

Turn the keyswitch on to continue.
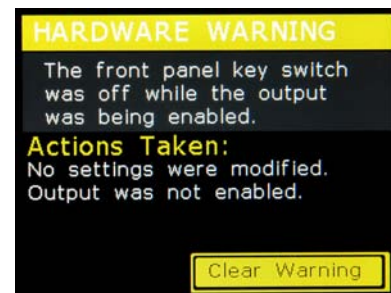
Keyswitch Fault

FAULT:CLEAR:ALL

The keyswitch was turned off during enabled operation.

On the screen, press the Clear Fault button.

The Home screen appears with a red keyswitch status icon.

Turn the keyswitch on to continue.
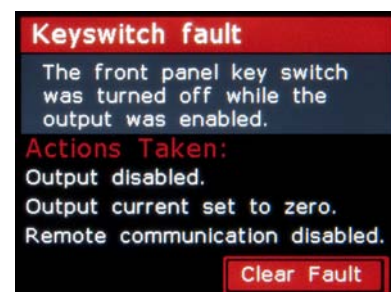
Red Rear Enable Status Icon

STATUS:REAR:ENABLE?

The rear enable was disabled at power-up, or it was disabled during disabled operation.

This is also the display after clearing a rear enable hardware warning or rear enable fault.

Rear Enable Hardware Warning

FAULT:CLEAR:ALL

The user attempted to enable the PCM-7510 while the rear enable was disabled.

On the screen, press the Clear Warning button.

The Home screen appears with a red rear-enable status icon.

Enable the rear enable to continue.

Rear Enable Fault

FAULT:CLEAR:ALL

The rear enable was disabled during enabled operation.

On the screen, press the Clear Fault button.

The Home screen appears with a red rear-enable status icon.

Enable the rear enable to continue.

Over Temperature Fault

FAULT:CLEAR:ALL

Either the ambient temperature or the exhaust air temperature exceeded the safe temperature operating range.

Allow cool, free air flow from front to rear.

■ Power Down

CAUTION
ALWAYS follow this procedure to power down the PCM-7510.

1. Disable the unit by pressing the front panel BUTTON or by sending a computer command "OUTPUT:DISABLE".

2. Turn off the keyswitch.

3. Turn off the high voltage supply.

4. Turn off the 24 VDC supply.

5. Wait at least 10 minutes before handling the output cable or laser diode.

WARNING

Risk of fatal electric shock. Wait at least 10 minutes after powering down the PCM-7510 before handling the output cable or laser diode.

Command Set

These are all the commands and queries that the PCM-7510 supports via remote RS232 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 PCM-7510 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 PCM-7510, the PCM-7510 sends a response. The user's software must wait for a response before sending another command, to avoid an overflow of the PCM-7510 receive buffer.

The commands are in alphabetical order except *LIST?. 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 PCM-7510. Example:

*LIST?
IDN?
SAVE
RECALL
LIST?
OUTPUT?
OUTPUT:ENABLE
OUTPUT:DISABLE
TRIG?
TRIG:INTERNAL
TRIG:EXTERNAL
TRIG:INT:PULSEWIDTH?
TRIG:INT:PULSEWIDTH
TRIG:INT:FREQ?
TRIG:INT:FREQ
TRIG:EXT:TERM?
TRIG:EXT:TERM
SETPOINT:CURRENT?
SETPOINT:CURRENT
TEMP:IN?
TEMP:EXHAUST?
FAULT?
FAULT:CLEAR:ALL
STATUS:KEYSWITCH?
STATUS:REAR:ENABLE?
PULSE:COUNT?
PULSE:COUNT:CLEAR

FAULT?

Returns the last 10 faults that have occurred since power-up. The codes for the faults are:

0 = No Fault
1 = Keyswitch was turned off while the instrument was enabled
2 = Rear Enable was disabled while the instrument was enabled
4 = Ambient temperature was out of range while the instrument was enabled
8 = Exhaust air temperature was out of range while the instrument was enabled
16 = 24 Volt DC Supply was out of range while the instrument was enabled
32 = High-voltage Power Supply was out of range while the instrument was enabled.

The first listed fault is the most recent. The example below shows there have been no faults since power-up:

FAULT?
0, 0, 0, 0, 0, 0, 0, 0, 0, 0

FAULT:CLEAR:ALL

Erases all previous faults. Example:

FAULT:CLEAR:ALL
All Faults Cleared

*IDN?

Short for Identity; returns the manufacturer's name, unit model number, serial number, firmware revisions, and manufacture date. Example:

*IDN?
DEI Scientific, PCM-7510, 7510-0001, Q99T99M99, mmddyy

OUTPUT?

Returns whether the output is enabled or disabled. Example:

OUTPUT?
Disabled

OUTPUT:DISABLE

Disables the output; the same as pressing the front-panel ENABLE button so it is unlit. Example:

OUTPUT:DISABLE
Disabled

OUTPUT:ENABLE

Enables the output; the same as pressing the front-panel ENABLE button so it lights green. Example:

OUTPUT:ENABLE
Enabled
(if successful)
CAN NOT ENABLE OUTPUT. CHECK FAULTS.
(if a fault is preventing the PCM-7510 from enabling)

PULSE:COUNT?

Returns the number of pulses since the PCM-7510 went active, Example:

PULSE:COUNT?
132479

PULSE:COUNT:CLEAR

Clears the pulse count. Example:

PULSE:COUNT:CLEAR
Cleared

*RECALL n

Recalls saved configurations and sets the PCM-7510 to them. The value of n must be between 1 and 4. Example:

*RECALL 2
Recalled Memory Location 2

*SAVE n

Saves the current configuration to non-volatile memory. The value of n must be between 1 and 4. Example:

*SAVE 3
Saved Memory Location 3

SETPOINT:CURRENT?

Returns the amount of output current in Amperes. Example:

SETPOINT:CURRENT?
55 Amps

SETPOINT:CURRENT n

Sets the amount of output current in Amperes The value of n must be between 0 and 275 Amps. Example:

SETPOINT:CURRENT 175
CURRENT 175

STATUS:KEYSWITCH?

Returns whether the keyswitch is enabled or disabled. Example:

STATUS:KEYSWITCH?
Disabled

STATUS:REAR:ENABLE?

Returns whether the rear enable is enabled or disabled. Example:

STATUS:REAR:ENABLE?
Disabled

TEMP:IN?

Returns the temperature of the intake air in degrees Celsius. Example:

TEMP:IN?
27

TEMP:EXHAUST?

Returns the temperature of the exhaust air in degrees Celsius. Example:

TEMP:EXHAUST?
38

TRIG?

Returns the whether the trigger is internal or external. Example:

TRIG?
Internal

TRIG:EXTERNAL

Sets the trigger to External. Example:

TRIG:EXTERNAL
External

TRIG:EXT:TERM?

Returns the termination impedance of the external trigger input in Ohms. Example:

TRIG:EXT:TERM?
50 Ohms

TRIG:EXT:TERM n

Sets the termination impedance of the external trigger input in Ohms. The value of n must be 50 or 10000. Example:

TRIG:EXT:TERM 50
TRIG:EXT:TERM 50

TRIG:INTERNAL

Sets the trigger to internal. Example:

TRIG:INTERNAL
Internal

TRIG:INT:FREQ?

Returns the internal trigger frequency in Hz. Example:

TRIG:INT:FREQ?
2400 Hz

TRIG:INT:FREQ n

Sets the internal trigger frequency. The value of n must be from 40 to 6000 Hz. Example:

TRIG:INT:FREQ 2400
2400 Hz

TRIG:INT:PULSEWIDTH?

Returns the pulse width of the current pulses, in nanoseconds. Example:

TRIG:INT:PULSEWIDTH?
10000 nsec

TRIG:INT:PULSEWIDTH n

Sets the pulse width of the current pulses. The value of n must be in nanoseconds from 5000 to 5,000,000. Example:

TRIG:INT:PULSEWIDTH 10000
TRIG:INT:DUTYCYCLE 10000

Specifications

Pulse Current Output	
Amplitude	50–250 Amperes
Resolution	1 Ampere
Output Polarity	Positive
Pulse Width	5000–5,000,000 nsec (5 µsec–5 msec) adjustable
Pulse Rise Time (from 10% to 90%) and Fall Time (from 90% to 10%)	
50–75 Amps Output	< 10 µsec
76–109 Amps Output	< 6 µsec
110–175 Amps Output	< 5 µsec
176–250 Amps Output	< 3 µsec
Maximum Average Output Power *See the Safe Operating Area and Maximum Power graphs on Page 8.*	
$V_{forward}$ 120–100 Volts	1250 Watts
$V_{forward}$ 99–10 Volts	($V_{forward}$ x 12.5 Amps)
$V_{forward}$ 9–5 Volts	100 Watts
Delay, Trigger to Output Pulse	1 µsec typical
Output Pulse Ripple & Droop	<= 1% of Output
Skew, from Internal or External Trigger to the Output Pulse	Pulse-to-Pulse Stability <= 25 nsec
Pulsed Output Cable (on rear of unit)	
DEI Assembly Part Number	6100-0007.
User Connector	Molex # 45714-0003. The user should create a 2-layer PCB of 0.063" thickness to interface with the connector.
Contact Polarity	Top contacts positive (+), bottom contacts negative (−)
Internal Trigger	
Frequency	40 Hz–6000 Hz adjustable
Frequency Resolution	
40 Hz–300 Hz	1 Hz
300 Hz–6000 Hz	100 Hz
Pulse Width	5 µsec–25 µsec
Pulse Width Resolution	
40 Hz–300 Hz	6400 nsec
300 Hz–2500 Hz	1600 nsec
2500 Hz–6000 Hz	25 nsec

External Trigger Input Signal	
Pulse Recurrence Frequency	<= 5 KHz
Connector	BNC
Termination	50 Ohms or 10,000 Ohms selectable
Input Voltage	0 V–5 V.
Logic	High = output to load; Low = no output to load
Trigger	On positive-going edge
Pulse Width	5 µsec–25 µsec
Low-Power Output Signals	
SYNC Output. *See Note 1 on Page 25.*	
Connector	BNC
Output Impedance	50 Ohms
Voltage	0–5 Volts
I_{MON} Output	
Connector	BNC
Output Impedance	50 Ohms
Voltage	0–1250 mV; corresponds to 0–250 Amps (5 mV per Amp output)
RS232 Computer Control	
Supported Baud Rate	115200
Bits, Parity, and Handshaking	8 data bits; 1 stop bit; no parity, no hardware handshaking
Connector	
Connector	DB9 female
Pinout	2 = received data (to PCM-7510) 3 = transmit data (from PCM-7510) 5 = Ground
Low Voltage DC Power Required	
Voltage	+ 24 V ± 3 V
DC Ripple Voltage	<= 1% of regulated voltage
DC Current	500 mA–1500 mA
Connector	
Type	Molex # 42816-0212, with 2 pins Molex # 42815-0042 (14–16 AWG wire)
Pinout	1 = 24 V 2 = 24 V return

High Voltage DC Power Required	
Voltage	($V_{forward}$ + 5 V) to ($V_{forward}$ + 10 V)
DC Ripple Voltage	<= 1% of regulated voltage
DC Current	3 Amps + ~125% of average output current
Connector	
Type	Molex # 42816-0612, with 6 pins Molex # 42815-0042 (14–16 AWG wire)
Pinout	1, 2, & 3 = + V_{in} 4, 5, & 6 = V_{in} return
Safety Controls	
Keyswitch	Enable = on; disable = off
Rear Enable BNC	Enable = center conductor shorted to shield Disable = center conductor not shorted to shield
General	
Operating Ambient Temperature	15°C–35°C
Cooling	Air cooling; airflow from front to rear of unit
Weight	25.6 lbs (~11.6 kg)
Dimensions (H x W x D)	6.7" x 7.7" x 20.7"
Mounting Holes	4.5" x 20.125" pattern; 4x clearance holes for 8-32 or M4 screws
Notes	
1. The SYNC output signal follows the internal or external trigger by about 5 to 15 nsec. This signal coincides with the signals that start and stop the output pulse. The SYNC output goes from 0 V to 5 V as soon as the output stage starts to drive the output, and falls from 5 V to 0 V as soon as the system turns off the output pulse. This signal can be used to run multiple systems in parallel by calibrating the external trigger pulses to account for the variation in timing in the PCM-7510.	

Warranty and Service

■ 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. (DEI)
Fort Collins, Colorado

Telephone: (970) 493-1901, extension 24
Fax: (970) 232-3025

Email: deiinfo@directedenergy.com, or
deitechsupport@directedenergy.com

Notes