DIRECTED ENERGY, INC.

PCX-7451

225 AMP PULSED CURRENT SOURCE

OPERATION MANUAL

VERSION 1.0

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SERIAL NUMBER:_____

DATE:_____

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********** WARNING **********

SAFE OPERATING PROCEDURES AND PROPER USE OF THE EQUIPMENT ARE THE RESPONSIBILITY OF THE USER OF THIS SYSTEM.

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.

ALL PERSONNEL WHO WORK WITH OR ARE EXPOSED TO THIS EQUIPMENT MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS AND/OR FATAL BODILY INJURY. DO NOT OPERATE THE UNIT OR PERFORM REPAIR OR ADJUSTMENTS UNLESS ANOTHER PERSON CAPABLE OF RENDERING FIRST AID AND RESUSCITATION IS PRESENT.

1.0 Quick-Start Guide

This quick-start guide provides a step-by-step guide to manually operating the PCX-7451. Please refer to the appropriate sections of the manual for additional instructions and guidelines. The SAFETY warnings in the manual should be read and understood prior to operating the PCX-7451.

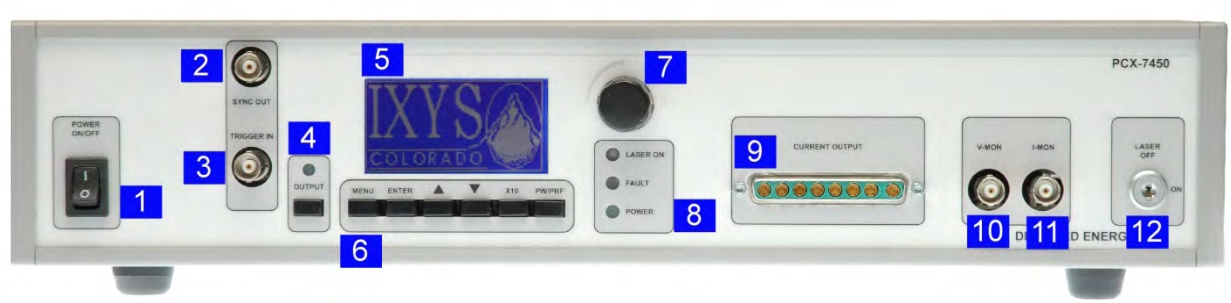


Photo 1

1. Power switch.
2. Sync output.
3. External Trigger input.
4. Output enable switch with LED
5. LCD Display
6. User interface switches
7. User interface encoder
8. LED indicators
9. Output connector
10. Voltage monitor output
11. Current monitor output
12. Laser key switch

1.1 Turning On And Operating The PCX-7451

1. Connect the diode to the output cable termination board, and plug the cable into the PCX-7451 (See Section 6.0).

2. Plug the AC power cord into the PCX-7451, and into an appropriate AC socket (See Sections 4.1 and 5.3).

3. Plug in the Interlock cable, this is a DSUB 15 pin connector on the rear panel of the instrument.

4. Turn on the PCX-7451 by pressing the **POWER SWITCH, 1**.

5. Every time the instrument is powered up a self test is performed, this test takes between 30 seconds and two minutes. During the self test all front panel LEDs, 4 and 8, will flash. If the self test does not successfully complete within two minutes, power down the instrument and call DEI Service and Support.

6. Turn off the **Laser key switch, 12**. The key switch must be on in order to enable pulses, but all the user setting should be configured with the key switch off in order to prevent accidental output pulses.

7. The following steps will require the use of the **LCD Display**, 5; **User interface switches**, 6; and the **User interface encoder**, 7. The **User interface switches**, 6, consists of five switches that will be referred to by the names: Menu, Enter, Up, Down, x10, PW/PRF. Configuring the output of the instrument should always be made in the order shown below.

8. Adjust the desired **Output Over Current**, Ioc. Press the MENU switch until the display is in the "Output Menu". Use the Up, Down, x10 switches and the encoder to change the value of "I oc". This setting is used to generate a hardware fault condition if the output current exceeds this value. This value should be at least five amps above the Output Current, Iout, setting in order to prevent false hardware faults.

9. Adjust the desired **Output Current**, Iout. Press the MENU switch until the display is in the "Output Menu". Use the Up, Down, x10 switches and the encoder to change the value of "I out". This setting is used to set the current output.

10. Adjust the desired **Output Voltage Trip Point**, V trip. Press the MENU switch until the display is in the "Output Menu". Use the Up, Down, x10 switches and the encoder to change the value of "V trip". This setting is used to generate a hardware fault condition if the output voltage falls below this value during the hold portion of the output pulse. This value should be at least ten volts below the Output Voltage, Vout, setting in order to prevent false hardware faults.

11. Adjust the desired **Output Voltage**, Vout. Press the MENU switch until the display is in the "Output Menu". Use the Up, Down, x10 switches and the encoder to change the value of "V out". This setting is used to set the voltage output.

12. Adjust the **Output Frequency**. Press the MENU switch until the display is in the "Pulse Menu". Use the Up, Down, x10 switches and the encoder to change the value of "Freq". The maximum frequency is 5000Hz, but the output frequency is also restricted to enforce a maximum of 300 Watts of total output.

13. Adjust the **Output Pulse Width**. Press the MENU switch until the display is in the "Pulse Menu". Use the Up, Down, x10 switches and the encoder to change the value of "Width". The maximum pulse width is 5000uSec, but the pulse with is also restricted to allow a maximum of 300 Watts of total output. Pulse width is defined as the beginning of the up ramp to the end of the down ramp.

14. Adjust the **Output Rise Time**. Press the MENU switch until the display is in the "Pulse Menu". Use the Up, Down, x10 switches and the encoder to change the value of "Rise". The maximum rise time is 1000uSec, but the rise time is also restricted to a maximum of ~45% of the pulse width. Minimum rise time is 5uSec.

15. Adjust the **Output Fall Time**. Press the MENU switch until the display is in the "Pulse Menu". Use the Up, Down, x10 switches and the encoder to change the value of "Fall". The maximum fall time is 1000uSec, but the fall time is also restricted to a maximum of ~45% of the pulse width. Minimum fall time is 5uSec.

16. Adjust the **Trigger Type**. Press the MENU switch until the display is in the "Pulse Menu". Use the Up, Down switches and the encoder to change the value of "Trig" adjust this setting to "Internal".

17. Saving this configuration. It is highly recommended that your user settings are saved before enabling pulses. Press the MENU switch until the display is in the "Configuration" Menu. Use the Up and Down switches to select the "Save Config" line. Use the encoder to select which memory location to save this configuration, there are six unique configurations that can be saved, 0-5. Memory location zero is the default boot up configuration that will automatically be loaded when the instrument is powered up. After selecting the desired memory location press the ENTER switch to save this configuration. After successfully saving this configuration the display will show that the "Active Config" is the one you just saved.

18. Turn ON the **Laser key switch, 12**. The LED indicator, 8, "Laser On" will now be on. At this point, the system is ready to drive the diode, and extreme caution should be exercised. The output power is potentially lethal. Any pulsed power system is capable of random triggering via transients. Therefore when the current source is turned on, or high voltage is present in the chassis, assume it is possible to get a pulse on the output connector. The diode, diode mounting board and output cable should not be touched or handled when the PCX-7451 is powered up.

19. Enable and Disable output pulses. Press the Output enable switch, 4. The Output LED, 4, will be on if output pulses are enabled and off if they are not. To disable pulses press the Output enable switch again.

1.2 PCX-7451 Power-Down Procedure

The following procedure should ALWAYS be followed when turning off the PCX-7451:

1. Disable the output. Press the **Output enable switch**, 4, if the **Output enable LED**, 4, is on.
2. Turn off the **Laser key switch,** 12.
3. Turn off the PCX-7451 by pressing the **POWER SWITCH,** 1.

2.0 PCX-7451 SYSTEM DESCRIPTIONS

2.1 Conceptual Description

The PCX-7451 pulsed current source is designed to drive laser diode bars and arrays requiring current of up to 225A at voltages to 120V, with precision, high fidelity electrical pulses. The PCX-7451 is capable of varying the parameters of diode forward current, diode forward voltage, current rise and fall times, pulse repetition frequency, pulse width, and duty cycle. Additionally, the unit has the capability of setting an internal maximum current limit, exclusively for the purpose of protecting the diode load. This means the user can set a maximum current that the unit will not exceed. If the PCX-7451 detects a current greater that the limit it will shut off all pulsing and alert the user, thus protecting the diode load.

2.2 System Overview

The PCX-7451 consists of four basic modules and one optional communication module: A front panel user interface/pulse generator, a pulsed current source, low voltage power supply, and a high voltage DC power supply. (See Figure 1 for a Block Diagram) The first module is the DEI's Digital Pulse Engine (DPE). This unit is the command center for the PCX-7451. It is a microprocessor controlled pulse generator and front panel user interface. Capable of supporting remote operation via and optional GPIB or RS-232 module, all commands are received, decoded, and executed through the DPE. After a command is received from the local front panel or from one of the remote interfaces the unit will execute the command in any of the other modules.

In addition to having an internal frequency generator, the digital pulse engine is also capable of creating single shot pulses and using an externally generated trigger source. The system software is designed to prevent the unit from operating outside of system power limitations. If the user configures the system to utilize more power than the design limit the pulse output will suffer, most notably as pulse sag or even pulse truncation. A discussion of the unit's power limitation and pulse fidelity is covered in Section 3.1.

A single low voltage power supply is used to power the system. This is a 15V DC output supply with universal AC input.

The digital pulse engine is also responsible for configuring the pulse characteristics. Controlling multiple Digital to Analog Converters (DACs), the parameters of forward current, forward voltage, current rise and fall times, over current threshold, pulse enable and pulse disable are set from this module. Additionally, remote communication and instruction processing are also controlled from the digital pulse engine.

After leaving the DPE as a TTL pulse the waveform is passed to the pulsed current source. This module consists of high current MOSFETS and over 36,000 uF of capacitance. This energy stored in these capacitors is in excess of 300 Joules and is very dangerous. Therefore, safety interlocks are provide on the unit chassis top cover, rear panel interface connector, and the front panel pulse output connector.

When the interlock is violated, the system discharges the capacitor bank to protect the user from possible injury due to electrical shock.

The pulsed current source also includes a current monitor and voltage monitor. Generated differentially to eliminate ground bounce, these signals provide a real time measurement of the PCX-7451 output. These signals are available on the unit front panel BNC's. They are output from 50 Ohm sources and are ideal for connection to an oscilloscope or a digitizer for data collection.

The final module is the system's high voltage power supply. A 300 Watt switch mode power supply provides the energy used in generating the high current pulses. Digitally controlled and monitored, this power supply alerts the user via the DPE if the power demand is greater than the factory set safety limit.

The system is housed in a standard 19" rack mountable chassis 17" wide, 16" deep and 3.5" high box, suitable for bench top or rack mount applications.

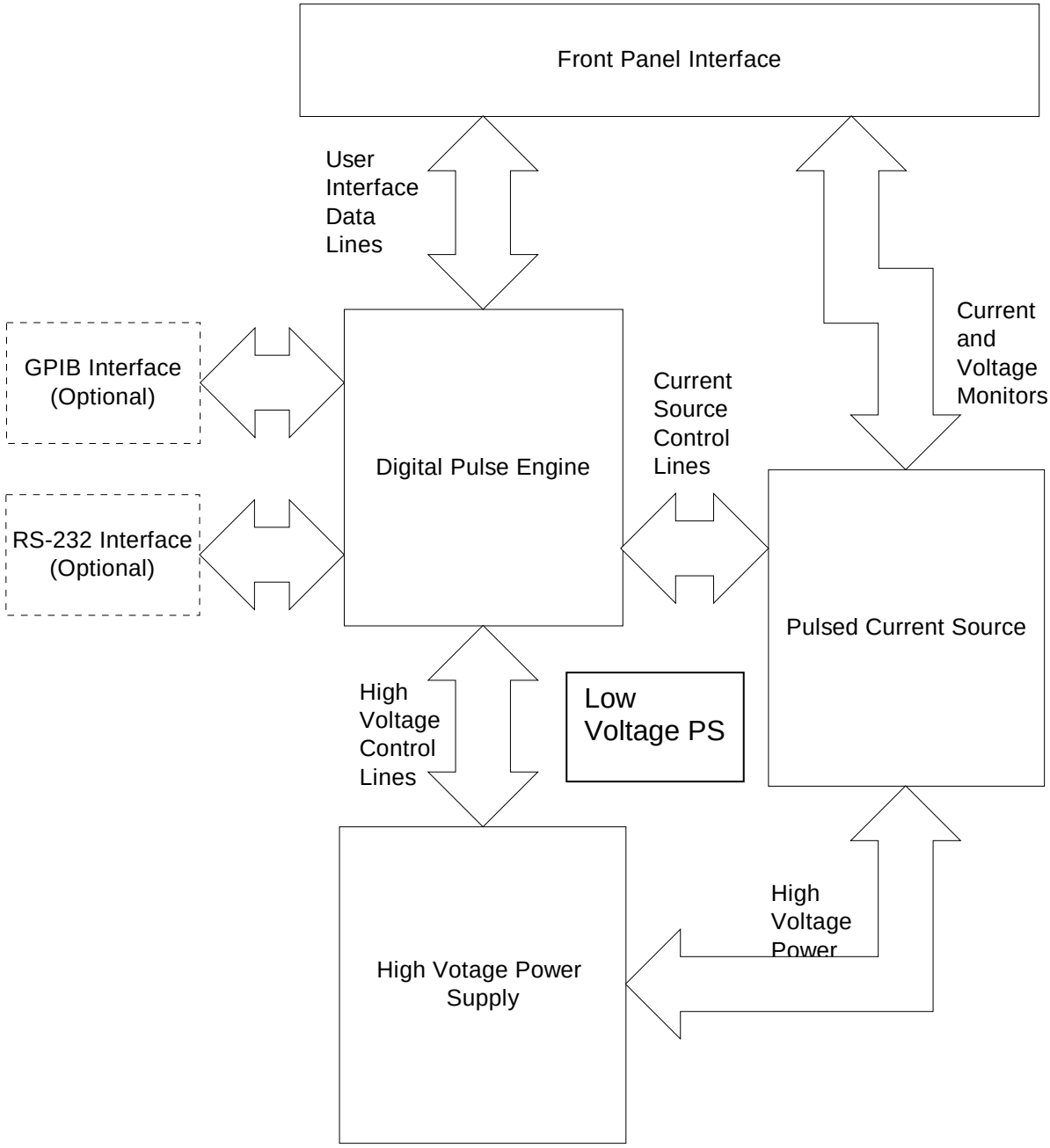


Figure 1: System Block Diagram

3.0 SPECIFICATIONS

PARAMETER	MODEL PCX7451A
Output Pulse Amplitude Range	20A to 225A
Output Current Resolution	0.2A
Accuracy At 25A Setpoint	~1%
Pulse Rise Time	Adjustable 5µs to 1000µs
Pulse Fall Time	Adjustable 5µs to 1000µs
Pulse Width	15 µs to 5ms (Measured from the beginning of the rising edge to the end of the falling edge)
Frequency Range	Single Shot or 0.1 Hz to 5kHz
Maximum Output Power	300 Watts- 20 Amp output current to 150 Amps 250 Watts- 150 Amps output current to 200 Amps 200 Watts -200 Amp output current to 225 Amps
Propagation Delay	Less than 2µs to start up ramp
Output Pulse Width Stability	~±0.5% at 1000µs pulse width, 125A at 120V output voltage
Output Pulse Amplitude Stability	~±0.5% at 1000µs pulse width, 125A at 120V output voltage
Output Pulse Flatness	~±0.1% at 1000µs pulse width, 125A at 120V output voltage
Over/undershoot	<2%
Jitter	<10ns shot-to-shot
Output Connector	8 Pin D-sub
COMPLIANCE VOLTAGE	
Range	Up to 120V
Resolution	1V
OVER CURRENT LIMIT	
Range	20A to 255A
Resolution	0.1A
TRIGGER IN	
Trigger Input	TTL or +5V ±1V, into 50Ω or 1K Ω, user selectable
Minimum Trigger Pulse Width	500ns
Input Trigger Connector	BNC, Front Panel
SYNC MONITOR OUTPUT	
Sync Monitor	TTL output into 50Ω
Sync Monitor Connector	BNC, Front Panel
CURRENT MONITOR OUTPUT	
CVR Monitor	75A/V in to 50 Ohms or greater, typically within 0.5% of the displayed actual current
CVR Monitor Connector	BNC, Front Panel
VOLTAGE MONITOR OUTPUT	
Voltage Monitor	25V/1V, 50 Ohms or greater, typically within 1% of the actual voltage
Voltage Monitor Connector	BNC, Front Panel
GENERAL	
Input AC Power	120-240VAC Nominal, 50/60Hz, Fused at 5A
Dimensions (H X W X D)	19" rack mount 3 1/2" x 17" x 16"
Weight	Approx. 20 lbs
Cooling	Air
Temperature Operating Range	10C to 35C
Safety	Complies with CDRH US21 CFR 1040.10

Table 1: PCX-7451 System Specifications.

3.1 Safe Operating Area

The PCX-7451 is limited to an average output power of 330 Watts. The PCX-7451 user interface will not allow pulse configurations that demand more than 330 Watts average power from the power supply. This limitation is used to derive the maximum positive duty cycle of the output pulse with the following formula.

$Duty\_Cycle_{MAX} < 100\% * 330\ Watts / (I_{OUT} * V_{OUT})$

The table below shows the maximum frequency verses $Duty\_Cycle_{MAX}$, if the instrument is running at the maximum frequency the maximum pulsewidth is 15uSec at that frequency. The only exception to this limitation is when $Duty\_Cycle_{MAX}$ is above 18%.

$Duty\_Cycle_{MAX}$ (%)	**Maximum Frequency (Hz)**
0.01 to 0.99	285
1.00 to 1.99	285
2.00 to 2.99	571
3.00 to 3.99	857
4.00 to 4.99	1142
5.00 to 5.99	1428
6.00 to 6.99	1714
7.00 to 7.99	2000
8.00 to 8.99	2285
9.00 to 9.99	2571
10.00 to 10.99	2857
11.00 to 11.99	3142
12.00 to 12.99	3428
13.00 to 13.99	3714
14.00 to 14.99	4000
15.00 to 15.99	4285
16.00 to 16.99	4571
17.00 to 17.99	4857
>= 18.00	5000

4.0 SAFETY

The high current output of this system dictates the use of caution when operating or servicing this equipment. The following is a summary of general safety precautions that must be observed during all phases of operation and repair of the PCX-7451.

4.1 Operating Safety Summary

The safety information contained in this summary is for both operating and servicing personnel. Specific warnings may be found throughout this manual, but may not appear in this summary.

4.1.1 Power Source

The PCX-7451 is designed to operate from a regulated power source. To assure proper system operation the input voltage should not vary by more than 10% from the recommended specification. The PCX-7451 accepts input voltages from 120VAC to 240VAC at 50Hz or 60Hz.

A protective grounding connection by way of the grounding conductor in the AC power cord is essential.

4.1.2 Grounding

The PCX-7451 is grounded through the grounding conductor of the AC power cord. **To avoid electrical shock, plug the PCX-7451 into a properly wired receptacle before making connection to any input or output connectors.** Use only a power cord that is in good condition.

4.1.3 Cover Removal

To avoid personal injury, do not remove the covers. **Do not operate the PCX-7451 while the covers are removed.** The top cover contains a safety interlock. To operate the unit with the top cover removed requires the interlock system to be bypassed Operating the unit with the top cover removed and the interlock bypassed voids any and all warranties associated with the PCX-7451. Removal of cover voids the instruments warranty.

4.1.4 General Operating Precautions

Do not open the unit while the system is in operation. Never handle or remove the output cable or laser diode while the unit is operating. Never short-circuit the output of the unit. Failure to observe these precautions can result in potential electric shock to personnel, arcing, and damage to the connectors and system. Ensure that the power-down procedure has been correctly followed and the unit turned off before handling or removing the output cable or laser diode.

4.2 Servicing Safety Summary

The PCX-7451 contains dangerous currents, voltages and stored energy. DEI strongly recommends that all repairs and adjustments be performed by factory qualified personnel. DEI will not be responsible for personal injury or damage to the driver that occurs during repair by any party other than the factory. Any repairs, adjustments or modifications made by anyone other than authorized DEI personnel voids the factory warranty.

4.2.1 Internal Energy Storage

The PCX-7451 contains capacitors that are used as energy storage elements. When charged, these capacitors contain over 300 Joules of stored energy. This is sufficient energy to cause serious injury or death. Dangerous voltages, floating ground planes and energy storage exist at several locations in the PCX-7451. Touching connections and/or components could result in serious injury or death. Although a safety discharge circuit is included to discharge the energy storage capacitors, the voltages should always be checked to determine energy storage is safe.

5.0 PREPARATION FOR USE

5.1 General

After unpacking, initial inspection and electrical installation procedures should be performed to assure that the unit is in good working order. If it is determined that the unit is damaged, the carrier should be notified immediately. Repair problems should be directed to the service department,

Directed Energy, Inc. (DEI),
Fort Collins, Colorado.
Telephone: (970) 493-1901 extension 24
FAX: (970) 493-1903
EMAIL: deiinfo@directedenergy.com

deitechsupport@directedenergy.com

5.1.1 What Is Included With The PCX-7451

Included with the PCX-7451 :

1. PCX-7451 with options installed
    a. Without Communications
    b. With RS-232 Communications
    c. With GPIB Communications
2. CTRL Interlock 15 pin DSUB connector
3. PCA-9155 Output cable with magnet
4. Power Cord
5. Instruction Manual

5.2 Initial Inspection

1. Inspect unit for exterior mechanical damage.

2. Inspect power input cord and input power module for obvious signs of damage.

5.3 Electrical Installation

Standard units are shipped ready for use with a nominal 120 - 240 VAC input.

6.0 LASER DIODE INTERCONNECTION

The PCA-9155 output cable assembly is provided with the PCX-7451. This cable assembly has a connector (Amphenol # 717TW-C-8W8-P-P3Y or Conec #3008W8PXX51A10X) and a stripline. Pins 2, 4, 6 & 8 are the positive pulse output, and pins 1, 3, 5 & 7 are the return. The connector of the output cable is marked with a “Positive” terminal and a “Negative” terminal. The Positive terminal is the power output terminal which is to be connected to the Anode of the Laser Diode. The Negative terminal is the power return or ground and is to be connected to the Cathode of the Laser diode. A magnet is mounting on the housing to activate the interlock reed switch.

The output is provided on a high current DSUB connector (Amphenol #77TW-C-8W8-S-MP3V-4R or Conec #3008W8SXX57A30X). The output cable is interlocked at the connector end next to the front panel. If the cable is disconnected from the PCX-7451, the interlock will be broken, and the PCX-7451 will disable output pulses, disarm the system, and display a fault code on the front panel display.

7.0 OPERATING CONSIDERATIONS

7.1 Local Mode Operation

This is the default operating mode that the unit assumes upon power up. It is designed for user front panel control. This allows the user to configure, test and operate the PCX-7451 without a host PC.

7.2 Remote Mode Operation

Units configured with the GPIB or RS-232 options can be remotely operated by a host PC. Remote mode operation is designed for this ability. This feature allows the user to create system level control software to run standardized test procedures for research test or manufacturing validation environments.

7.3 High Voltage Power Supply

The PCX-7451 is equipped with a 3A current limited power supply used to create the energy converted into the pulsed current source. This supply is controlled by the digital pulse engine to assure the pulsed current source is only being charged when the system is "Armed". **Warning: The pulsed current source will still have charge even when not "Armed". Do access the unit's internal electronics, there will be a potential for shock immediately after the unit has been energized.**

7.4 Pulsed Current Source

The pulsed current source is the heart of the PCX-7451. It is where the energy created by the high voltage power supply and the control functions of the digital pulse engine meet to create the current pulse. Consisting of MOSFET switches and a large capacitor bank, the pulsed current source is capable of regulating pulses from 20A to 225A. Onboard control circuitry minimizes over and undershoot to create clean rising and falling edges. The current source has the ability to control the current rise and fall times.

7.5 Interlock Safety System

The interlock system is intended for operator safety. Any attempt to bypass this system invalidates any and all warranties associated with the PCX-7451. The chassis interlock switch is located at the back of the unit near the top cover. This switch ensures that only when the top cover is on will the high voltage power supply be energized, the pulsed current source enabled and the digital controller will allow pulses to be enabled. The interlock system has two primary subsystems, a hardwired interlock loop and a firmware redundant routine.

The hardwired loop connects the top cover switch, the rear panel control interface connector, a separate loop for the front panel connector to provide a signal to the digital pulse engine that the interlock loop is made. If any switch is broken this signal loses its integrity and the system immediately enters the FAULTED state. For more information regarding the FAULTED state see section 9.4.

The second half of the interlock system is the firmware response. The DPE executes an asynchronous routine each time the interlock is violated. This routine disables the high voltage and disables the pulse output signal. In Local mode operation the PCX-7451 displays a message on the user front panel interface indicating a fault has occurred The firmware has now forced the unit offline and the pulses cannot be re-enabled until the fault is cleared. User intervention is therefore required to re-enable the system.

7.6 Front Panel Controls and Indicators

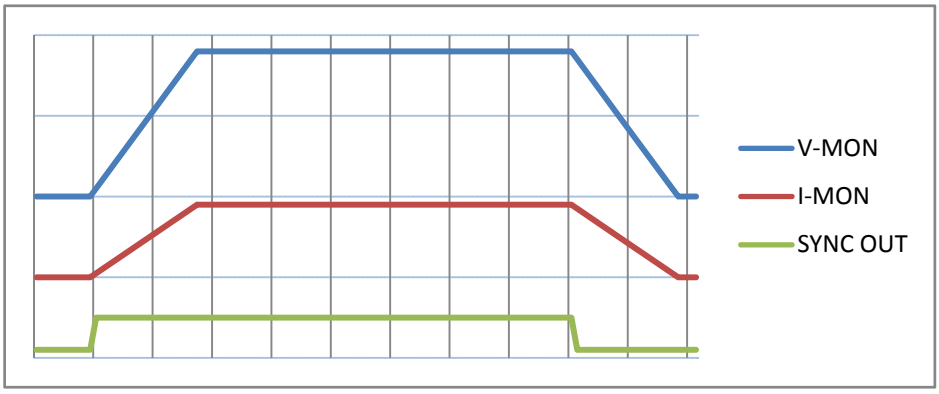
Photo 1 in section 1.00 shows the PCX-7451's control panel. The display, encoder wheel, and buttons allow stand-alone operation of the PCX-7451. A description of each follows. The photo below identifies each of the controls and indicators.

7.6.1 Power Switch and LED

The switch labeled **POWER ON/OFF**, **1**, controls all AC power in the chassis. The POWER LED in the LED STATUS DISPLAY illuminates when the AC power is turned on and DC voltages are available.

7.6.2 Synchronous Pulse Monitor

The BNC Connector labeled **Sync Output**,**2**, is a 5V TTL signal into 1 meg-Ohm or 4V signal into 50 Ohms that is synchronous with the high voltage pulse. This is designed to assist the user in triggering while monitoring the Vmon or Imon signals with an oscilloscope. A sample waveform is shown below, the **Sync Output** is high at the beginning of the up ramp and drops low at the beginning of the down ramp.



7.6.3 External Trigger

The BNC connector labeled **Trigger In, 3**, is an input signal into 50 Ohms or 1000 Ohm input used for external pulse triggering. The user is able to select which termination is used with the Graphic User Interface. This input signal was designed to allow the user to trigger multiple PCX-7451 units from a single pulse generator. It allows the user to create synchronous waveforms from multiple units.

7.6.4 Voltage Monitor (Vmon)

The BNC connector V-MON, **10**, is a real time monitor of the high current pulse created on the pulsed current source with a scaling of 25V equals 1V when monitored with an oscilloscope with an input impedance of 50 Ohm.

7.6.5 Current Monitor (Imon)

The BNC connector I-MON, **11**, is a real time monitor of the high voltage pulse current created on the pulsed current source card with a scaling of 75A equals 1V when monitored with an oscilloscope with an input impedance of 50 Ohm.

7.7 Rear Panel Connectors

7.7.1 J1 – Comm RS-232 Option

The connector labeled "J1 COMM" is the RS-232 or GPIB interface for those units with the optional RS-232 or GPIB interface. The RS-232 pin out is standard nine pin DSUB. Only pins 2, 3, and 5 are required to communicate to the instrument.

Pin 1	DCD	Data Carrier Detect
Pin 2	RxD	Receive Data
Pin 3	TxD	Transmit Data
Pin 4	RTS	Data Terminal Ready
Pin 5	GND	Ground
Pin 6	DSR	Data Set Ready
Pin 7	RTS	Request To Send
Pin 8	CTS	Clear To Send

7.7.2 J2 - CTRL

The DB-15 connector labeled "J2" is the control interface connector. Sockets 4 and 12 of this connector are switch closure interlocks. These sockets are in series with the top cover interlock. These sockets can be wired to a door switch, system kill switch, or other safety interlock. If the sockets are not connected, or if the top cover is removed and output pulses are enabled the unit will issue an interlock fault, and will cease operation.

The PCX-7451 is shipped with a mating DB-15 connector with pins 4 and 12 shorted. This connector can be plugged into J2 to close the interlock pins, permitting operation of the unit. This mating plug may be changed to meet the user's requirements. For example, pins 4 and 12 can be wired to the normally-closed contacts of an emergency stop button. Then if the emergency stop button is pressed, the interlock circuit will be opened, and the driver will be disabled, cease pulsing, and a fault will be asserted.

The DB-15 pins and sockets are labeled within the connectors. Viewing the DB-15 with the row of 8 sockets to the right, sockets 1 is the upper-most pin in the row of 8.

7.7.3 J1 – GPIB Option

The optional GPIB connector labeled "J1" is the GPIB interface connector for those units with the optional GPIB (IEEE-488) interface.

7.7.4 AC Power Entry Module

The driver is grounded through the grounding conductor of the AC power cord. To avoid electrical shock, plug the driver into a properly wired receptacle before making connection to any input or output connectors. Use only a power cord that is in good condition.

The PCX-7451 accepts input voltages of 120-240VAC, 50/60Hz. The fuses in the module are 5A fast blow.

7.8 Diode Loads

The PCX-7451 is designed to support many types of diode loads. With a variable forward voltage and forward current it is the user's responsibility to verify their diode specifications against the PCX-7451 capabilities.

See Section 6.0 for additional information on connecting the diode to the PCX-7451.

8.0 HARDWARE OPERATING INSTRUCTIONS

This section provides basic operating instructions for the PCX-7451 hardware.

WARNINGS

1. To avoid personal injury, do not remove the covers. Do not operate the PCX-7451 while the covers are removed. The top cover does contain a safety interlock. Bypassing this safety mechanism violates any and all warranties associated with the PCX-7451.

2. Do not handle or remove the output cable or laser diode while the PCX-7451 is in operation. Never short circuit the pulse current output of the pulser. Failure to observe these precautions can result in potential electric shock to personnel, arcing, and damage to the connectors of the system.

3. Pulsed power systems are capable of random triggering via transients and therefore when the PCX-7451 is turned on, or voltage is present in the chassis, assume it is possible to get a pulse on the output connector. For this reason never touch the output connector or laser diode while the system is active.

4. The PCX-7451 contains capacitors that are used as energy storage elements. When charged, these capacitors contain approximately 300 Joules of stored energy. This is sufficient energy to cause serious injury or death. **Assure that the AC power cord is disconnected from the system. Verify that the capacitor bank is fully discharged. Verify with a voltmeter that all circuits are de-energized before servicing.** Dangerous voltages, floating ground planes and energy storage exist at several locations in the PCX-7451. Touching connections or components could result in serious injury or death.

8.1 Power-Up Procedures

The unit should be powered up using the following procedures:

1. Connect both ends of the power cord. One to the PCX-7451 and the other to your site's power outlet. The PCX-7451 is capable of accepting input voltages from 120VAC to 240VAC.

2. Push the power switch located on the left side of the unit's front panel to the ON position to activate the AC power.

3. Turn on the key switch located on the right side of the unit's front panel.

4. Configure the unit from the front panel, GPIB port, or RS-232 port. See the quick-start guide in Section 1.0 of this manual for specific operating instructions.

8.2 Power-Down Procedures

1. Disable all pulsing, verify by checking the OUTPUT status LED. It will be off if pulsing is disabled.

2. Turn off the key switch on the right side of the unit's front panel.

3. Push the power switch to the OFF position to activate the AC power. It is located on the left side of the unit's front panel.

8.3 System Fusing

The PCX-7451 has protection fusing for the system input. These fuses are used to prevent hardware damage due to a system level failure. The fuses are 5A 250V fast blow and are located in the power entry module located at the rear of the system.

9.0 LOCAL MODE OPERATING INSTRUCTIONS

9.1 PCX-7451 Switches

Output Enable Switch

The **Output Enable Switch**, 4, is used to enable and disable pulses. It may be used regardless of which screen is displayed on the LCD. The function of pressing this button changes depending on the trigger mode. There are three trigger modes, internal, external and single shot. If the unit is in internal trigger mode pressing this button will enable or disable pulses at the frequency the unit is programmed to. The pulse will continue until the button is pressed again. In external trigger mode, output pulses will occur when the unit is triggered from the TRIGGER IN, 3,BNC connector. In single shot mode, pressing this switch will output a single pulse.

MENU Switch

The **MENU Switch** is used to switch between all the different user screens on the LCD.

ENTER Switch

The **ENTER Switch** is only used for saving and loading user configurations in the user configurations menu. All other settings are active immediately.

UP & DOWN Switches

The **UP & DOWN Switches** are used to navigate to the lines on the LCD. By using these switches the user is able to change all the user settings.

X10 Switch

The **X10 Switch** is used to change the cursor position on the line that is being adjusted by the user. For example, if the user is in the *Pulse Menu* with the *Freq line* selected and if the cursor is on the ones digit, pressing the X10 switch will move the cursor to the tens digit. Pressing it again will move the cursor to the hundreds digit and so on.

PW/PRF Switch

The **PW/PRF Switch** allows easy adjustment of the Pulsewidth, PW, and Pulse Repetition Frequency, PRF. Pressing this button will jump to the Pulse Menu immediately and will toggle between the Freq line and Width Line.

9.2 Graphic User Interface

The LCD provides the user of the instrument with the ability to set and monitor many functions of the instrument. Using the switches as described in the previous section the user can navigate between the following screens which will be referred to as different menus.

PCX-7451 Menu

This menu provides the user with the units serial number and firmware revisions, there are NO user adjustable setting in this menu.

Pulse Menu

This menu allows the user to view and/or modify the Pulse Frequency, Pulsewidth, Risetime, Falltime and Trigger type.

Output Menu

This menu allows the user to view and/or modify the Pulse Over Current (Ioc), Pulse Current output (Iout), Pulse Voltage trip point (Vtrip),Pulse Voltage Output (Vout).

The Maximum Duty Cycle (Max DC) can't be modified by the user and is present for information only. It is the calculated maximum positive duty of the pulse output to assure the High Voltage Power Supply never exceeds 330 Watts.

Monitor Menu

This menu allows the user to view the High Voltage Power Supply Voltage output, and the Heatsink & Ambient temperatures, none of these values are adjustable. During normal operation the High Voltage Power Supply voltage reading should exceed the Vout setting in the previous menu.

Status Menu

This menu allows DEI service to assist the end user with any instrument issues that might exist. There are no user setting in this menu. All position should have a checkmark during normal usage. The status indicators usage is listed below.

HARWARE Line

1. Hardware issue 0426-25. Unit must be returned to DEI service
2. Hardware issue 0424-PE. Unit must be returned to DEI service
3. Hardware issue 0424-FADC. Unit must be returned to DEI service
4. Hardware issue 0424-FDAC. Unit must be returned to DEI service
5. Hardware issue 0424-FSP. Unit must be returned to DEI service
6. Hardware issue 0424-EA. Unit must be returned to DEI service

INTERLOCK Line

1. Rear Interlock is open. Assure CNTR cable is installed.
2. Key switch is in the off.
3. Output cable or the interlock magnet on the output cable is not present.

TEMPERATURE Line

1. Ambient temperature is out of range.
2. Heatsink temperature is out of range.

HVPS Line

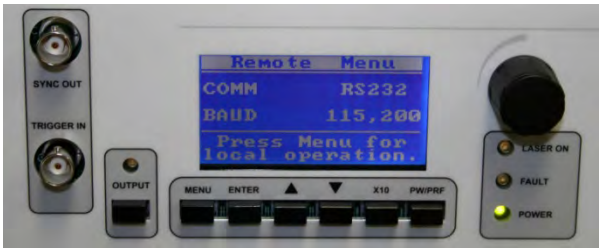
1. HVPS over current or over temperature.
2. HVPS output is over 330Watts.

OUTPUT PULSE Faults

The last three line items are output pulse faults which will described in the fault section of the manual.

Remote Menu

This menu allows the user to select the Communication mode, either RS232 or GPIB, RS232 baudrate and GPIB address. If this menu comes up when the instrument is being remotely controlled by a computer the user must press the MENU switch to return to front panel operation.



Diagnostics Menu

This menu should not be accessed by the user unless instructed to by DEI Service Personnel. Running these diagnostics test can damage the instrument and/or laser diode if proper procedures are not followed.

Configuration Menu

This menu is used to save and load the saved user configurations. The user can select the configuration that they want to load or save in the menu and then hit the enter button to execute the load or save. Configuration 0 is the default and is loaded up every time the instrument is powered up.

9.3 Configuring the Pulses

Pulses are configured using the Pulse and Output Menus described in the previous section. Although you can physically configure the pulse parameters in any order, it is strongly recommended that you configure them in the following order.

- Output Over Current
- Output Current
- Voltage Output
- Voltage Trip Point
- Frequency
- Pulsewidth
- Pulse Risetime
- Pulse Falltime
- Trigger Type

Output Over Current

The Output Over Current, I_{OC}, can be adjusted between 20 Amps and 255 Amps. This parameter sets a threshold for a fault condition. A fault will occur if the instrument's output current exceeds this value. It is recommended that this be set at least five amps above the Output Current to avoid false faults.

Output Current

The Output Current, I_{OUT}, can also be adjusted between 20 Amps and 225 Amps. Another limitation is that I_{OUT} can't exceed I_{OC}. This parameter adjusts the output amplitude.

Output Voltage

The Output Voltage, V_{OUT}, can be adjusted between 20 Volts and 120 Volts. This parameter adjusts the maximum voltage at the load. This parameter can adversely affect the output current; for example assume we are driving a purely resistive load of 2 Ohms, if I_{OUT} is set to 50 Amps then V_{OUT} would have to be set to at least 100 Volts to avoid clipping the output current.

Voltage Trip Point

The Voltage Trip Point, V_{TRIP}, can be adjusted between 1 Volt and 120 Volts. Another limitation is that V_{TRIP} can't exceed V_{OUT}. This parameter sets a threshold for a fault condition. A fault will occur if the instrument's output voltage falls below this value during the hold portion(after the up ramp and before the down ramp) of the output pulse. It is recommended that this be set at least ten volts below V_{OUT} to avoid false faults.

Frequency

The Pulse Frequency can be adjusted between 0.1Hz to 5000Hz. This frequency is as limited by the I_{OUT} and V_{OUT} values.

This limitation is done automatically for the user but a brief explanation is as follows... I_{OUT} and V_{OUT} are used to calculate the maximum duty cycle of an output pulse to assures the maximum output power is never exceeded. For more information see the SOA section of the manual.

Pulsewidth

The Pulsewidth can be adjusted between 15uSec and 5000uSec. Pulsewidth is define as the width of the pulse from the beginning of the risetime to the end of the falltime. It is restricted to not exceed the Maximum Duty cycle, see SOA section of the manual for more clarification.

Pulse risetime and falltime

The risetime and falltime can be adjusted between 5uSec and 1000uSec. Risetime is define from 0% to 100% and falltime is defined from 100% to 0% of the output current. There is one addition restriction on both of these values, they can NOT exceed 45% of the pulsewidth.

Trigger type

The trigger type can be configured by the user, there are four trigger modes.

Internal Trigger

Internal trigger, uses the instruments own timing source to control the timing of the pulses. This is the preferred timing method.

External Trigger 50 Ohm termination

This trigger mode allows the user to connect a timing source to the TRIGGER IN BNC cable to control the pulse output frequency. All pulse settings, including pulse frequency must be set before using the external trigger. The pulse frequency must be set equal to or higher than the maximum trigger rate the user wishes to clock the instrument. If the user attempts to send trigger pulses faster than the frequency is set to, the instrument ignores them. This input has a 50 Ohm termination. External trigger pulses are ignored unless the output is enabled.

External Trigger 1000 Ohm termination

Same as ‘External Trigger 50 Ohm termination’ but with 1000 Ohm termination. This allows the user to clock the instrument using sources that can’t drive a 50 Ohm input.

Single Shot

This trigger mode sends out a single pulse every time the Output Enable button.

9.5 System Faults

In the event of a system fault, the instrument powers down the HVPS and disables the output. A power down cycle is then required before output pulses can be resumed. Below is a short description of the most common faults and possible solutions to eliminate any false faults.

Ioc Fault

I_{OC}, Output Pulse Over Current. A fault will occur if the instrument's output current exceeds the I_{OC} setting. It is recommended that this be set at least five amps above the Output Current to avoid false faults. In the event that the user is having unexpected errors I_{OC} should increased.

Von Fault

V_{ON} Faults occur when the output voltage falls below the V_{TRIP} setting during the hold portion(after the up ramp and before the down ramp) of the output pulse. It is recommended that this be set at least ten volts below V_{OUT} to avoid false faults. In the event that the user is having unexpected errors, V_{TRIP} should decreased.

Over Temperature Faults

Over Temperature Faults should only occur if airflow is blocked or the instrument is being operated in an environment that exceeds the Temperature Operating Range Specifications.

Voff Fault

V_{OFF} Faults occur when the output has voltage when there is no pulse output and the internal crowbar circuit is active. There are no user adjustments that can be made to eliminate this fault.

Keyswitch Fault

This fault occurs when the Keyswitch is turned from on to off with the output active.

Rear Interlock / Cover Interlock

These faults occur when the rear interlock is open or the cover of the instrument is removed. Check the interlocks and top cover to assure that they are not open.

9.6 Saving and Loading user configurations

For user convenience the PCX-7451 has the ability to save up to six different configurations numbered 0 to 5. Configuration 0 is the default boot up configuration. To save or load a user configuration the user should navigate to the Configurations menu. Using the up and down switches the user can select to save or load a configuration. The encoder is then used to select the configuration desired and then press the enter button to actually load or save it. As soon as the configuration is loaded or saved that configuration number will be displayed in the 'Active Configuration Line' and will remain there until the user modifies any pulse parameters.

10.0 FACTORY SERVICE AND SUPPORT

For more information regarding your PCX-7451 system or for information pertaining to an operational problem, please contact the factory for further assistance:

Directed Energy, Inc. (DEI),
Fort Collins, Colorado.
Telephone: (970) 493-1901 extension 24
FAX: (970) 493-1903
EMAIL: deiinfo@directedenergy.com

deitechsupport@directedenergy.com

11.0 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 the 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 to misuse, negligence 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 by 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.