DIRECTED ENERGY, INC.

PCX-150A

150 AMP PULSED CURRENT SOURCE

OPERATION MANUAL

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-150. 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-150.

1.1 Turning On And Operating The PCX-150

1. Connect the diode to the output cable termination board, and plug the cable into the PCX-150 (See Section 6.0).

2. Plug the AC power cord into the PCX-150, and into an appropriate AC socket (See Sections 4.1 and 5.3).

3. Turn on the PCX-150 by pressing the **POWER** button.

4. Turn ON the key switch on the right side of the PCX-150 front panel. If the key switch is off, the PCX-150's controller will detect a key fault, and will not allow the system to be armed.

5. The front panel display will read *Configuration Menu - Local Mode*. Press **SELECT** to access the *Config Pulse* menu. Turn the **ENCODER** wheel clockwise to change the display to *YES*. Press the **SELECT** button.

6. Select the *Internal PRF* trigger source (this is the default). Press **SELECT** to implement the selection.

7. The next option displayed is the *Pulse Frequency*. The **RANGE** button selects the frequency exponent, and the encoder wheel sets the number. Using the **RANGE** button and **ENCODER** wheel, select the desired frequency. Press select to implement the selection.

8. The next option displayed is the *Pulse Width*. The **RANGE** button selects the pulse width exponent, and the encoder wheel sets the number. Using the **RANGE** button and **ENCODER** wheel, select the pulse width. Press **SELECT** to implement the selection.

9. The next option displayed is the *Duty Cycle*. If a valid pulse width has been entered, the Duty Cycle selection can be ignored. Conversely, the *Pulse Width* selection can be skipped, and a duty cycle selected. In this case, the pulse width will be calculated by the PCX-150 based upon the frequency and duty cycle that are entered. The duty cycle is set using the **ENCODER** wheel. Press **SELECT** to skip they Duty Cycle selection, or after setting the duty cycle, press **SELECT** to implement the selection.

10. When **SELECT** is pressed in the *Duty Cycle* menu, the display will return to the *Config Pulse* menu. Choose *YES* using the **ENCODER** wheel to go through the

Config Pulse menu selections again, or choose *NO* (the deault), then press the **SELECT** button. The display will show the *Config Output* menu.

11. Rotate the **ENCODER** wheel to *YES*, and press SELECT. The V_F (Forward Voltage) option will be displayed. Using the **ENCODER** wheel and **RANGE** button, set the V_F to a voltage appropriate for the diode. Press **SELECT** to implement the selection.

12. The I_F (Output Current) option will be displayed. Using the **ENCODER** wheel and **RANGE** button, set the I_F to a current appropriate for the diode. Press **SELECT** to implement the selection.

13. The I_{OC} (Output Over Current Limit) option will be displayed. The I_{OC} setting limits the output current that can be set or output to the value entered here (I.E. if the diode current cannot exceed 50A, setting I_{OC} to 50A will prohibit the user from inadvertently setting the output current to 150A. Using the **ENCODER** wheel and **RANGE** button, set the I_{OC} to an over-current appropriate for the diode. Press **SELECT** to implement the selection.

14. The I_{Ramp} (Output Current Ramp Increment Value) option will be displayed. This is the soft start ramping function. When selected to a current level the PCX-150 will increment the pulses from 0A to Output Current (I_F) in steps equal to the I_{Ramp} set point. Using the **ENCODER** wheel and **RANGE** button, set the I_{Ramp} to an increment current appropriate for the diode. Press **SELECT** to implement the selection.

15. The display will now return to the *Config Output* menu. Choose *YES* using the **ENCODER** wheel to go through the *Config Output* menu selections again, or choose *NO* by turning the **ENCODER** wheel counter-clockwise, then press the **SELECT** button. The display will return to the *Config Output* menu.

16. Press the **MODE** button once to shortcut to the *Configuration Mode Home* menu, or press **SELECT** repeatedly to scroll through the menu options until you return to the *Configuration Mode Home* menu.

17. Push the **MODE** button to arm the system. Arming the system turns on the high voltage DC power supply, and charges the current source's capacitor bank. 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-150 is turned on.

18. Push the **PULSE ON** button to enable the PCX-150, and generate output pulses to the diode. Remember if the PCX-150 is configured to create a ramp the beginning of the pulse train will be changing by the I_{Ramp} value.

19. Pushing the **PULSE ON** button again will disable the PCX-150, and return to an armed status.

20. Push the **MODE** button to disarm the system and return to the *Home* menu. From this menu, the system can be re-armed, or the system configuration can be changed by pressing **SELECT** to scroll through the configuration menus.

1.2 PCX-150 Power-Down Procedure

The following procedure should ALWAYS be followed when powering down (turning off) the PCX-150:

1. Disable the output. If the PCX-150 is pulsing, press the **PULSE ON** button to disable the output.

2. If the PCX-150 is in the ARMED mode, press the **MODE** button to disarm the PCX-150. Turn off the key switch and the AC power switch.

2.0 PCX-150 SYSTEM DESCRIPTIONS

2.1 Conceptual Description

The PCX-150 pulsed current source is designed to drive laser diode bars and arrays requiring current of up to 150A at voltages to 100V, with precision, high fidelity electrical pulses. The PCX-150 is capable of varying the parameters of diode forward current, diode forward voltage, soft start ramp current increment, 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-150 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-150 consists of four basic modules: A front panel user interface, a pulse generator, a pulsed current source, and a high voltage DC power supply. (See Figure 1 for a Block Diagram) The first two of these modules are incorporated in DEI's Digital Pulse Engine (DPE). This unit is the command center for the PCX-150. It is a microprocessor controlled pulse generator and front panel user interface. Capable of supporting remote operation via GPIB or RS-232 control, 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. In internal PRF mode, the system software is designed to prevent the unit from operating outside of system power limitations. However, in external trigger mode this burden falls to the user. It is extremely important to recognize this aspect of the PCX-150. 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.

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, 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 30,000 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-150 output. For the user these signals are available on the unit front panel BNC's. They are launched 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" wide, 21" deep and 3.5" high box, suitable for bench top or rack mount applications.

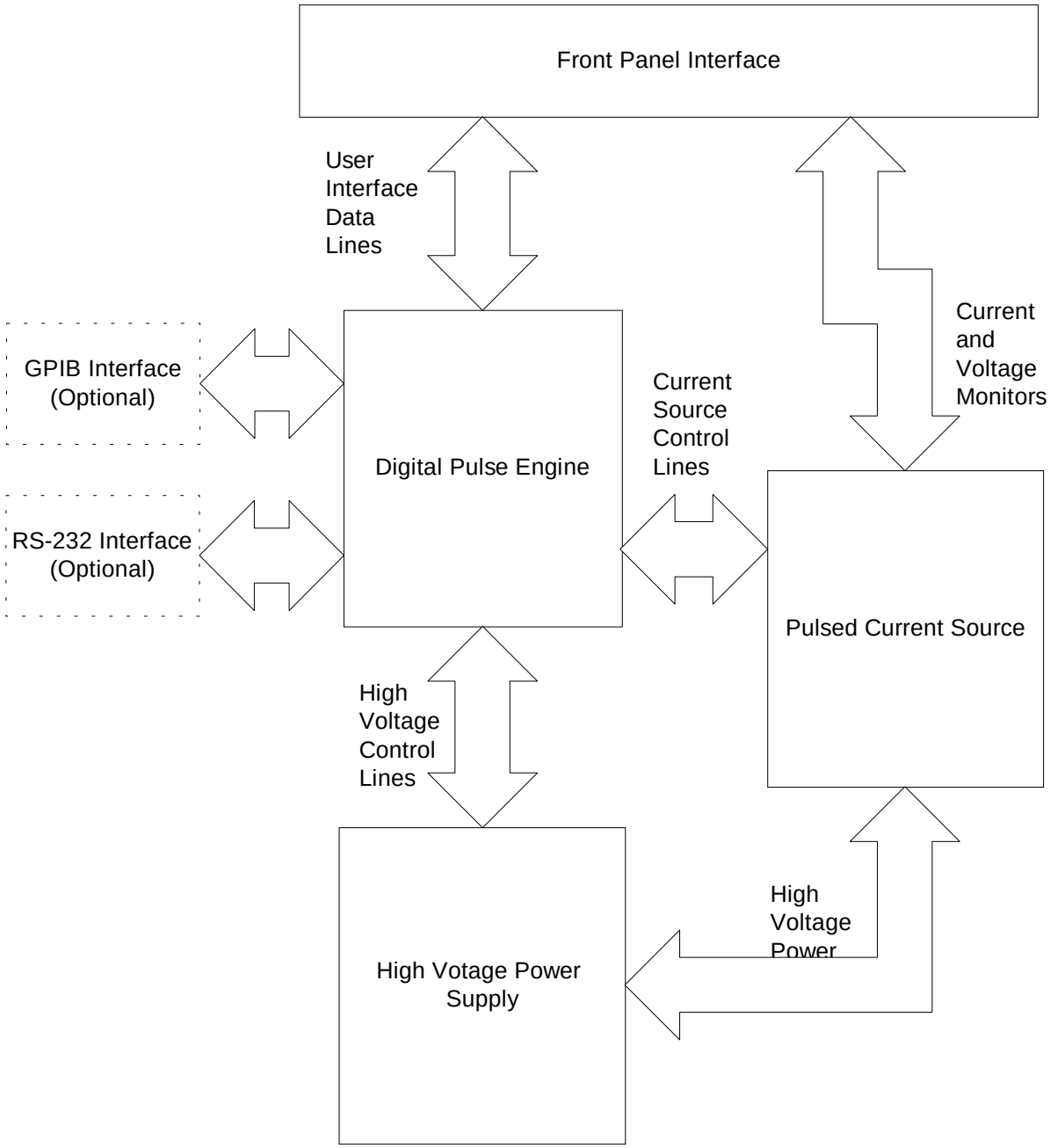


Figure 1: System Block Diagram

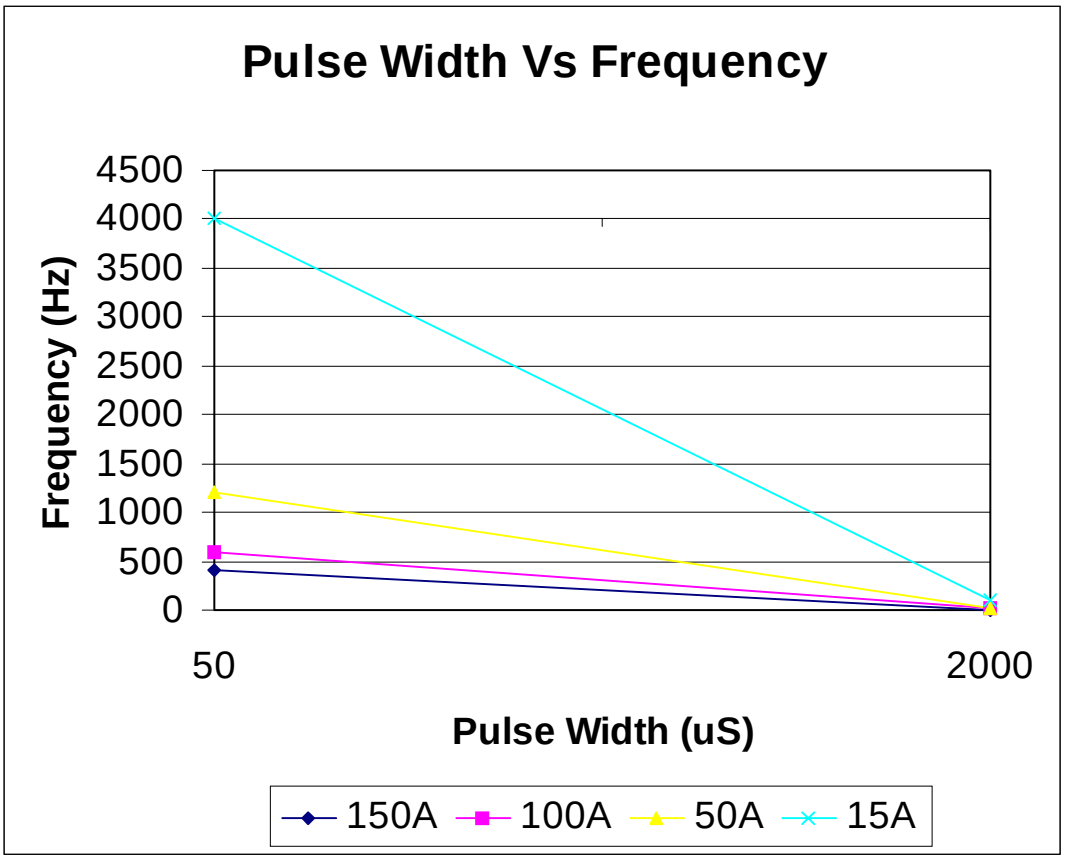
3.0 SPECIFICATIONS

PARAMETER	MODEL PCX150-25 Drives 1 to 12 Diodes in Series	MODEL PCX150-50 Drives 1 to 25 Diodes in Series	MODEL PCX150-100 Drives 1 to 50 Diodes in Series
PULSE OUTPUT CURRENT			
Amplitude Range	1A to 125A	1A to 150A	1A to 150A
Output Current Resolution	0.1A		
Accuracy At ≥25A Setpoint	1%		
Slow-start Ramp Resolution	0.1A		
Pulse Rise Time	<10µs (10%-90%) (1)		
Pulse Fall Time	<10µs (10%-90%) (1)		
Pulse Width	50µs to 5ms		
Pulse Recurrence Frequency Range	Single Shot to 5KHz		
Maximum Duty Cycle and Average Current	4% at 125A, 6% at 100A, 40% at 15A. The maximum average output power is 150W, and the average current cannot exceed 6A.	2% at 150A, 3% at 100A, 20% at 15A. The maximum average output power is 150W, and the average current cannot exceed 3A.	2% at 150A, 3% at 100A, 20% at 15A. The maximum average output power is 300W, and the average current cannot exceed 3A.
Output Pulse Width Stability	≤±0.5% at 1ms pulse width, 125A at maximum output voltage		
Output Pulse Amplitude Stability	≤±0.5% at 1ms pulse width, 125A at maximum output voltage		
Output Pulse Flatness	≤±0.1% at 1ms pulse width, 125A at maximum output voltage		
Over/undershoot	<5%		
Jitter	<10ns shot-to-shot		
Output Connector	Ribbon Cable, Front Panel		
COMPLIANCE VOLTAGE			
Range	1V to 25V	1V to 50V	1V to 100V
Resolution	1V		
CURRENT LIMIT			
Range	1A to 150A		
Resolution	1A		
TRIGGER IN			
Trigger Input	TTL or +5V ±1V, into 50Ω		
Minimum Trigger Pulse Width	100ns		
Input Trigger Connector	BNC, Front Panel		
SYNC MONITOR OUTPUT			
Sync Monitor	TTL output into high impedance		
Sync Monitor Connector	BNC, Front Panel		
CURRENT MONITOR OUTPUT			
CVR Monitor	50A/1V into 50Ω, typically within 1% of the displayed actual current		
CVR Monitor Connector	BNC, Front Panel		
VOLTAGE MONITOR OUTPUT			
Voltage Monitor	50V/1V into 50Ω, typically within 1% of the actual voltage		
Voltage Monitor Connector	BNC, Front Panel		
GENERAL			
Input AC Power	90-240VAC Nominal, 50/60Hz		
Dimensions (H X W X D)	3 1/4" x 17" x 21"		
Weight	Approx. 22 lbs		
Safety	Complies with CDRH US21 CFR 1040.10		

Table 1: PCX-150 System Specifications.

3.1 Safe Operating Area

The PCX-150 is limited to an average output current of 3A-DC. The PCX-150 checks the system configuration to determine if the frequency, pulse width and forward current demand more than 3A average current from the power supply. The PCX-150 user interface will not allow configurations that require an average current greater than the 3A limit. In the event the average output current is greater than 3A, the PCX-150 will generate a High Voltage Power Supply Current Limit Fault and disable operation. The SOA graphs below show the maximum pulse width and pulse frequencies at various output current levels, at any output voltage level.



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-150.

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-150 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-150 accepts input voltages from 100VAC 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-150 is grounded through the grounding conductor of the AC power cord. **To avoid electrical shock, plug the PCX-150 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-150 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-150.

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-150 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-150 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-150. Touching connections and/or components could result in serious injury or death.

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
FAX: (970) 493-1903
EMAIL: deiinfo@directedenergy.com

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 90 - 240 VAC input.

6.0 LASER DIODE INTERCONNECTION

The diode end of the output cable is marked with a D1 terminal and a D2 terminal. The D2 terminal is the power output terminal. The D1 terminal is the power return or ground. The D2 terminal will be a positive potential with respect to ground, it is the anode connection.

The output cable is interlocked at the diode mounting board. If the cable is disconnected from the PCX-150, or if the cable is inadvertently cut, the interlock will be broken, and the PCX-150 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-150 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-150 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-150. 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 1A to 150A. Onboard control circuitry minimizes over and undershoot to create clean rising and falling edges.

7.5 Interlock Safety System

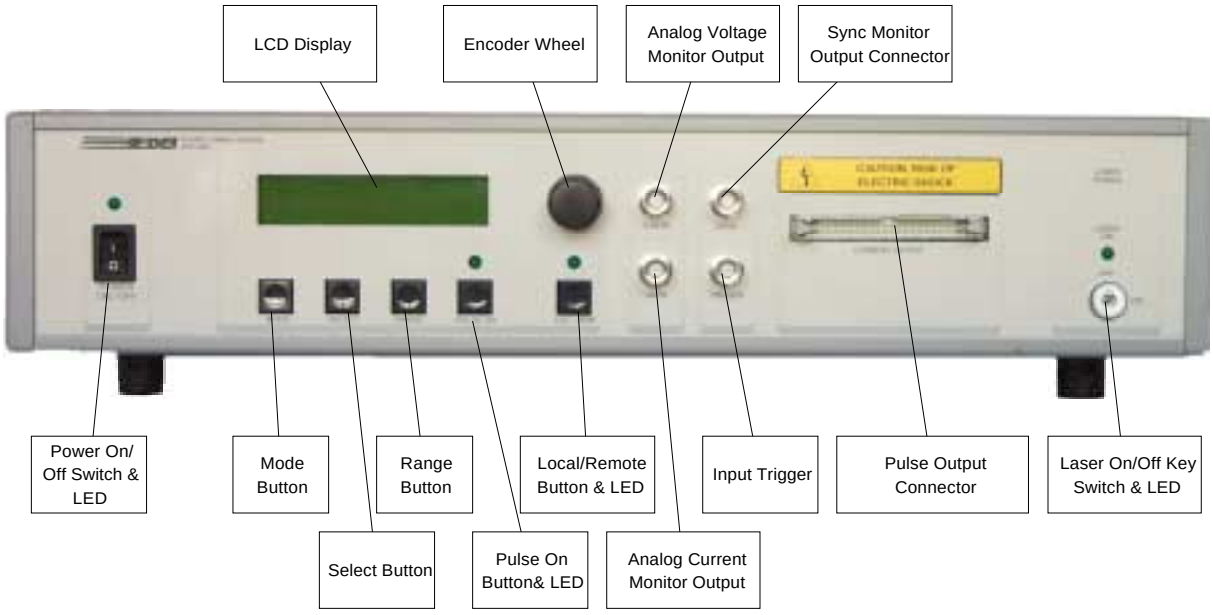
The interlock system is intended for operator safety. Any attempt to bypass this system invalidates any and all warranties associated with the PCX-150. The chassis interlock switch is located at the back of the unit near the top cover. This switch ensures that only when the top cover is on will the high 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, with 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-150 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

This is the PCX-150's local control panel. The display, encoder wheel, and buttons allow stand-alone operation of the PCX-150. 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" controls all AC power in the chassis. The LED above the switch illuminates when the AC power is turned on and DC voltages are available.

7.6.2 Synchronous Pulse Monitor

This is a 5V TTL signal into 1 meg-Ohm or 2.5V 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.

7.6.3 External Trigger

This is an input signal into 50 Ohms used for external Pulse Repetition Frequency (PRF) triggering. It is designed to allow the user to trigger multiple PCX-150 units from a single pulse generator. This allows the user to create synchronous waveforms from multiple units.

7.6.4 Voltage Monitor (Vmon)

This is a real time monitor of the high current pulse created on the pulsed current source with a scaling of 50V equals 1V when monitored with an oscilloscope with an input impedance of 50 Ohm.

7.6.5 Current Monitor (Imon)

This is a real time monitor of the high voltage pulse current created on the pulsed current source card with a scaling of 50A equals 1V when monitored with an oscilloscope with an input impedance of 50 Ohm.

7.6.6 Local/Remote Button

This button is for switching the PCX-150 into remote or GUI controlled operation or into local front panel control. This button has a corresponding LED. This front panel indicator displays the unit's control mode. In local front panel control mode the LED is OFF. If operating form either a serial or GPIB remote host the LED is ON. (This button is only on units that support GPIB or RS-232 operation)

7.7 Rear Panel Connectors

7.7.1 J1 - Comm

The male DB-9 connector labeled "J1 COMM" is the RS-232 interface for those units with the optional RS-232 interface. Its pin out is standard three wire RS-232.

Pin2	RxD	Receive
Pin3	TxD	Transmit
Pin5	GND	Ground

7.7.2 J2 - CTRL

The DB-15 connector labeled "J2 CTRL" 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. The unit will issue an interlock fault, and will cease operation.

The PCX-150 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 on the connectors. Viewing the DB-15 with the row of 8 sockets to the top, sockets 1 and 2 are the right-most pins in the row of 8.

7.7.3 J3 - GPIB

The GPIB connector labeled "J3 GPIB" 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-150 accepts input voltages of 100-240VAC, 50/60Hz. The fuses in the module are 7A fast blow.

7.8 Diode Loads

The PCX-150 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-150 capabilities.

See Section 6.0 for additional information on connecting the diode to the PCX-150.

8.0 HARDWARE OPERATING INSTRUCTIONS

This section provides basic operating instructions for the PCX-150 hardware.

WARNINGS

1. To avoid personal injury, do not remove the covers. Do not operate the PCX-150 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-150.

2. Do not handle or remove the output cable or laser diode while the PCX-150 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-150 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-150 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-150. 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-150 and the other to your site's power outlet. The PCX-150 is capable of accepting input voltages from 100VAC 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 Pulse On 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-150 has protection fusing for the system input. These fuses are used to prevent hardware damage due to a system level failure. The fuses are 7A 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 Home Menu

Local mode operation is implemented with a command function tree. The trunk of the tree would be represented by the home state. This is the *Configuration Mode*. From the *Configuration Mode* the other branches of the function tree can be accessed. Other main branches include the *Configure Pulses Menu*, *Configure Output Menu, Save Configuration Menu*, *Load Configuration Menu,* and the *Fault Status Menu*. Metaphorically speaking each of these menus has either branches or leaves below them. From the *Configure Pulse Menu* the leaf functions of *Set Trigger Source, Set Frequency, Set Pulse Width,* and *Set Duty Cycle* are accessible. An example of a branch function would be from the *Fault Status Menu* the branch function of *Show Faults* exists. If selected the user can view any active faults. The display of the active faults is also a leaf function.

Included in Appendix A located at the end of this manual is the local mode menu tree diagram. It is recommended that the user keep this menu tree handy when first learning the structure of the Local mode operation. Once the user is familiar they will find local mode operation a handy alternative for configuring and operating the PCX-150.

9.2 The Range Button

The RANGE button is used when varying parameters that can change by a power of 10. By pressing the range button the user can increment the exponent within its acceptable range. This allows the user to quickly set the parameters, without having to scroll the encoder wheel excessively. The RANGE button functions with the following commands:

- Set Current

- Set Pulse Width
- Set Frequency
- Set Current Trip Point
- Set Forward Voltage
- Set Ramp Current

The RANGE button is effectively a 10X multiplier. For example, when setting output current, the resolution of the encoder wheel is 0.1A. Therefore without adjusting the range, the encoder wheel must be turned many times to increase the current from 0A to 100A. However if the current is set to 1.0A, if the RANGE button is pressed once, it changes to 10A, and if it is pressed twice, it changes to 100A. Therefore from the power-up default of 1.0A, to set the output to 100A, press the RANGE button twice. Pressing it once will change it to 10A, and pressing it again will change it to 100A. To set the current to 55A, set the current to 5.5A by rotating the encoder wheel, then press the RANGE button once. The output will change from 5.5A to 55A.

Using the RANGE button to change frequency is similar to the example for setting the current above. To set the frequency to 2KHz, first set it to 2Hz using the encoder wheel, then press the range button three times. The first press will change it to 20Hz, the second press to 200Hz, and the third press to 2KHz.

9.3 Configuring the Pulses

This is the branch of the PCX-150 function tree that allows the user to configure the pulse generator parameters of trigger source, frequency, pulse width and duty cycle. From this menu state the user can select Yes or No to either access the pulse generator parameters or skip them, respectively.

9.3.1 Setting the Trigger Source

This is where the user can choose from Internal Pulse Repetition Frequency (Internal PRF), External PRF, or Single Shot mode. The internal pulse generator mode is recommended since it will let the PCX-150 calculate the average power supply current used in the system. This will prevent the user from selecting a configuration that exceeds the current capability of the unit. The external PRF mode is recommended for applications that need multiple current sources synchronized to one control gate signal. Through external PRF an array of PCX-150 current sources can be remotely controlled by a host PC and gated from one pulse generator. The Single Shot mode is for applications that need single pulse or frequencies less than one hertz. It can be used to test the pulser once it is installed at the users site.

In Internal PRF, the pulse frequency and width are set through the *Pulse Configuration* controls.

In External PRF, the pulse width is set through the *Pulse Configuration* controls. When a TTL trigger is received on the front panel *Trigger* input, an output pulse is generated, with a width equal to the width set in the *Pulse Configuration -Set pulse Width* menu.

In Single-Shot mode, the pulse width is set through the *Pulse Configuration* controls. When the *Pulse On* front panel button is pressed, an output pulse is generated, with a width equal to the width set in the *Pulse Configuration -Set pulse Width* menu.

The DPE stores discrete pulse widths for each trigger source. Therefore different pulse widths can be set for internal PRF, External PRF and Single Shot. When the trigger source is changed, the pulse width previously entered for that source will be recalled.

9.3.2 Setting Frequency

Available only when the trigger source is in the Internal PRF mode. Frequency can be varied by the encoder wheel and/or the range button for user convenience. The RANGE button selects the frequency exponent, and the encode wheel sets the number. The unit supports 1% resolution of frequencies and allows for user control to this level of accuracy.

9.3.3 Setting Pulse Width

The pulse width variable is actually three independent variables depending on trigger source. This lets the unit keep track of different pulse widths for internal, external or single shot triggering. The RANGE button selects the pulse width exponent, and the encoder wheel sets the number. Using the RANGE button and ENCODER wheel, select the pulse width. Press SELECT to implement the selection. The PCX-150 supports 1% accuracy, and the width is displayed in engineering units.

9.3.4 Setting Duty Cycle

Only available in the Internal PRF trigger source, this variable is for users who do not want to calculate the pulse width by hand. Based upon the user's desired frequency, the PCX-150 will change the pulse width to match the desired “Pulse On Time” duty cycle. If a valid pulse width has been entered, the Duty Cycle selection can be ignored. Conversely, the *Pulse Width* selection can be skipped, and a duty cycle selected. In this case, the pulse width will be calculated by the PCX-150 based upon the frequency and duty cycle that are entered. The duty cycle is set using the ENCODER wheel. Press SELECT to skip they Duty Cycle selection, or after setting the duty cycle, press SELECT to implement the selection.

9.4 Configuring the Output

This is the branch of the PCX-150 function tree that allows the user to configure the current pulse parameters of forward voltage, forward current, over current threshold

and current ramp increment. From this menu state the user can select Yes or No to either access the current pulse parameters or skip them, respectively.

9.4.1 Setting Forward Voltage

This command determines the voltage amplitude created by the PCX-150. The configurable nature of this option allows for the PCX-150 to be used with many different diodes. By setting this forward voltage to the diode forward voltage optimum efficiency can be achieved. Using the ENCODER wheel and RANGE button, set the V_F to a voltage appropriate for the diode. Press SELECT to implement the selection.

9.4.2 Setting Forward Current

This is where the current pulse amplitude is set. With 100mA resolution from 1A to 150A, the user can set the output amplitude best suited for their application. Using the ENCODER wheel and RANGE button, set the I_F to a current appropriate for the diode. Press SELECT to implement the selection.

9.4.3 Setting Over Current Threshold

Ranging from 1A to 165A, the I_{OC} setting limits the output current that can be set or output to the value entered here (I.E. if the diode current cannot exceed 50A, setting I_{OC} to 50A will prohibit the user from inadvertently setting the output current to 150A. This provides a level of security that the diode load will not be driven with currents greater than the threshold set. Using the ENCODER wheel and RANGE button, set the I_{OC} to an over-current appropriate for the diode. Press SELECT to implement the selection.

9.4.4 Setting Current Ramp Increment

Ranging from 1A to 150A the user can set an increment value that the PCX-150 will use to soft start the pulse train. This allows a gradual turn on of the pulse current. In the event the user selects a ramp increment that is an uneven multiple of the forward current, the last step will be reduced. For example, if the forward current is 100A, and the ramp current is set to 7A, the PCX-150 will create a pulse train that starts with the pulse profile 7A, 14A, 21A, ... 91A, 98A, and then 100A pulses. Due to the overhead associated with pulse ramping this function is only available for frequencies less than 2kHz. Using the ENCODER wheel and RANGE button, set the I_{Ramp} to an increment current appropriate for the diode. Press SELECT to implement the selection.

Note: Since the diode forward current is varying, the diode forward voltage profile is ignored during the ramp function. Therefore all Von and Voff faults are ignored during the ramp. They are enable once the ramp is finished.

9.5 Checking System Fault Status

In normal operation this mode will display the “No Faults” message. However, in the event that a fault is active it will display the “Show Faults?” message. By using the encoder wheel the user can select Yes or No to access the fault buffer. Individually displayed and viewed with the select button are:

- Interlock Fault
- Key Switch Fault
- Over Temperature Fault
- High Voltage Power Supply Current Limit Fault
- Support Power Dropout Fault
- Diode Over Current (Ioc) Fault
- Voltage Sag During On Pulse (Von) Fault
- Voltage Detected During Off Pulse (Voff) Fault

9.6 Saving A System Setup in Local Mode

For user convenience the PCX-150 has the ability to save up to five different configurations. Named PCX1, PCX2, up to PCX5 the user can keep most used configurations in a fast access state. By selecting one of the five configurations and saving from this menu option the user can later recall their favorite system setups. Located in static RAM, the setups will be intact even when system power is off.

Parameters saved are: Trigger source, frequency, pulse width, duty cycle, V-forward, I-forward, I-overcurrent., and I-ramp

9.7 Loading A System Setup

To access an existing setup the user can select one of the five default names, PCX1, PCX2 …PCX5 and then let the PCX-150 load the different parameters associated with the configuration. In remote mode operation the user can use any four alpha-numeric name

Parameters that are recalled: Trigger source, frequency, pulse width, duty cycle, V-forward, I-forward, I-overcurrent, and I-ramp.

9.8 Local Mode Operation Front Panel Controls

The PCX-150 front panel consists of five function buttons, a selector wheel, and a display. Below is a brief description of the function supported by each front panel component.

Display: This is the user's status window into how the PCX-150 is configured and operating. In addition to configuration information the display also indicates the fault status. For more information on the Fault Display String see section 9.4.

Mode Button: This button changes the system from *Configuration Mode* to *HVPS Armed Mode*. Pressing the mode button again will return the PCX-150 from *HVPS Armed Mode* the *Configuration Mode* menu.

Select Button: This button is for traversing the function tree. By pressing the select button the user moves from trunk to branches, from branches to leafs, and from leafs to branches. Additionally the select button calls the leaf functions that implement the commands in the PCX-150 hardware. This means that after using the selector wheel and/or the range button to vary the configuration the hardware will not implement the new value until the select button has been pressed.

Range Button: This button is used when varying parameters that have exponents. By pressing the range button the user can increment the exponent within its acceptable range.

Pulse Enable: This button is used in the *PCX Armed Mode*. It is for enabling the high current pulse. It has a corresponding LED which illuminates if the pulses are enabled.

Selector Wheel: This is for varying the parameters such as Frequency, Forward Voltage, or Trigger Source, etc. Additionally it is also used to answer all yes and no confirmation questions.

9.9 Optional Front Panel Controls

Local/Remote Button: This button is for switching the PCX-150 into remote or GUI controlled operation or into local front panel control. This button has a corresponding LED. This front panel indicator displays the unit's control mode. In local front panel control mode the LED is OFF. If operating form either a serial or GPIB remote host the LED is ON. (This button is only on units that support GPIB or RS-232 operation)

10.0 REMOTE MODE OPERATION

10.1 Remote Mode Instructions

The remote mode instructions are the same for serial or GPIB operation. However the packaging of the data is different. The instructions are given in a table format for both protocols. See section 10.2.2 for the serial mode instruction set and data packaging. See section 10.3.2 for the GPIB mode instruction set and data packaging information.

10.2 RS-232 Serial Operation

This remote control port allows a user to connect a personal computer as the remote host to the DEI PCX-150 pulsed current source. Utilizing a standard three wire interface and DEI's defined communication protocol the user can write a custom control program for their particular testing needs.

10.2.1 Serial Data Packets

The data packets sent to the DEI PCX-150 over the serial bus should be of the following format:

To Address	From Address	Packet Length	Op Code	Data 1	Data 2	…	Data 'n'	Stop Byte

Where the data is as follows:

Data Byte	Function	Value
To Address	PCX-150 Address	0x01h
From Address	Remote Host Address	Variable [0 to255] Recommend 0x00h
Packet Length	Total number of bytes sent for this command	See Instruction Set
Operation Code	This commands hardware code	See Instruction Set
Data1..N	Any data to send to PCX-150	See Instruction Set
Stop Byte	Serial termination byte	0x0Ah

The data packets returned by the DEI PCX-150 will be of the following format:

To Address	From Address	Packet Length	Op Code	**Error Code**	Data 1	…	Data 'n'	Stop Byte

Where the data is as follows

Data Byte	Function	Value
To Address	Remote Host Address	Variable [0 to255]

		Recommend 0x00h
From Address	PCX-150 Address	0x01
Packet Length	Total number of bytes sent by PCX-150 for this command	See Instruction Set
Operation Code	This commands hardware code	See Instruction Set
Error Code	Any Non-zero value represents a specific error or warning	See Error Code table
Data1..N	Any data from the PCX-150	See Instruction Set
Stop Byte	Serial termination byte	0x0Ah

10.2.2 Instruction Set & Serial Data Packet Format

Instruction	**Opcode (hex)**	**Send Length**	**Receive Length**	**Data Bytes**	**Data Format**
Set Frequency	0x20	8 bytes	6 bytes	Send 3	Unsigned char
Set Pulse Width	0x22	8 bytes	6 bytes	Send 3	Unsigned char
Set Duty Cycle	0X24	6 bytes	10 bytes	Send 1 Rec-4	Unsigned char
Set Trigger Source	0x25	6 bytes	6 bytes	Send 1	Unsigned char
Set I-forward	0x2E	7 bytes	6 bytes	Send 2	Unsigned short
Set I-trip	0x2C	7 bytes	6 bytes	Send 2	Unsigned short
Set I-ramp	0x67	7 bytes	6 bytes	Send 2	Unsigned short
Set V-forward	0x81	7 bytes	6 bytes	Send 2	Unsigned short
Set HVPS Armed	0x84	6 bytes	6 bytes	Send 1	Unsigned char
Pulse Enable/Disable	0x2F	6 bytes	6 bytes	Send 1	Unsigned char
Read Fault Buffer	0x35	5 bytes	7 bytes	Rec-1	Unsigned char
Reset/Clear Faults	0x1F	5 bytes	6 bytes		
Read Frequency Status	0x30	5 bytes	9 bytes	Rec-4	Unsigned char
Read Pulse Width Status	0x32	5 bytes	9 bytes	Rec-4	Unsigned char
Read Duty Cycle Status	0x34	5 bytes	7 bytes	Rec-1	Unsigned char
Read Trigger Source Status	0x35	5 bytes	7 bytes	Rec-1	Unsigned char
Read I-forward Status	0x90	5 bytes	8 bytes	Rec-2	Unsigned short
Read I-trip Status	0x82	5 bytes	8 bytes	Rec-2	Unsigned short
Read I-ramp	0x68	5 bytes	8 bytes	Rec-2	Unsigned short
Read V-forward Status	0x91	5 bytes	8 bytes	Rec-2	Unsigned short
Read HVPS Armed Status	0x94	5 bytes	7 bytes	Rec-1	Unsigned char
Read Pulse Enable Status	0x40	5 bytes	7 bytes	Rec-1	Unsigned char
Save Configuration1	0x70	9 bytes	6 bytes	Send-4	4 char's
Save Configuration2	0x71	9 bytes	6 bytes	Send-4	4 char's
Save Configuration3	0x72	9 bytes	6 bytes	Send-4	4 char's
Save Configuration4	0x73	9 bytes	6 bytes	Send-4	4 char's
Save Configuration5	0x74	9 bytes	6 bytes	Send-4	4 char's
Load Configuration	0x76	6 bytes	6 bytes	Send-1	Unsigned char

Get Config 'X' Name	0x75	6 bytes	11 bytes	Send-1 Rec-5	Unsigned char 5-Char's
Read Active Config	0x77	5 bytes	6 bytes	Send-1	Unsigned char
Set Mode	0x63	6 bytes	6 bytes	Send-1	Unsigned char
Test Communication	0x65	5 bytes	6 bytes		

10.2.3 Serial Programming Data

For this discussion the data is defined as follows.

Unsigned Char, Char	8 bit byte
Unsigned Short, Short	16 bits (2 – 8 bit bytes)

Set Frequency: This command expects three data bytes. The first two bytes are an unsigned short which represent the mantissa of the frequency. This value is from 100 to 1000. The third byte is the exponent. It is a char. When the exponent is zero or positive it is in regular binary notation. When the exponent is below zero it should be passed in two's complement notation.

For example if you wished to send the value of 33Hz to the PCX-150 you will need to do the following. The value of the mantissa is 330, and the exponent is –1. Now the master computer must convert them to hexadecimal for passing to the PCX-150. The mantissa is #330d which is #014Ah. The exponent is #-1d and in two's complement this becomes #0FFh. So the three data bytes in this example are: [01, 4A, FF] all in hexadecimal representation

Set Pulse Width: This command expects three data bytes. The first two are a unsigned short which represent the mantissa of the pulse width. This value is from 100 to 1000. The third byte is the exponent. It is a char. When the exponent is zero or positive it is in regular binary notation. When the exponent is below zero it should be passed in two's complement notation.

For example if you wished to send the value of 563usec (563E-6 sec) to the PCX-150 you will need to do the following. The value of the mantissa is 563, and the exponent is –6. Now the master computer must converting them to hexadecimal for passing to the PCX-150. The mantissa is #563d which is #0233h. The exponent is #-6d and in two's complement this becomes #0FAh. So the three data bytes in this example are: [02, 33, FA] all in hexadecimal representation

Set Duty Cycle: This command expects one data byte. It is an unsigned char. Acceptable values for this parameter is from 1 to 100, representing the duty cycle values from 1% to 100%. Please note that the PCX-150 does not compute non whole number values of duty cycle. This means if the duty cycle is 20.3% the PCX-150 will fill the duty cycle status variable with 0. A zero will be used to represent all non whole number values of duty cycle. If a parameter is passed outside of the acceptable duty cycle range the PCX-150 will generate an error code.

Set Trigger Source: This command expects one data byte. It is an unsigned char. Acceptable values are 1, 2 and 3, see the Table # below to determine function. Values outside of this range will generate an error code.

1	Front Panel Single Shot
2	Internal Pulse Repetition Frequency (PRF) Generator
3	External Trigger PRF

Set V-Forward: This command expects two data bytes. It is an unsigned short. For the PCX-150-100V models the acceptable values for this parameter is from 0 to 100. While for the PCX-150-50V models the acceptable values for this parameter is from 0 to 50. Values outside of the unit's specific V-forward range will generate an error code.

Set I-Forward: This command expects two data bytes. It is an unsigned short. To achieve 0.1A resolution without passing floating point numbers the PCX-150 expects the parameter to reflect the desired forward current multiplied by 10 to remove the need for a floating point number. Acceptable values for this parameter is from 0 to 1500. Values outside of this range will generate an error code.

For example if you wished to set a forward current of 123.5A the data would need to be processed accordingly. First multiply 123.5 by 10 to get 1235. Now convert 1235d to hexadecimal. The value is #04D3h. So the two data bytes in this example are: [04, D3] all in hexadecimal representation.

Set I-Trip: This command expects two data bytes. It is an unsigned short. Acceptable values for this parameter is from 0 to 165. Values outside of this range will generate an error code.

Set I-Ramp: This command expects two data bytes. It is an unsigned short. To achieve 0.1A resolution without passing floating point numbers the PCX-150 expects the parameter to reflect the desired current increment multiplied by 10 to remove the need for a floating point number. Acceptable values for this parameter is from 0 to 1500. Values outside of this range will generate an error code.

For example if you wished to set a current ramp of 3.5A the data would need to be processed accordingly. First multiply 3.5 by 10 to get 35. Now convert 35d to hexadecimal. The value is #023h. So the two data bytes in this example are: [00, 23] all in hexadecimal representation.

If the frequency is greater than 2kHz the Set I-ramp command will return an error code.

Set HVPS Armed: This command expects one data byte. It is an unsigned char. Acceptable values for this parameter are from 0 to 255. Values outside of this range will generate an error code. Sending a value of 1 will enable the HVPS, while all

other values will disable the HVPS. Please note that the PCX-150 will ramp the HVPS to voltage before replying. This may take up to 4 seconds to occur. Adjust any timeouts to support this delay. This command should be executed before the Pulse Enable/Disable command is executed. Additionally, make sure the PCX-150 pulses are disabled before disabling the HVPS.

Pulse Enable/Disable: This command expects one data byte. It is an unsigned char. Acceptable values for this parameter is from 0 to 255. Values outside of this range will generate an error code. Sending a value of 1 will enable the pulses, while all other values will disable the pulses. Please note that the PCX-150 expects the HVPS to be armed before the pulses are enabled for proper system operation. Executing these in the incorrect order will cause system faults and a truncated pulse may occur on the output. Additionally, make sure the PCX-150 pulses are disabled before disabling the HVPS.

Reset/Clear Faults: This command issues a reset to all system peripherals in an attempt to clear any latched faults. If the fault is still active the fault will be latched. This can be determined by immediately following this command with the Read Fault Buffer command. The Reset/Clear Faults does not return any data byte for processing.

Read Faults Buffer: This command queries the present content of the fault buffer. It returns one data byte for processing. This byte is an unsigned char in which each bit represents a particular system fault. The fault buffer bit-wise map is as follows:

Bit	Fault
0x80h	HVPS Fault
0x40h	Support Power Fault
0x20h	Over Temperature Fault
0x10h	Interlock Fault
0x08h	Key Switch Fault
0x04h	Voltage During Off Time
0x02h	Voltage During On Time
0x01h	Over Current Fault

Read Frequency Status: This command queries the internal pulse generator's programmed frequency. It returns three data bytes for processing. These are the mantissa and exponent in the same formatting as the Set Frequency command. For a discussion of the data formatting please see the Set Frequency command.

Read Pulse Width Status: This command queries the internal pulse generator's programmed pulse width. It returns three data bytes for processing. These are the mantissa and exponent in the same formatting as the Set Pulse Width command. For a discussion of the data formatting please see the Set Pulse Width command.

Read Duty Cycle Status: This command queries the internal pulse generator's programmed duty cycle. It returns one data bytes for processing. This data byte is

an integer value from 0 to 100. Representing the duty cycle values from 1% to 100%. Please note that the PCX-150 does not compute non whole number values of duty cycle. This means if the duty cycle is 20.3% the PCX-150 will fill the duty cycle status variable with 0. A zero will be used to represents all non whole number values of duty cycle.

Read Trigger Source Status: This command queries the internal pulse generator's trigger source. It returns one data byte for processing. For a discussion of the data formatting please see the Set Trigger Source command.

Read V-Forward Status: This command queries the forward voltage set point. It returns two data bytes for processing. For a discussion of the data formatting please see the Set V-Forward command.

Read I-Forward Status: This command queries the forward current set point. It returns two data bytes for processing. For a discussion of the data formatting please see the Set I-Forward command.

Read I-Trip Status: This command queries the over current trip set point. It returns two data bytes for processing. For a discussion of the data formatting please see the Set I-Trip command.

Read I-Ramp Status: This command queries the forward current set point. It returns two data bytes for processing. For a discussion of the data formatting please see the Set I-Ramp command.

Read HVPS Armed Status: This command queries the HVPS armed status. It returns one data byte for processing. For a discussion of the data formatting please see the Set HVPS Armed command.

Read Pulse Enable Status: This command queries the pulse enable/disable status. It returns one data byte for processing. For a discussion of the data formatting please see the Set Pulse Enable command.

Save Configuration1 to Save Configuration5: These five command save the current configuration in one of the five pre-defined memory spaces. Each instruction passes a four byte name. If operating in local mode the unit automatically names the configurations 'PCX1' through 'PCX5'. In remote mode the four byte name is left up to the user to define. It can be any alphanumeric string that can be represented in ASCII notation.

For example if you wanted to save the current configuration with the name 'TEST'. The data would be as follows. The location will be passed as part of the operation code and the name in ASCII format. Therefore the data is [54,45,53,54] all in hexadecimal. (Note: 'T' = 0x54h in ASCII, 'E' = 0x45h in ASCII, and 'S' = 0x53h in ASCII)

Load Configuration 'x': This command loads the current configuration from one of the five pre-defined memory spaces. It updates the PCX-150 hardware only. If the

user wants the remote host to know the new values they will be responsible for queering the unit with the Read commands. The PCX-150 expects the configuration number in each data packet.

Get Configuration 'x' Name: This command retrieves the current configurations name from one of the five pre-defined memory spaces. The PCX-150 expects the configuration number in the command packet and places the configuration number and a four byte name in the reply packet.

For example if you wanted to retrieve the name of the configuration in location four. Let's again assume the name of the packet is 'TEST' The data would be as follows. The location will be passed as a hexadecimal number to the unit. While the configuration number and name will be in the reply packet. In the command packet the data is one byte that is [4]. While in the reply packet the packet will be five bytes long with the name in ASCII format. Therefore the data is [4, 54,45,53,54] all in hexadecimal. (Note: 'T' = 0x54h in ASCII, 'E' = 0x45h in ASCII, and 'S' = 0x53h in ASCII)

Read Active Configuration: This command reads the last loaded configuration identification number. If configuration one to five are loaded that number will be reflected in the ID number. If the configuration is not one of the five loaded the PCX-150 will return zero.

Set Mode: This command sets the local or remote mode status. The PCX-150 expects one data byte. It is an unsigned char. Acceptable values for this parameter is from 0 to 255. Values outside of this range will generate an error code. Sending a value of 1 will set the unit in remote mode and illuminate the front panel LOC/REM LED, while all other values will place the unit in local mode operation and turn off the LOC/REM LED. Please note that the PCX-150 will disarm HVPS and disable the pulses whenever it changes modes.

Test Communication: This command is for debugging and communication recovery. There is no data transferred just a reply when the unit is present and the data packet received is valid.

10.2.4 Serial Programming Features and Limitations

- When controlling the PCX-150 from a serial linked remote host it becomes the remote host's responsibility to poll the fault buffer status. In the event of a fault the PCX-150 will hardware protect the diode load and the PCX-150 hardware.

- When the PCX-150 is in remote mode it disables the encoder wheel and all of the user front panel buttons except for Local/Remote. This button allows the user to change the mode from the unit's front panel interface.

- The PCX-150 will accept remote commands in Local mode. Please note that if the remote host elects to operate in this mode it becomes the remote host's responsibility to poll for any parameter status change. The PCX-150 does not notify the remote host when parameters change.

- The diode forward voltage set point is programmed by the Set V-Forward command. When the Set HVPS Armed command is issued this value sets the HVPS output voltage. If the V-forward value is changed while the HVPS is enable the unit will not reflect this change. This feature is designed to protect laser diodes. If the forward voltage needs to be changed it is the remote hosts responsibility to DISARM the PCX-150, change V-Forward, and then ARM the PCX-150 to get the new forward voltage. This is the DEI recommended process to insure diode protection.

10.3 GPIB Operation

The PCX-150 is capable of receiving instructions over its GPIB interface. This is an application specific interface and presently is not compliant with IEEE-488.1 or IEEE-488.2 standards. Developed for specific applications, this interface provides the user with asynchronous event reporting (see section 10.3.4 for details) removing the need for fault polling associated with the PCX-150's serial interface. Since GPIB is a well defined interface the packet formatting associated with the serial interface is not needed. Therefore the GPIB data packets to control the PCX-150 is limited to the operation code, data, and error code. This simplifies the data packets and when combined with the parallel nature of the GPIB bus it results in a faster interface than serial.

10.3.1 GPIB Addressing

The GPIB interface is hardwired to address 7. This address is set in the firmware cannot be changed by the user.

10.3.2 GPIB Data Packets

The data packets sent to the DEI PCX-150 over the GPIB bus should be of the following format:

GPIB Header 0x01	Op Code	Data 1	Data 2	…	Data 'n'

Where the data is as follows:

Data Byte	Function	Value
GPIB Header	This tells the firmware the origin of the command	0x01h
Operation Code	This commands hardware code	See Instruction Set
Data1..N	Any data to send to PCX-150	See Instruction Set

The data packets returned by the DEI PCX-150 will be of the following format:

Op Code	**Error Code**	Data 1	Data 2	…	Data ‘n’

Where the data is as follows

Data Byte	Function	Value
Operation Code	This commands hardware code	See Instruction Set
Error Code	Any Non-zero value represents a specific error or warning	See Error Code table
Data1..N	Any data from the PCX-150	See Instruction Set

10.3.3 Instruction Set and GPIB Data Packet Formatting

Instruction	Opcode (hex)	Send Length	Receive Length	Data Bytes	Data Format
Set Frequency	0x20	5 bytes	2 bytes	Send 3	Unsigned char
Set Pulse Width	0x22	5 bytes	2 bytes	Send 3	Unsigned char
Set Duty Cycle	0X24	3 bytes	6 bytes	Send 1 Rec-4	Unsigned char
Set Trigger Source	0x25	3 bytes	2 bytes	Send 1	Unsigned char
Set I-forward	0x2E	4 bytes	2 bytes	Send 2	Unsigned short
Set I-trip	0x2C	4 bytes	2 bytes	Send 2	Unsigned short
Set I-ramp	0x67	4 bytes	2 bytes	Send 2	Unsigned short
Set V-forward	0x81	4 bytes	2 bytes	Send 2	Unsigned short
Set HVPS Armed	0x84	3 bytes	2 bytes	Send 1	Unsigned char
Pulse Enable/Disable	0x2F	3 bytes	2 bytes	Send 1	Unsigned char
Read Fault Buffer	0x35	2 bytes	3 bytes	Rec-1	Unsigned char
Reset/Clear Faults	0x1F	2 bytes	3 bytes	Rec-1	Unsigned char
Read Frequency Status	0x30	2 bytes	5 bytes	Rec-3	Unsigned char
Read Pulse Width Status	0x32	2 bytes	5 bytes	Rec-3	Unsigned char
Read Duty Cycle Status	0x34	2 bytes	3 bytes	Rec-1	Unsigned char
Read Trigger Source Status	0x35	2 bytes	3 bytes	Rec-1	Unsigned char
Read I-forward Status	0x90	2 bytes	4 bytes	Rec-2	Unsigned short
Read I-trip Status	0x82	2 bytes	4 bytes	Rec-2	Unsigned short
Read I-ramp	0x68	2 bytes	4 bytes	Rec-2	Unsigned short
Read V-forward Status	0x91	2 bytes	4 bytes	Rec-2	Unsigned short
Read HVPS Armed Status	0x94	2 bytes	3 bytes	Rec-1	Unsigned char
Read Pulse Enable Status	0x40	2 bytes	3 bytes	Rec-1	Unsigned char
Save Configuration1	0x70	6 bytes	2 bytes	Send-4	4 char's
Save Configuration2	0x71	6 bytes	2 bytes	Send-4	4 char's
Save Configuration3	0x72	6 bytes	2 bytes	Send-4	4 char's
Save Configuration4	0x73	6 bytes	2 bytes	Send-4	4 char's
Save Configuration5	0x74	6 bytes	2 bytes	Send-4	4 char's
Load Configuration	0x76	3 bytes	2 bytes	Send-1	Unsigned char
Get Config 'X' Name	0x75	3 bytes	7 bytes	Send-1 Rec-5	Unsigned char 5-Char's
Read Active Config	0x77	2 bytes	3 bytes	Send-1	Unsigned char
Set Mode	0x63	3 bytes	3 bytes	Send-1	Unsigned char
Test Communication	0x65	2 bytes	2 bytes		

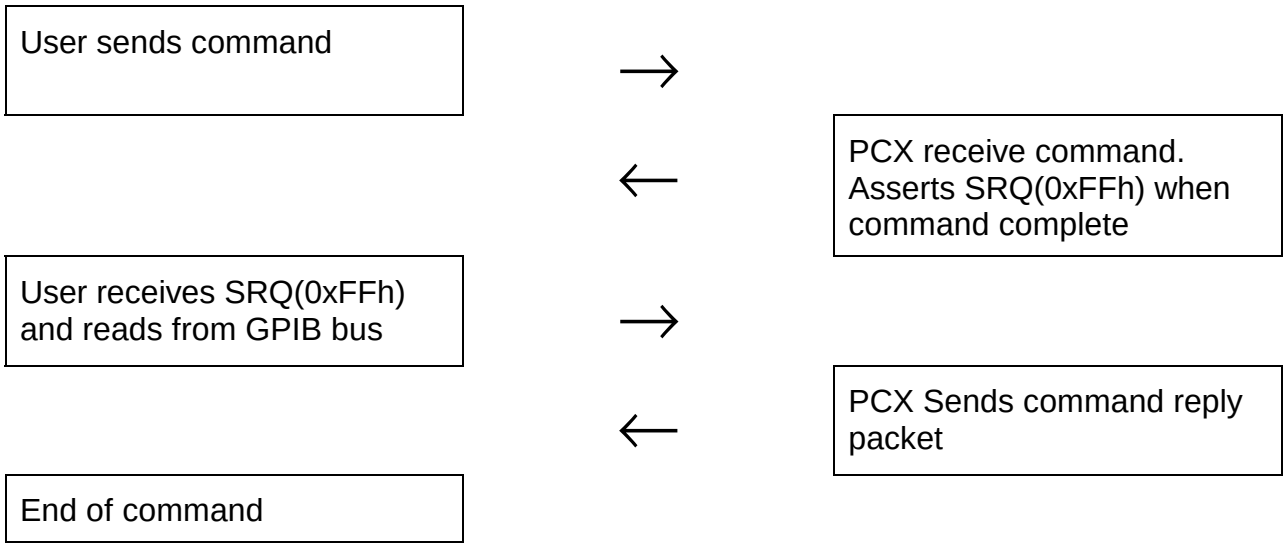
10.3.4 GPIB Asynchronous Event Reporting

Description	SRQ Event Code
The PCX-150 is telling the user software that it is changing to local mode operation, due to the front panel local/remote button operation	0x44h
The PCX-150 is telling the user software that a fault has occurred and the unit has been disabled.	0x55h
The PCX-150 is requesting the user software to update itself, usually after power up or when changing to remote mode operation.	0x77h
The PCX-150 is tell the user software that there is data ready to be read back.	0xFFh

10.3.5 GPIB Programming Features and Limitations

- Not IEEE-488.1 or IEEE-488.2 compliant.
- Application specific interface.
- Hardwired to GPIB Address 7.

10.3.6 Example GPIB Protocol



10.4 Error Codes

Error Code	Description	Problem	Action
#101	Invalid Operation Code	Command Packet Incorrect or Corrupted	Verify packet data integrity with emphasis on op-code byte.
#104	Invalid Trigger Source	DTS-1500A does not support this function. Software Malfunction	None Recommended. If error is repeatable contact factory.
#105	Invalid Duty Cycle	Duty Cycle out of range	Verify packet data integrity with emphasis on data byte.
#107	Invalid Frequency	Frequency out of range	Verify packet data integrity with emphasis on data bytes.
#108	Invalid Pulse Width	Pulse Width out of range	Verify packet data integrity with emphasis on data bytes.
#115	Invalid Configuration	Configuration not valid at ID number requested. Most likely never saved	Verify packet data integrity with emphasis on ID byte. Save a new configuration at this ID location.
#116	Failed Load Configuration	Error accessing SRAM configuration data. Configuration not valid, possibly corrupted	Verify packet data integrity with emphasis on ID byte. Re-save configuration at this ID location.
#140	Invalid V-forward	V-forward out of range	Verify packet data integrity with emphasis on data bytes.
#141	Invalid I-forward	I-forward out of range	Verify packet data integrity with emphasis on data bytes.
#142	Invalid I-trip	I-trip our of range	Verify packet data integrity with emphasis on data bytes.
#152	PCX Armed when V-forward changed	This is a warning that the V-forward has changed while the power supply is enabled	The PCX-150 needs to be disarmed an re-armed to correctly set the HVPS for the new V-forward
#154	Invalid Ramp Value	I-ramp out of range, either below zero or greater than Iforward setpoint	Verify packet data integrity with emphasis on data bytes.
#155	Parameter change violates HVPS 3A limit	Changing frequency, pulse width or Iforward will result in configuration needing more than 3A HVPS average current	Change one of the three critical parameters to create a valid configuration
#156	Invalid Duty Cycle	Changing frequency or pulse width will result in configuration with duty cycle greater than 25%.	Change frequency or pulse width to create a configuration that has a valid duty cycle.
#157	I-Ramp Unavailable	Ramping function is not allowed when frequency is greater than	Reduce frequency or do not use ramp with current system

		2kHz	settings

11.0 FACTORY SERVICE AND SUPPORT

For more information regarding your PCX-150 system or for information pertaining to an operational problem, please contact the factory for further assistance:

DIRECTED ENERGY, INC.
2401 RESEARCH BLVD SUITE 108
FORT COLLINS, CO 80526
TEL (970) 493-1901
FAX (970) 493-1903
EMAIL deiinfo@directedenergy.com

12.0 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 waranteed, 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 judgement, 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.

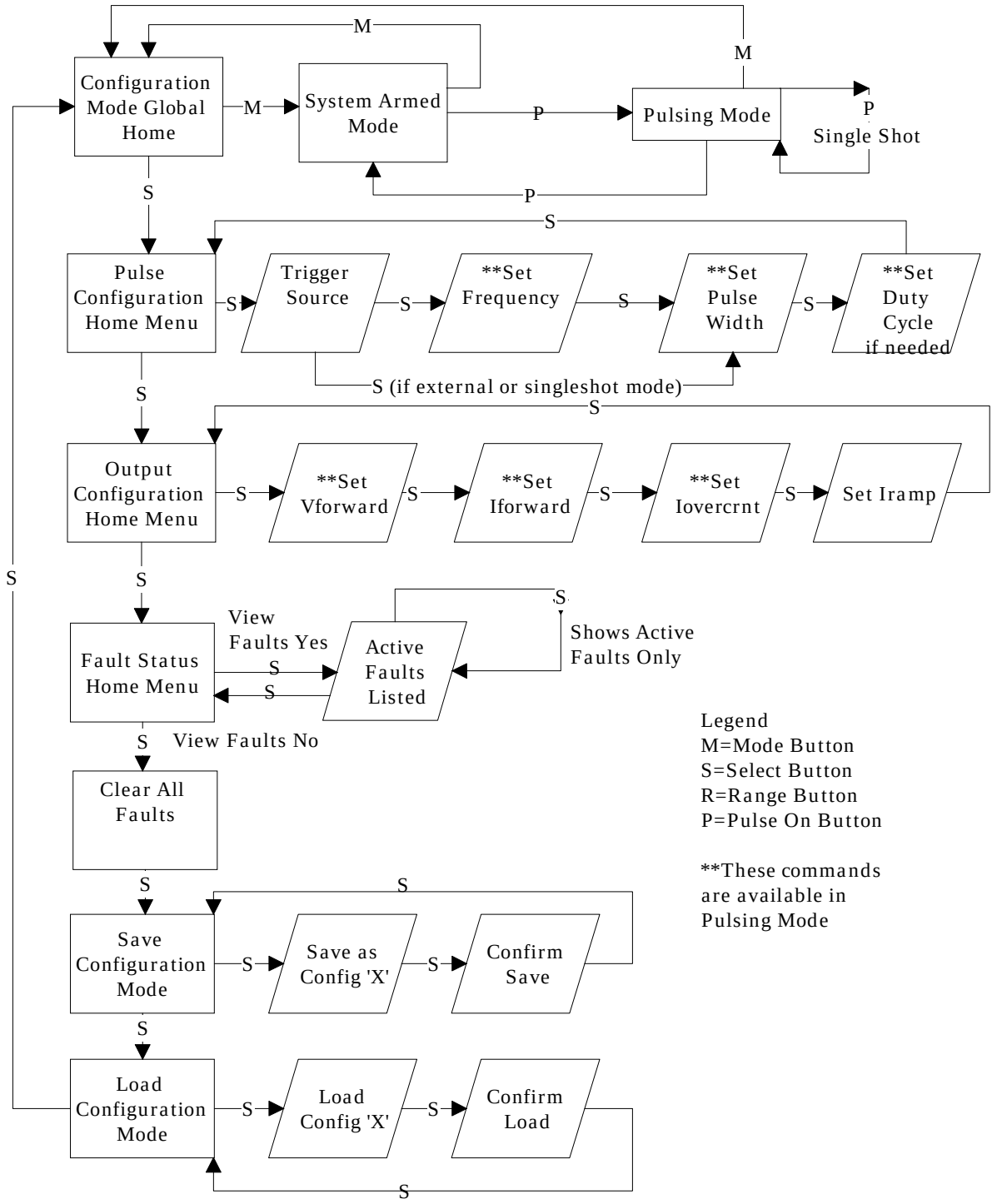
DEI's sole obligation, and buyer's sole remedies, under this agreement shall be limited to a refund of the purchase price, or at DEI's sole discretion, to the repair or replacement of products in kind that prove, to DEI's satisfaction, to be defective, when returned to the DEI factory, transportation 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.

Appendix A

PCX-150A Local Configuration Mode Function Tree



Legend
M=Mode Button
S=Select Button
R=Range Button
P=Pulse On Button

**These commands are available in Pulsing Mode

Note: The mode button will act as a short cut by returning the user to the Configuration Mode Gloabal Home menu option.

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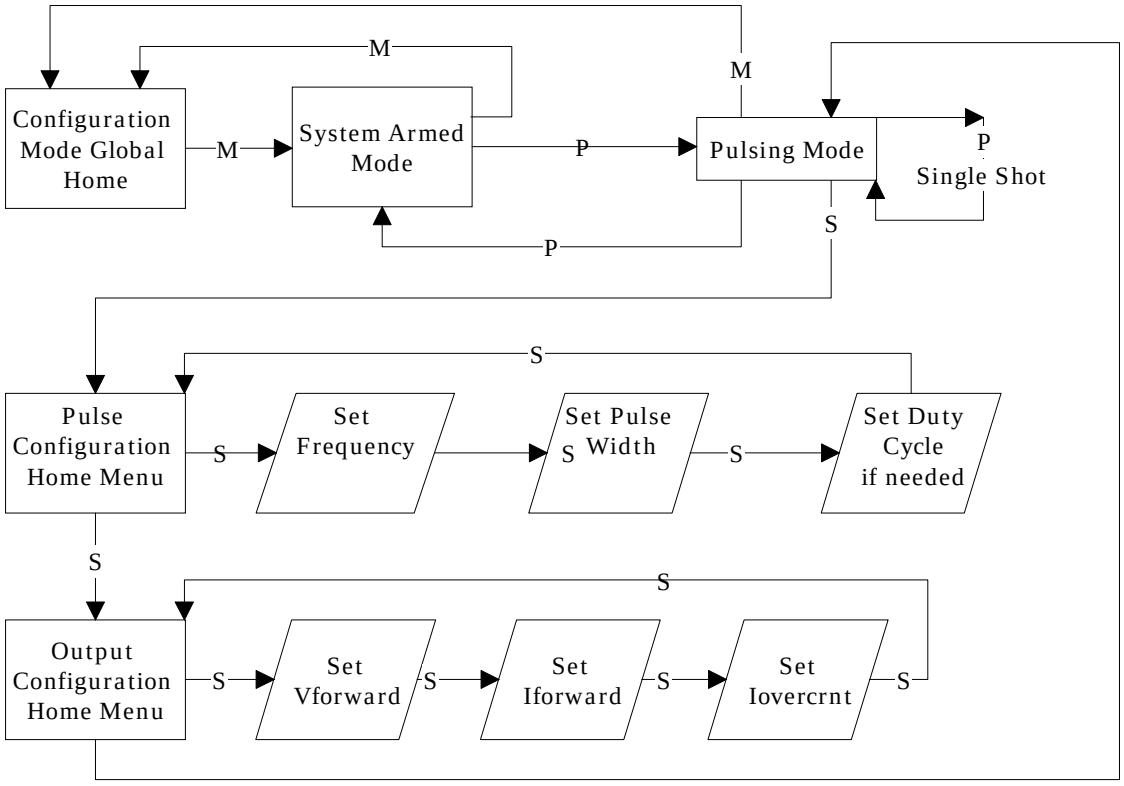
PCX-150A Local Pulse Mode Function Tree



Legend
M=Mode Button
S=Select Button
R=Range Button
P=Pulse On Button

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