
THORLABS

PCD1K Pockels Cell Driver

User Guide



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Chapter 1 Warning Symbol Definitions

Below is a list of warning symbols you may encounter in this manual or on your device.

Symbol	Description
	Direct Current
	Alternating Current
	Both Direct and Alternating Current
	Earth Ground Terminal
	Protective Conductor Terminal
	Frame or Chassis Terminal
	Equipotentiality
	On (Supply)
	Off (Supply)
	In Position of a Bi-Stable Push Control
	Out Position of a Bi-Stable Push Control
	Caution: Risk of Electric Shock
	Caution: Hot Surface
	Caution: Risk of Danger
	Warning: Laser Radiation
	Caution: Spinning Blades May Cause Harm

Chapter 2 Safety



Shock Warning



High voltage inside. To avoid electrical shock, before powering the unit, make sure that the protective conductor of the 3-conductor power cord is correctly connected to the protective earth contact of the socket outlet. Improper grounding can cause electrical shock resulting in severe injury or even death.



Danger High Voltage



The PCD1K can produce hazardous voltages and currents which may be harmful or even lethal. Use caution and exercise preventative safety measures to prevent contact between these high voltages and any personnel. The PCD1K has no user serviceable parts. Service should only be performed by trained service personnel. Do not remove the cover or defeat the cover interlock. The interlock prevents high voltage supplies from operating with the cover removed.



Danger High Voltage – Use Supplied Cables



The PCD1K can produce hazardous voltages and currents which may be harmful or even lethal. Use the supplied SHV cables to interface to your device. Thorlabs provides mating connectors with the Pockels Cell Driver. Other vendors using lower voltages may interface with BNC's. Thorlabs provides a BNC to SHV adapter that may be used. Always install the BNC adapter first.



Caution



This unit must not be operated in explosive environments. Do not operate in wet or damp conditions. Do not obstruct the air-ventilation slots in the housing!



Warning



The unit is supplied with either a 115 V parallel blade line cord for North American use or a European compatible 220 V line cord. For all other applications use an IEC 320 compatible line cord fitted with a plug appropriate for your AC wall socket. Do not replace detachable mains lead with an inferior cord. This may cause a failure, damage, shock, or injury. Changing of the mains fuse can be done by the user, refer to section 7.2 on page 22 for proper fuse selection. With the exception of the mains fuse and the connector (for cleaning), there are no user serviceable parts in this product.

**Caution**

Mobile telephones, cellular phones or other radio transmitters should not be used within the range of three meters of this unit since the electromagnetic field intensity may exceed the maximum allowed disturbance values according to EN50082-1.

**Warning**

The maximum USB and BNC cable length is 3 meters to avoid a susceptibility to RF interference according to IEC61000-4-3.

**Note**

If equipment is used in a manner not specified by the Thorlabs, the protection provided by the equipment may be impaired.

**ATTENTION**

This equipment has been tested and found to comply with all requirements of the Canadian Interference-Causing Equipment Standard ICES-003 for digital apparatus.

**ATTENTION**

Thorlabs GmbH is not responsible for any radio television interference caused by modifications of this equipment or the substitution or attachment of connecting cables and equipment other than those specified by Thorlabs GmbH. The correction of interference caused by such unauthorized modification, substitution or attachment will be the responsibility of the user.

This device can only be returned when packed into the complete original packaging, including all packing inserts. If necessary, ask for a replacement package.

Chapter 3 Description

A Pockels cell is an electro-optic device (much like an electro-optic modulator) that consists of an electro-optic crystal through which light is transmitted. The polarization direction of the light is controlled by the voltage applied to the crystal. The Pockels effect explains the behavior of the Pockels cell: an applied constant or variable voltage results in an electric field (**E**) across the crystal, which produces linear changes in the birefringence of the crystal (in contrast to the Kerr effect, which is quadratic with **E**). Applying a constant voltage allows the Pockels cell to operate as a voltage-controlled wave plate. By applying a variable voltage, one can use a Pockels cell to vary the phase delay through the crystal. Pockels cells are essential components in various optical devices such as Q-switches for lasers and electro-optical modulators.

The Thorlabs PCD1K driver is a voltage amplifier designed to drive a low voltage KD*P Pockels Cell up to 1000 V with a rise time better than 1.2 μ s. It features a touch screen LCD display and encoder, allowing for full functionality through a simple interface. The amplifier can operate with an internal or external input signal and offset.

Internal operation allows the driver to fully function without any external signals or DC voltages. An internal frequency generator can produce a square wave up to 250 kHz. The interface allows the user to adjust the amplitude, frequency, duty cycle, and DC offset. Full DC adjustment is also available internally. A "TRIGGER OUT" BNC on the front panel provides access to the internally generated signal.

External operation allows the user to control both the input signal, typically a square wave, and a DC offset independently. The "SIGNAL IN" BNC is typically a square wave toggling between two optical states while the "OFFSET IN" BNC adjusts DC offset for alignment. The 10 V input can be configured as -10 V to 0 V, ± 5 V, or 0 V to 10 V through the LCD setting menu.

A voltage monitor output is provided to allow real-time monitoring of the high voltage output. The monitor has a scaling of 100:1 so that an output of 1000 V results in a 10 V monitor voltage. Since this is a differential signal, the monitor output is a bipolar ± 5 V signal.

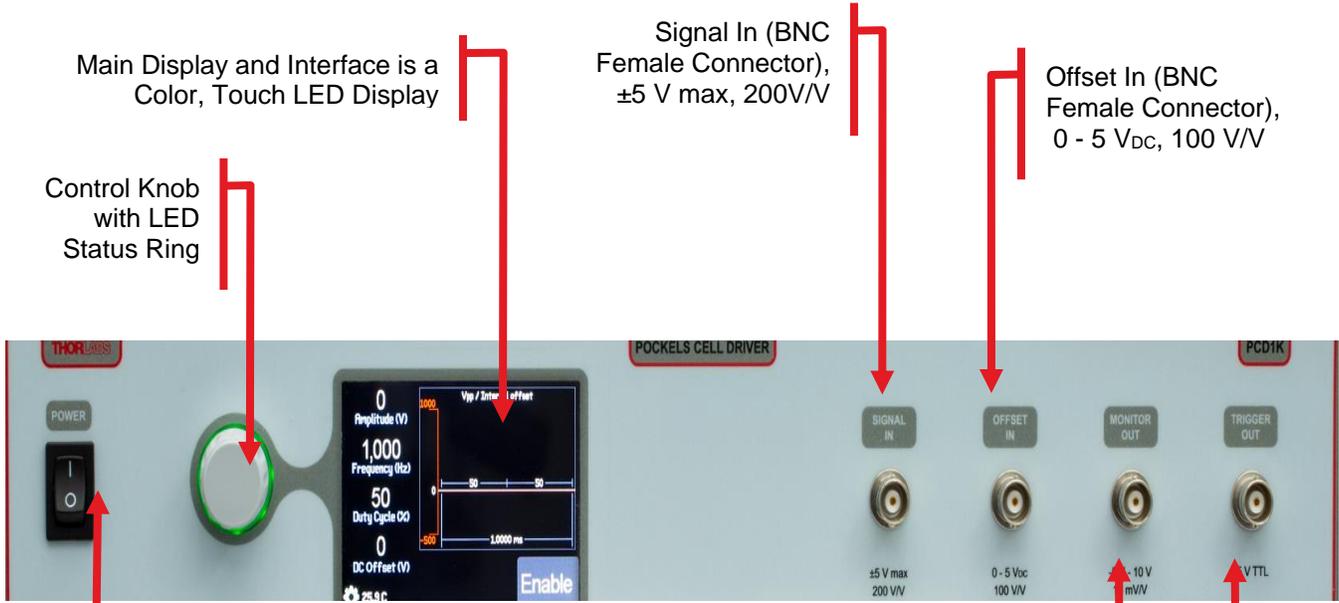
For added safety, a HV Enable button on the touchscreen must be pressed to connect the HV output to the output BNC. The output is automatically disabled each time the system is powered on.

The output is provided differentially with a separate shielded positive and negative signal through SHV style connectors rated for 1 kV+. The shield is directly connected to the case and provides a completely enclosed high voltage path to prevent user access to potentially dangerous high voltage. These SHV outputs are located on the rear panel to limit user accessibility and keep SHV outputs away from low voltage signals. Two CA3262 60" SHV Coaxial Cables are included with the PCD1K driver. Additionally, there is a safety interrupt that prevents the unit from working while the cover is open, though the user should not open the PCD1K driver as there are no user serviceable parts inside.

The driver is also fully configurable through USB control through either terminal commands such as HyperTerminal, through a provided software application, or through SDKs.

Chapter 4 Chassis Overview

Below is a short description of the outside of the PCD1K driver.



Main Display and Interface is a Color, Touch LED Display

Signal In (BNC Female Connector), ±5 V max, 200V/V

Offset In (BNC Female Connector), 0 - 5 V_{DC}, 100 V/V

Control Knob with LED Status Ring

Figure 1 Front Panel

Main Power Toggle Button

Monitor Out (BNC Female Connector), -5 - 10 V, 10 mV/V

Trigger Out (BNC Female Connector), +5 V TTL

High Voltage Output Positive Output (SHV Female Connector), ±500 V max, 100 mA

High Voltage Output Positive Output (SHV Female Connector), ±500 V max, 100 mA



Figure 2 Back Panel

USB 2.0 Type-B Port

Main Power Plug with Fuse Draw

Chapter 5 Setup

The PCD1K Pockels Cell Driver is designed to operate from 85 to 264 VAC, and there is no need to make any adjustments as the switching power supply will determine the correct voltage automatically. Use the proper line cord for your region.

1. Locate the unit on a dry, level working surface. Verify that the ventilation vents are not obstructed.
2. Make sure the POWER switch on the front of the unit is in the OFF position.
3. Plug the female end of the AC line cord provided into the AC Input Receptacle on the rear of the unit. Plug the male end into a properly grounded AC socket.
4. Connect the two SHV cables between the rear panel output positive and negative connectors and the Pockels Cell. This step should always be done with power off and the power cord installed. High voltages can be accessible otherwise.
5. Turn the power switch on. The LCD will display a THORLABS splash screen before switching to the main operation screen.
6. The LCD is a touchscreen. Simply select the parameter you wish to adjust (Amplitude, Frequency, Duty cycle, and Offset) and adjust using the displayed popup keypad or the control knob. Note that the control knob will be color coded to the function.
7. By default, the display will be set as internal operation. To change this setting, press the gear icon on the bottom left to enter the setting menus and adjust the operating mode.
8. You can set operating limits for the Pockels Cell installed to prevent operating above its limits. This can be found in the settings menu.
9. When all adjustments have been made, tap "ENABLE" located on the bottom right of the touchscreen.

Chapter 6 Operation

6.1. Touchscreen LCD Display and Control Knob

The Pockels Cell driver uses an easy-to-use touchscreen interface and a rotary knob with an LED indicator ring to make system adjustments. Any one of the four parameters can be selected by single tapping the display over the parameter. The control knob will modify the value by the increment set in the settings menu (see page 9). A double tap on the parameter will activate the keypad popup.

6.1.1. Home Screen

Figure 3 below shows the basic home screen when the PCD1K driver is in the default internal mode. The control knob will indicate the status – Enabled (red) or Disabled (green) – if none of the values are selected. Each of the values on the left side can be adjusted simply by tapping the desired parameter once to change it with the control knob or double tapping to bring up the keypad popup menu, see Figure 4 below. The knob's color will change to depending on the parameter being changed. These colors can be changed in the settings menu (see page 13). The top right section shows a graph of the internal setup parameters for a visual representation of the differential output. Tapping the gear icon brings up the Settings Menu (see page 9). The temperature shows the internal temperature of the chassis. Finally, tapping the Enable button will enable the driver and changes the button to Disable with a red background.

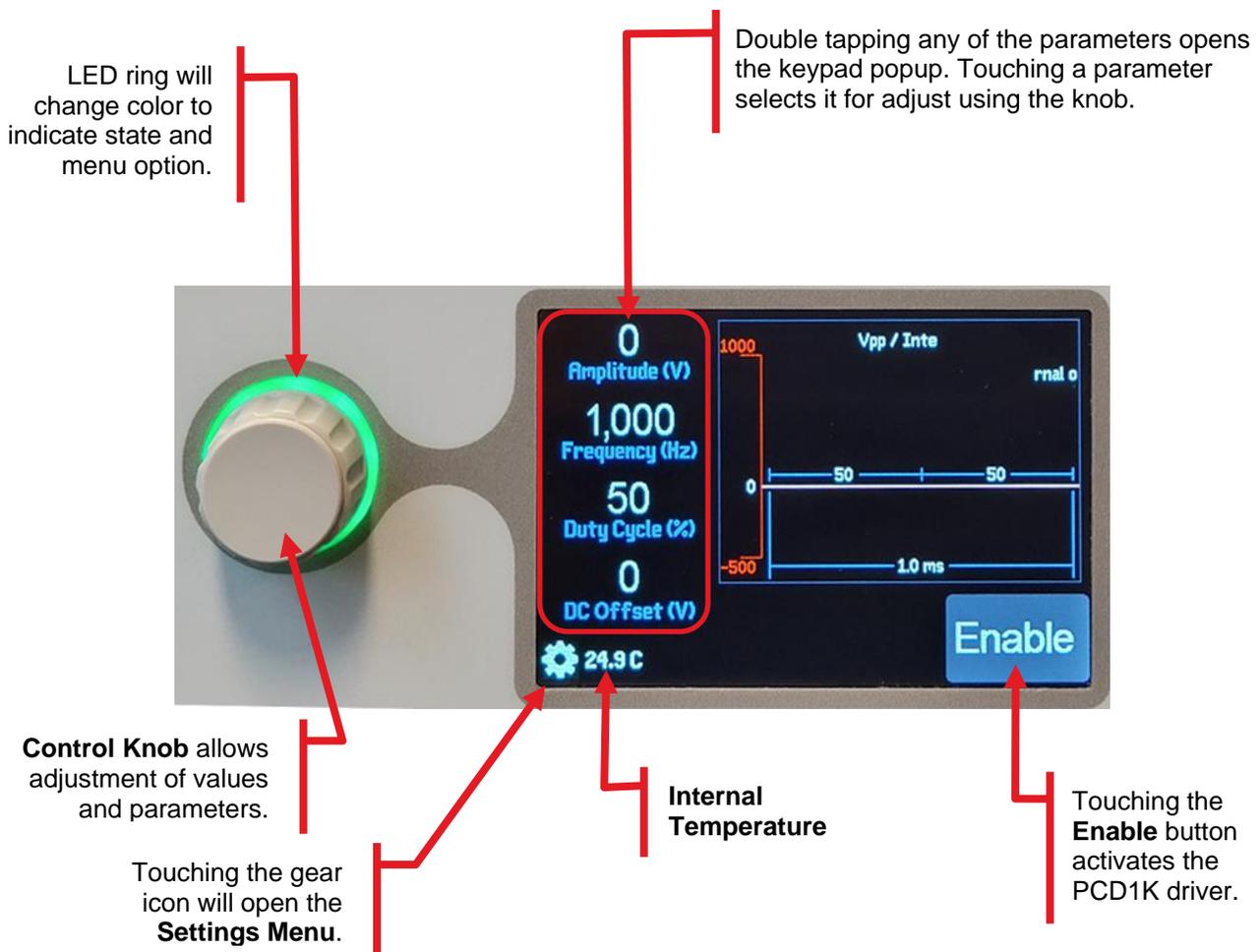


Figure 3 Home Screen – Default Internal Mode

6.1.2. Adjusting the Four Parameters

When double tapped, a popup keypad screen will appear allowing for direct adjustment of the value; see Figure 4 below. While the parameter is selected, the rotary knob can be used to adjustment the value even when the keypad popup is not selected. The knob backlight will glow with a color for each parameter chosen.



Figure 4 Setting the Amplitude

The other menu and their function are:

- **Clear:** Clears the value entered.
- **Apply:** Sets the value entered and does not close the popup menu
- **Cancel:** Closes the keypad window and returns the value to what it was before the window was opened.
- **Undo:** Changes the value back to what it was before the window was opened and keeps the window open.
- **Accept:** Sets the value entered and closes the popup menu.
- **+/-:** Increases or decreases the value by one.
- **Value Bar:** The bar between the '+' and '-' will show a relative level from 0 to the limit set in the setup menu under System Limits.

The same adjustment screen will be available for each parameter chosen and adjusting their value is the same. The color of the selection knob will change to match the parameter selected. These colors can be changed in the Settings Menu, see page 13.

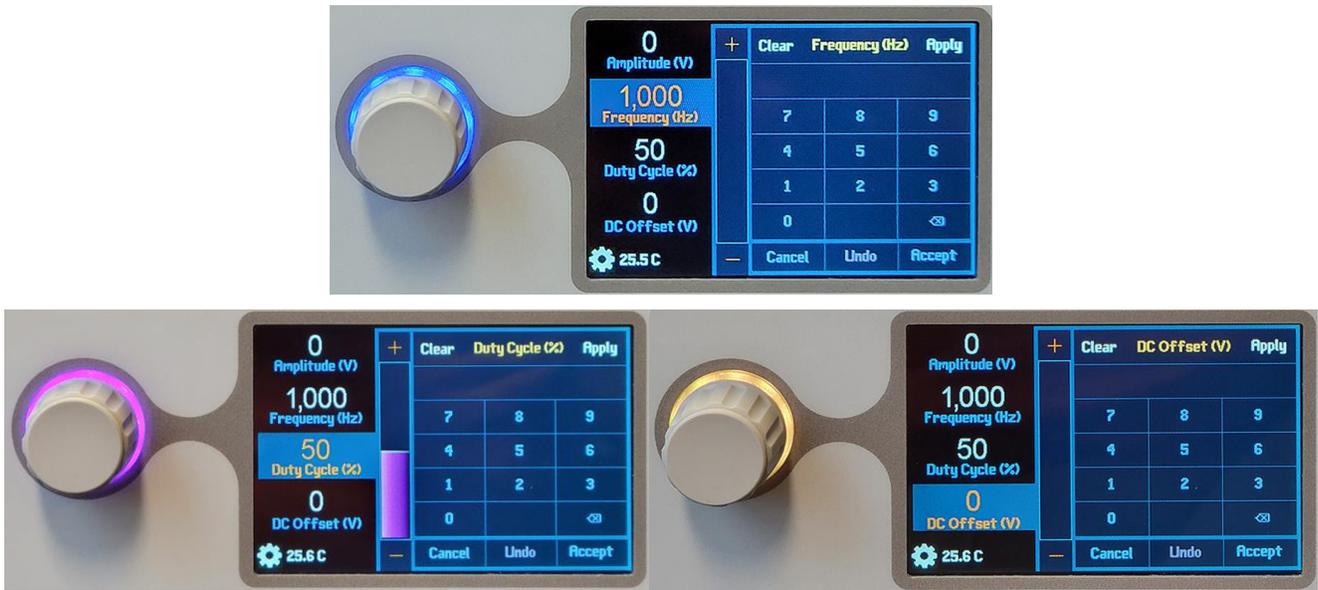


Figure 5 Frequency, Duty Cycle, and DC Offset Menus

6.2. Settings Menu

Pressing the gear icon on the main screen will bring up the Setup menu. The System tab, Signal menu will open by default.

The System tab allows the user to change the signal source, the limits – maximum and minimum, and save and load the settings so different profiles can be created for different devices.

The Knob tab allows the user to adjust the knob functions and the knob colors and increments.

The About tab will display the serial number and firmware versions.



Tapping the question mark icon will activate the **Help** mode.

Figure 6 Signal Setting Menu

6.2.1.1 Signal Menu

The user can select from four modulation **Signal Sources** from the drop-down menu, see Figure 7 below:

- **External BNC – Unipolar Positive:** Sets the signal to 0 V to 5 V
- **External BNC – Unipolar Negative:** Sets the signal to -5 V to 0 V.
- **External BNC – Bi-Polar:** Sets the signal to -2.5 V to +2.5 V.
- **Internally Generated:** Default

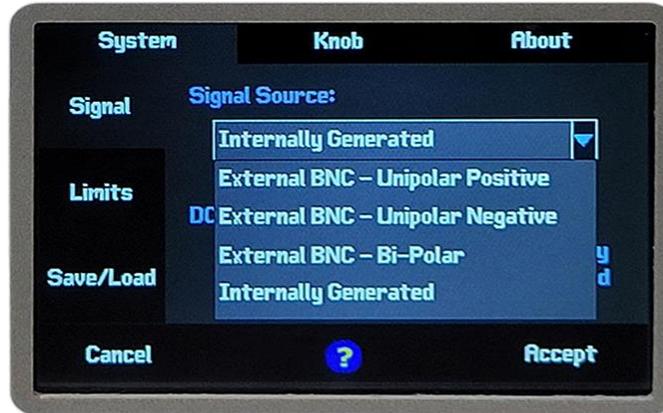


Figure 7 Signal Source Drop Down Menu

The DC offset can be switched from External BNC to Internally Generated by tapping the desired option on the screen. The slider bar will denote which option is selected. The default setting is Internally Generated.

6.2.1.2 Limits Menu

The Limits menu allows the user to set minimum and maximum limits on amplitude, frequency, duty cycle and DC offset. This allows safety limits to be enforced preventing cells from being overdriven.

It should be noted that these limits will not be applied to the “SIGNAL IN” BNC input. That signal is passed through directly to the output amplifiers without interruption from the system logic. The “OFFSET IN” is directly read by an analog to digital converter and sets the output offset supply directly through the microcontroller. In this case, the limits can be enforced.

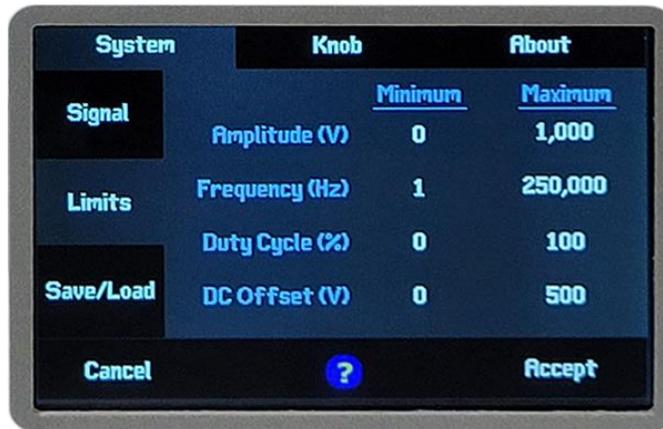


Figure 8 Limits Menu

6.2.1.3 Save/Load Menu

The Save/Load menu allows the user to save their current settings as the default (Save menu option) or as a new profile (Save profile menu option) for easy recall later. This allows multiple devices to be set up and used with the PCD1K driver and their settings recalled quickly. See Figure 9 below.



Figure 9 Save/Load Menu and Operations Dropdown Menu

The Operations dropdown menu has five options, and their functions are:

- **Save:** Saves all the settings, except knob color, to be loaded every time the device starts up.
- **Save profile:** Saves the settings to one of five profiles, which can be recalled as needed
- **Load profile:** Loads the settings from one of the saved profiles
- **Delete profile:** Deletes the selected profile
- **Restore defaults:** Resets all the settings to factory defaults. **WARNING! This cannot be undone.**

The PCD1K driver can save up to five profiles. To save a profile, tap the Save/Load menu option, tap the Operation dropdown box and select Save profile. Two new options appear: Profile and Name. One of the profiles, 1 – 5, must be selected before a name can be entered. If the profile number selected has already had a profile saved to it, the name will be shown in the Name field. If no profile is saved or the user chose the default name, the Name field will display: “-----”. See Figure 10 below.

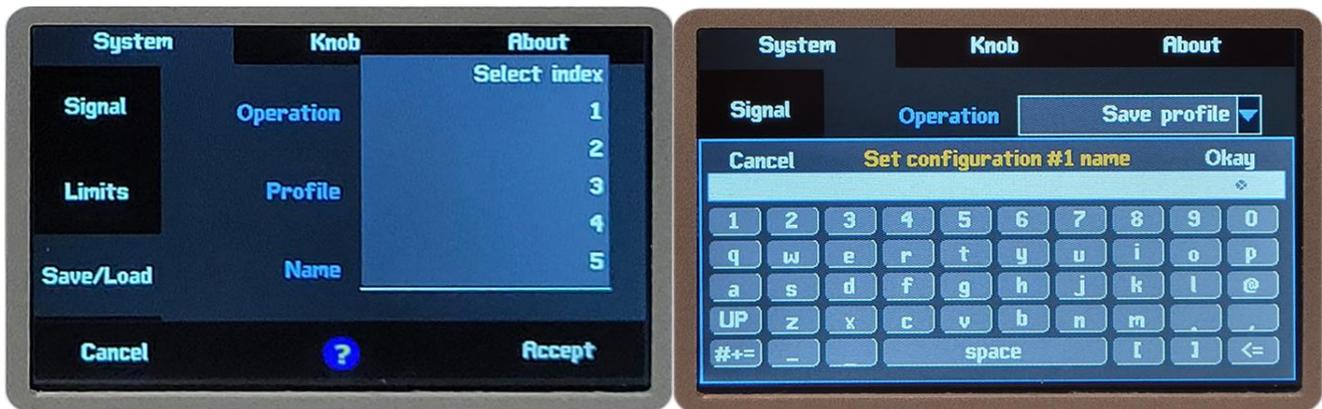


Figure 10 Save Profile and Name Menus

6.3. Knob Tab

The display tab is primarily used to setup user preferences with respect to the color schemes for the different adjustment options. The adjustment knob located to the left of the display provides a color matched backlight that will default to white light to indicate the system is powered on. Each time a parameter is selected to change, the background color will change to the designated parameter color. The sensitivity of the knob for each parameter may also be set.

6.3.1. Knob Function

Tapping the corresponding option will allow the user to set the parameter to their desired value.

- **Knob Timeout:** Set the number of seconds before the options popup window closes. If set to 0, the window never closes. The default value is 0.
- **Knob Brightness (%):** Sets the brightness as a percentage from 0% to 100% of the knob LED. Setting the value to 0 turns the LED off. The default value is 75.
- **Output Enabled:** Tapping the color brings up an HSB color selection popup window. Selecting a color will change the LED color.
- **Output Disabled:** Tapping the color brings up an HSB color selection popup window. Selecting a color will change the LED color. Note, if the unit is Enabled, the LED will not change from the Output Enable color. To preview the LED color, first disable the unit from the home screen.

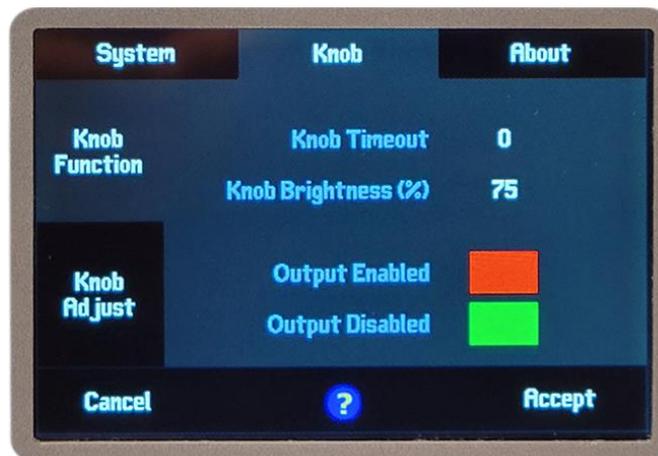


Figure 11 Knob Function Menu

6.3.2. Knob Adjust

Tapping the corresponding option will allow the user to set the parameter to their desired value. The color selection and knob increment selections function the same for all of the 4 parameters. The default values are shown in Figure 12 below.

- **Color:** Tapping the color brings up an HSB color selection popup window. Selecting a color will change the LED color. Note, if the unit is Enabled, the LED will not change from the Output Enable color. To preview the LED color, first disable the unit from the home screen.
- **Knob Increment:** Tapping this option brings a popup window that allows the user to set the amount the knob increments or decrements when the knob is turned.



Figure 12 Knob Adjust Menu

6.4. About Tab

The About Tab is an information tab that displays the company name, part name (Pockels Cell), serial number and the firmware revisions. There is no interactable content on this page.



Figure 13 Info Tab

6.5. Help Icon

The user can get help on any of the settings menu options by tapping the question mark icon at the bottom middle of the screen. See Figure 6 on page 9. Not that this help is only available on the various Settings tabs wherever the question mark icon is shown. After tapping the icon, it will change to a question mark icon with an arrow.

While active, the help mode will disable selection of any of the options. Instead, tapping any menu, value, or selection option button on the screen will bring up a help popup window. The user needs to tap something to exit out of help mode, even the help icon. For example, tapping the question mark icon then tapping the Signals Tab will bring up the help popup screen shown in Figure 14 below.

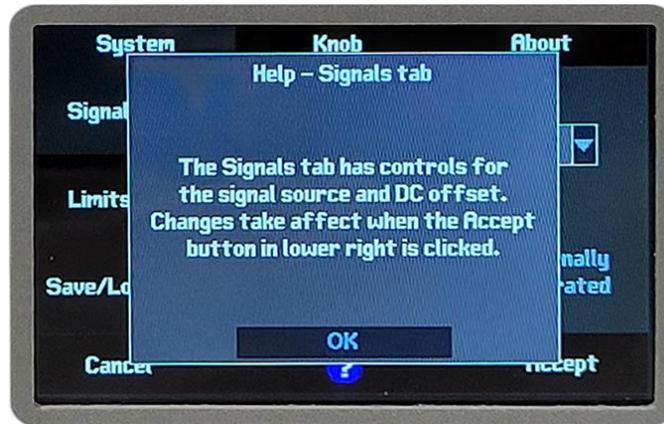


Figure 14 Signals Help Popup Window Example

To close the popup window and exit the help mode, tap on the OK on-screen button.

6.6. Front Panel BNC Connections



Figure 15 Front Panel BNC Connectors

6.6.1. Signal Input

This “Signal Input” BNC provides an external modulation input typically driven with a square wave. This input is selectable between 3 different voltage range options. Ranges can be set to 0 V to 5 V, -5 V to 0 V, or ± 2.5 V with a circuit gain of 200 V/V. To select between the different voltage ranges, touch the gear icon on the lower left of the screen. In the settings tab touch signals and choose from the drop-down box. By default, the system will use “Internally Generated”. This ignores any “Signal Input” signals and uses the internally generated frequency to drive the output.



Figure 16 Signal Setting Menu

The Pockels Cell driver is designed to drive square wave signals with output rise times of $\leq 1.2 \mu\text{s}$ or better. The high input impedance and adjustable range allow for this to be driven by a wide range of input devices such as function generators and data acquisition cards. This output is combined with the DC Offset to provide a full range of adjustment to a typical low voltage Pockels Cell.

6.6.2. DC Offset

The “DC OFFSET” BNC allows the user to apply an external DC voltage to adjust the output offset. This is typically used for alignment and calibration of the Pockels Cell. By default, the offset is set to internally generated. To use the external BNC, select the gear icon on the bottom left and choose settings as shown in Figure 16 above. The DC Offset needs to be set to the External BNC option.

The Pockels Cell driver utilizes a differential output. This means that the DC offset is with respect to the “Negative Output”, not the SHV shell. For example, a DC offset of 0 V would result in the peak-to-peak signal of “Positive Output” will be centered around “Negative Output”. As DC offset is increased, this voltage shifts more positive with respect to “Negative Output”.

The Offset is generated by a high voltage power supply located between the “Positive Output” SHV and the “Negative Output” SHV connectors. As such it cannot be adjusted all the way to 0 V. The minimum offset is limited to approximately 5 V and linearly adjusts to the maximum of 500 V. See Figure 17 below for the conversion from input voltage to output offset.

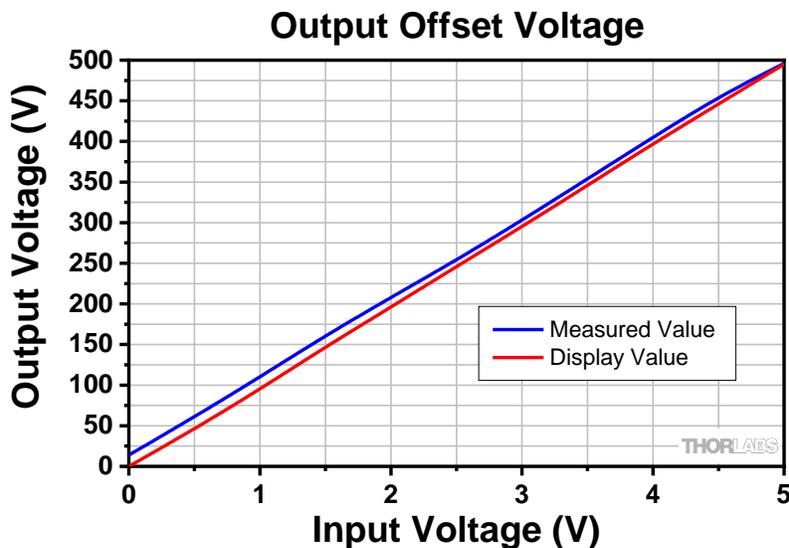


Figure 17 0 V verse 500 V DC Offset Graph

6.6.3. Monitor Output

The monitor output provides a voltage measured across the “Positive Output” to “Negative Output” BNC’s and attenuates by 100x. The actual output rise/fall time at the Pockels cell will be increased based on the length and impedance of the attached coax cables. Note that this output is not 50Ω drive compatible. A load impedance or at least 2 kΩ is required for proper operation.

6.6.4. Trigger Output

The trigger output is a TTL level output that provides a system trigger for use with the internally generated signal. When using Internally Generated modulation, a TTL approximate of the signal will be outputted to this BNC. Note that this output is not 50 Ω drive compatible. A load impedance or at least 2 kΩ is required for proper operation.

6.7. Output Connections (Rear BNCs)

The PCD1K driver is a differential output driver which means the load requires a connection across the output positive and output negative SHV connectors. It is not intended for single connection applications. The SHV shell is directly connected to the chassis protective ground and is not intended for a signal return path. It is intended to provide high voltage isolation and safety. As such, the load positive and negative signal outputs must be isolated from the protective ground at the load.

This driver is generally intended to provide square wave outputs. Most applications of Pockels Cells are to pass or block optical signals. As such rise and fall time is generally important for user applications. This is generally a function of the load capacitance of the cell and connecting cables and is limited by the drivers' current capabilities.

$$I_{out} = C \times \frac{\Delta V}{\Delta t}$$

Where the C is the combined capacitance of the cable set and Pockels Cell, V is the applied voltage change and t is the rise or fall time for a square wave signal.

The outputs are short circuit protected above 100 mA.

6.8. Computer Control Operation

6.8.1. GUI Operation

A Windows GUI application software is provided to the user to control the Pockels Cell Driver from the computer. A Software Development Kit (SDK) also comes with the device, which will allow the user to integrate the Pockels Cell Driver into his own applications.

6.8.1.1 Software Requirements

- Windows 7, 64-bit or later
- .Net Framework 4.5 (or higher) must be installed
- Microsoft Visual Studio for SDK Demo project

6.8.2. Installation

The installation package is available from the Pockels Cell Driver product page on the Thorlabs, Inc. web site for users to download. The installation includes two components: Pockels Cell Driver Control Software and Thorlabs Device SDK, as shown in Figure 18.

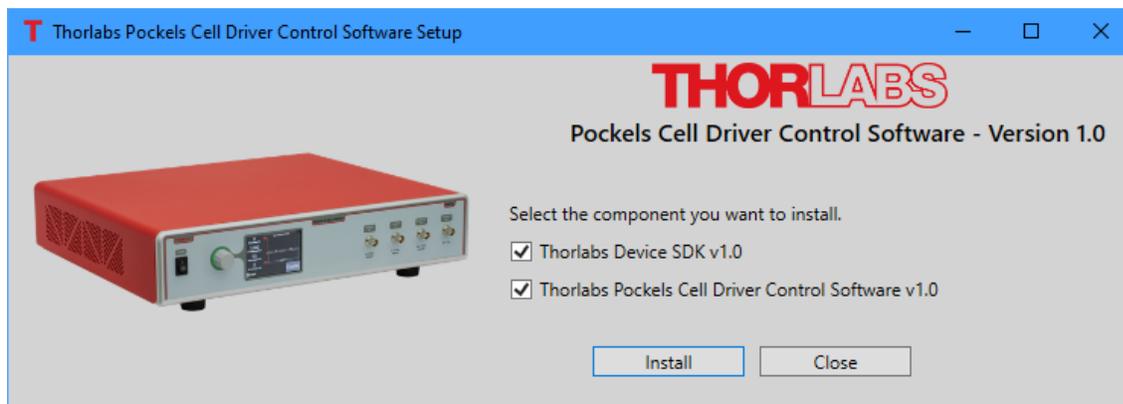


Figure 18 Pockels Cell Driver Software Installation

For the first time installation, both components are checked and must be installed. The setup checks if another version of the selected component was installed. If another version exists, the new installation cannot complete until another version is removed.

The following files are installed in the following directories:

1. GUI application executable and dependencies (DLLs) are installed in
C:\Program Files (x86)\Thorlabs\TL_Devices\PockelsCellDriver
2. Thorlabs Device Plugin is stored in folder
C:\Program Files (x86)\Thorlabs\ TL_Devices\TL_Device_Plugins
3. Thorlabs Device SDK files are stored in folder
C:\Program Files (x86)\Thorlabs\ TL_Devices\TL_Device_SDK

Thorlabs Device Dynamic-Link Library (TLDeviceSDK.dll) and its dependency are required by the GUI application, or any other applications developed with the Thorlabs Device SDK. To make it convenient to run the executables without copying the DLLs, the full path to TLDeviceSDK.dll, C:\Program Files (x86)\Thorlabs\TL_Devices\TL_DEVICE_SDK\Bin is added to the Windows **PATH** environment variable.

6.8.3. Command Line Operation

The system may also be controlled by a command line language through the USB port. This is offered to enable operation through a terminal interface or for those who may want to write their own program to control the unit. The command language is described below. Prior to running the command line interface, the unit should be powered on, and a USB cable should be connected between the PCD1K driver and the host.

The terminal emulator should be set as follows:

Terminal Emulator Settings	
Baud Rate	115.2 kb/s ¹
Data Bits	8
Parity	None
Stop Bits	1
Flow Control	None

If you are using a terminal program, be sure to check the option “Append line feeds to incoming line ends”, or a similar option, depending upon the program you are using. In HyperTerminal you can find this option by navigating to File → Properties, selecting the Settings Tab and clicking “ASCII Setup...” button. It is the first option in the “ASCII Receiving” box.

If the connection is correct, you will see the following after pressing the Enter key.

Command error CMD_NOT_DEFINED

Followed immediately by the prompt: >

The basic structure of the interface is a keyword followed by either an equals sign “=” or a question mark “?”. The “=” or “?” will determine if the string is a command or a query. All strings (commands and queries) must be terminated by a carriage return (CR) or pressing the ENTER key on the computer.

The command structure is as follows:

Keyword = argument (CR)

Where “keyword” defines the function and “argument” is a numerical value followed by a carriage return (CR).

See listing below.

The query structure is as follows:

Keyword? (CR)

The “keyword” defines the function and the question mark (?) indicates a query. The string is terminated with a carriage return (CR). See listing below. There are a few exceptions to this which are noted below.

The prompt symbol “>” will appear on power up and after a command is accepted by the system indicating it is ready to receive another command line.

¹ kilobits per second, other baud rates can be applied

6.8.4. Keywords (Basic Commands and Queries)

The following table describes basic commands and queries:

Command Syntax	Description
?	Returns a list of all available commands
ID?	Returns product header and firmware version
ena?	Returns enabled state (0=Disabled, 1=Enabled)
ena=	Sets enabled state (0=Disabled, 1=Enabled)
ss?	Gets signal source (0=uni pos, 1=uni neg, 2=bipolar, 3=int)
ss=	Sets signal source (0=uni pos, 1=uni neg, 2=bipolar, 3=int)
os?	Gets offset source (0=External, 1=Internal)
os=	Sets offset source (0=External, 1=Internal)
eo?	Get external offset voltage (0 to 500 Volts)
ia?	Get internal signal amplitude (0 to 1000 Volts)
ia=	Set internal signal amplitude (0 to 1000 Volts)
idc?	Get internal drive duty cycle (0 to 100 percent)
idc=	Set internal drive duty cycle (0 to 100 percent)
if?	Get internal drive frequency (0 to 250000 Hz)
if=	Set internal drive frequency (0 to 250000 Hz)
io?	Get internal offset (0 to 500 Volts)
io=	Set internal offset (0 to 500 Volts)
tmp?	Get current heat sink temperatures
save	Save startup profile
save=	Save settings to profile index (1-5)
load=	Load configuration from index (1-5)

Keywords (Advanced Commands and Queries)

The following table describes advanced commands and queries:

Command Syntax	Description
iamin?	Get internal signal amplitude minimum (1-iamax)
iamin=	Set internal signal amplitude minimum (1-iamax Volts)
iamax?	Get internal signal amplitude maximum (iamin-1000 Volts)
iamax=	Set internal signal amplitude maximum (iamin-1000 Volts)
idcmin?	Get internal drive duty cycle minimum (0-idcmax %)
idcmin=	Set internal drive duty cycle minimum (0-idcmax)
idcmax?	Get internal drive duty cycle maximum (idcmin-100%)
idcmax=	Set internal drive duty cycle maximum (idcmin-100%)
ifmin?	Get internal drive frequency minimum (0-ifmax Hz)
ifmin=	Set internal drive frequency minimum (0-ifmax Hz)
ifmax?	Get internal drive frequency maximum (ifmin-250000 Hz)
ifmax=	Set internal drive frequency maximum (ifmin-250000 Hz)
iomin?	Get internal offset minimum (0-iomax)
iomin=	Set internal offset minimum (0-iomax)
iomax?	Get internal offset max (iomin-500 Volts)
iomax=	Set internal offset max (iomin-500 Volts)
cfgnamex=	Set name for profile x (x=1-5, maximum of 20 chars)
cfgnamex?	Get name for profile x (x=1-5)
clear=	Clear profile from index (1-5)
faults?	Get active faults
errors?	Get error count with error(s) bit mask since last check
lasterror?	Get the last error
nexterror?	Get the next error from the list of errors
clearerrors	Clear all errors
errorid=	Get description for error n (n=Error description to get)
model?	Get the model
fwver?	Get firmware version
serial?	Get serial number
friendly?	Get friendly name
friendly=	Set friendly name (maximum of 20 chars)
defaults	Restore system to factory defaults

Chapter 7 Maintenance

7.1. Cleaning the PCD1K Driver

There are no serviceable parts inside. Do not open.

The exterior of the unit can be cleaned with a soft, lint free damp cloth. If needed, a mild detergent can be used. No harsh chemicals or abrasives should be used.

7.2. Changing the Fuse

The PCD1K driver uses a 1.0 A, 250 VAC Littlefuse part number 0239001.HXP fuse. Should the fuse blow and need to be replaced, the same fuse must be used. The fuse can be found in the tray below the AC mains plug.



Shock Warning



To avoid electrical shock and severe injury, before changing the fuse: turn the PCD1K off, unplug the AC mains cord from the wall then the PCD1k. Failure to do so can cause electrical shock resulting in severe injury or even death.

To replace the fuse:

1. Remove the mains power cord.
2. Pull the fuse draw open.
3. Remove the old fuse and dispose appropriately.
4. Insert the new 1.0 A Type T Slow Blow fuse into the tray.
5. Close the tray and plug in the mains power cord.

The unit can then be plugged back in and powered on. If the unit fails to start, refer to the Trouble Shooting section starting on page 23 or contact your local technical support office.

Chapter 8 Trouble Shooting

8.1. Error Codes

When a fault is detected by the firmware, an error message is shown on the front panel display. Some errors, referred to as “Non-severe Errors” in the table below, will allow the system to continue to operate. Other errors, referred to as “Severe Errors” in the table below, will cause the system to either shut off the output or prevent it from turning on.

Should an error occur, the table below may be used to determine what the issue is and how to resolve it.

Error Message	Description	Solution
Non-severe Errors – System will continue to operate		
Ext. Offset Saturated	Ext. Offset Saturated - The input voltage into the external offset control is higher than the limit (5V).	Unit will continue to function. Display will keep displaying this error message until the external offset control's input voltage decreases to under the limit. User should check the input once this message is shown.
Severe errors – Output disables		
Temperature Fault	Temperature fault is active - Output would be shut off with this fault.	With this fault, the device is overheated which may cause damage to internal electronics. Lower the output voltage or the driven frequency if possible. Make sure the ambient room temperature is within the specified operating temperature range, the side air intake holes are free of obstruction or that the fan exit holes are not blocked.
Fan Fault	Fan fault is active - Output would be shut off with this fault.	This fault indicates that the fans are not working properly. Make sure there is no object stuck inside of the fans to prevent them from spinning. If either of the fans failed, contact local tech support for RMA.
Low Voltage Supply Fault	Voltage Supply fault is active - Output would be shut off with this fault.	This fault indicates there could be some problem with the unit's main power supply. Contact local tech support for RMA.
Interlock - Case Open	Interlock fault is active - The output cannot be enabled with this fault.	This fault indicates the enclosure interlock was defeated, i.e., case was opened. The device cannot operate with an open case due to safety concerns. Thus, the output cannot be enabled until this error is cleared.

8.2. Fault Tracing

The following table describes some typical problems that may be encountered while using the PCD1K driver and possible solutions to these problems.

Problem	Solution(s)
Unit does not turn on when switching the power switch to the ON position.	<ol style="list-style-type: none"> 1. Make sure AC line cord is fully inserted into the AC Input receptacle and plugged into an outlet providing 100 to 240 VAC. 2. Fuse(s) may be open. Refer to section 7.2 on page 22 for information on replacing open fuses. If the problem persists, please return the unit to Thorlabs for evaluation.
Unit does not enable the Source when pressing the ENABLE button.	<ol style="list-style-type: none"> 1. Make sure that the AC Line Cord is properly plugged in, and Key Switch is turned to "ON" position. 2. Verify both fans are spinning 3. Check to make sure the cover is installed, and ALL screws are securely in place. A safety interlock ensures the cover is installed before enabling the high voltage power supplies.
Unit is enabled but there is no Output.	<ol style="list-style-type: none"> 1. Verify by checking the "Monitor Out" BNC. This measures directly across the output connections. 2. If expected signal is present, check all cable connections between the PCD1K driver and Pockels Cell. 3. If expected signal is not present, there may be a short on the output. The driver output includes short circuit protection. Power the unit off and remove all connections. Power back on and recheck "Monitor Out". Next add the cables, then add the Pockels Cell to narrow down the cause.
Unit is enabled but there is no Output when using external modulation.	<ol style="list-style-type: none"> 1. Check the output of the modulating source and confirm the Output is "On". 2. Go into the setup menu and verify the External Input is enabled and that the correct input voltage range is selected.
I can't connect to the PCD1K driver over the USB com port.	<ol style="list-style-type: none"> 1. Make sure that the com port is configured correctly for the unit. Refer to Section 6.8.2 on page 18 for the correct com port settings. 2. The incorrect com port is selected on your terminal program or PCD1K application.

Chapter 9 Specifications

General Specifications	
Bandwidth (Square Wave)	250 kHz
Output Voltage (Max)	
Differential ²	1000 V
Each Output to Chassis ³	±500 V
Output Current ⁴	85 mA
Output Rise/fall time ⁵	<1.2 μs
Signal In BNC ⁶	
Voltage ⁷	5 Vpp
Range Options	-5 to 0 V, ±2.5 V, or 0 to 5 V
Impedance	2 kΩ
Offset in BNC ⁶	
Voltage	0 V to 5 V DC
Impedance	10 kΩ
Monitor Out BNC ⁶	
Voltage	±5 V
Max Load Current	10 mA max
Min Load Impedance	500Ω
Trigger Out BNC ⁶	
Voltage	5 V TTL
Max load current	5 mA max
Min load impedance	1 kΩ
Output Connector (Rear)	SHV
USB Port Type	USB 2.0 Type-B
Operating Temperature	15 °C - 35 °C
Storage Temperature	0 °C - 50 °C
AC Input	85 - 264 VAC, 50 - 60 Hz Switching Power Supply
Power	130 VA
Fuse	1.0 A Type T Slow Blow
Display	3.5" TFT LCD Touchscreen
Size (L x W x H)	15.60" x 17.01" x 4.14" (396.3 mm x 432.0 mm x 105.3 mm)
Weight	13.0 lbs. (5.9 kg)

² This is the max voltage as seen at the load, or Pockels Cell, with both outputs connected.

³ This is the voltage seen at each output connector with respect to the system chassis, or SHV shell.

⁴ The output is short circuit protected above output current limit.

⁵ Actual rise/fall is dependent on load characteristics. Worst case test performed with 10' cable set (~30 pF/ft) and 10 pF Pockels Cell at 1000 Vpp output.

⁶ The maximum USB and BNC cable length is 1.5 meters in order to avoid a susceptibility to RF interference according to IEC61000-4-3.

⁷ Input voltage range needs to be set through the LCD setting menu to one of 3 options.

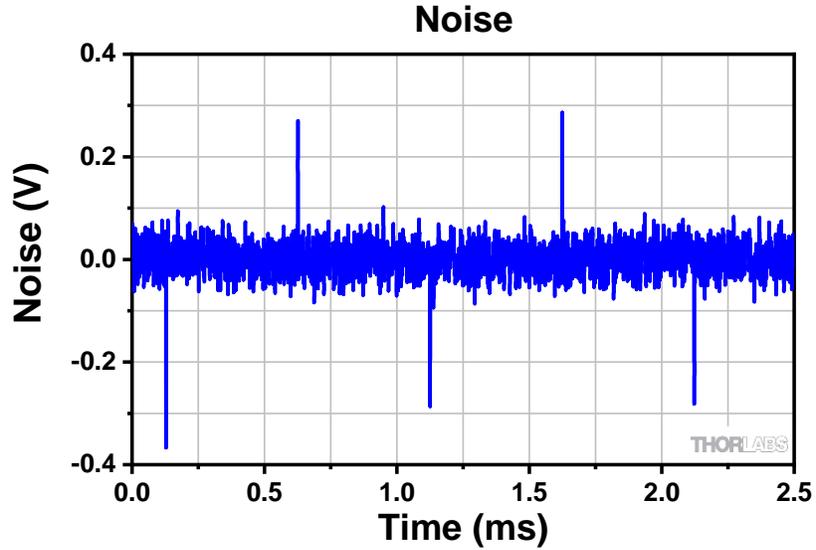


Figure 19 This graph shows the differential noise performance. The PCD1K driver was connected to a Pockels cell, driven with 0 V, and the noise was measured across the Pockels cell.

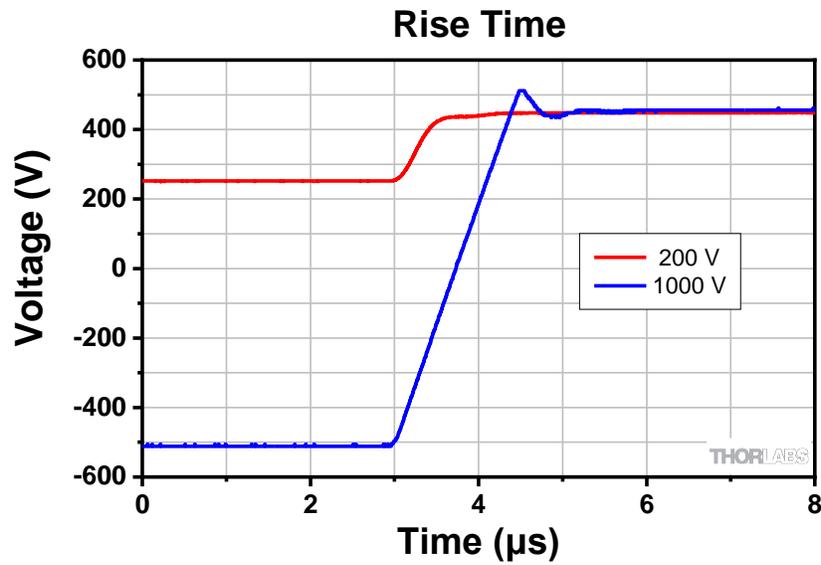


Figure 20 This graph shows the rise times for 200 V and 1000 V signals from the PCD1K driver when driving a 20 pF Pockels cell with the included CA3262 cables.

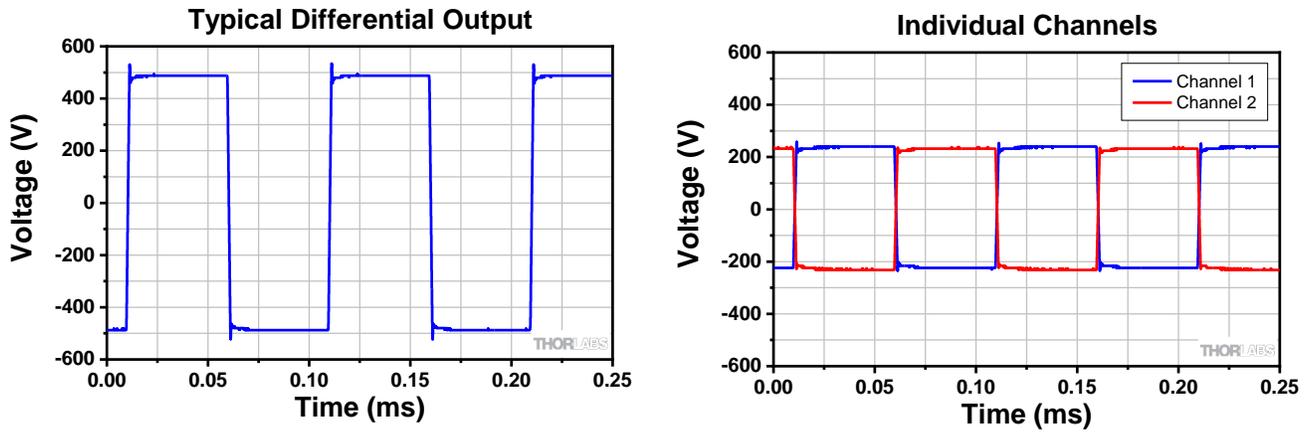
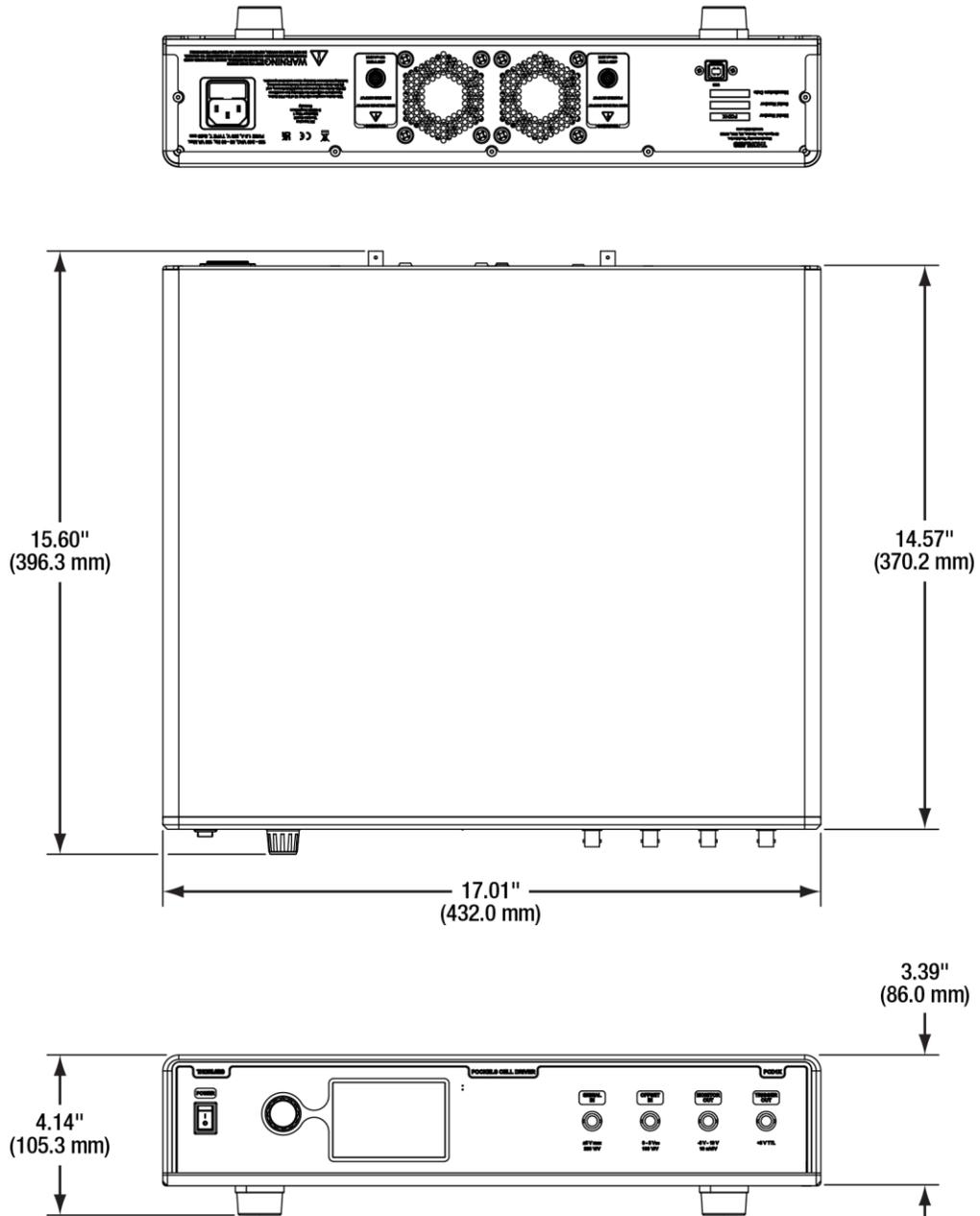


Figure 21 Left shows a typical differential output, right shows the same signal as single ended. CH1 is the positive output to system ground. CH2 is the negative output to system ground.

Chapter 10 Mechanical Drawing



Chapter 11 Regulatory

11.1. WEEE

As required by the WEEE (Waste Electrical and Electronic Equipment Directive) of the European Community and the corresponding national laws, Thorlabs offers all end users in the EC the possibility to return “end of life” units without incurring disposal charges.

- This offer is valid for Thorlabs electrical and electronic equipment:
- Sold after August 13, 2005
- Marked correspondingly with the crossed out “wheelie bin” logo (see right)
- Sold to a company or institute within the EC
- Currently owned by a company or institute within the EC
- Still complete, not disassembled and not contaminated



Wheelie Bin Logo

As the WEEE directive applies to self-contained operational electrical and electronic products, this end of life take back service does not refer to other Thorlabs products, such as:

- Pure OEM products, that means assemblies to be built into a unit by the user (e. g. OEM laser driver cards)
- Components
- Mechanics and optics
- Left over parts of units disassembled by the user (PCB's, housings etc.).

If you wish to return a Thorlabs unit for waste recovery, please contact Thorlabs or your nearest dealer for further information.

Waste Treatment is Your Own Responsibility

If you do not return an “end of life” unit to Thorlabs, you must hand it to a company specialized in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.

Ecological Background

It is well known that WEEE pollutes the environment by releasing toxic products during decomposition. The aim of the European RoHS directive is to reduce the content of toxic substances in electronic products in the future.

The intent of the WEEE directive is to enforce the recycling of WEEE. A controlled recycling of end of life products will thereby avoid negative impacts on the environment.

11.2. FCC Statement

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

11.3. EU CE Certificate of Conformance



THORLABS

www.thorlabs.com

EU Declaration of Conformity

in accordance with EN ISO 17050-1:2010

We: Thorlabs Inc.
 Of: 56 Sparta Avenue, Newton, New Jersey, 07860, USA

in accordance with the following Directive(s):

2014/35/EU	Low Voltage Directive (LVD)
2014/30/EU	Electromagnetic Compatibility (EMC) Directive
2011/65/EU	Restriction of Use of Certain Hazardous Substances (RoHS)

hereby declare that:
 Model: **PCD1K**

Equipment: **Pockels Cell Driver**

is/are in conformity with the applicable requirements of the following documents:

EN 61010-1	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use.	2010
EN 61326-1	Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements	2013

and which, issued under the sole responsibility of Thorlabs, is/are in conformity with Directive 2011/65/EU of the European Parliament and of the Council of 8th June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment, for the reason stated below:

contains no substances in excess of the maximum concentration values tolerated by weight in homogenous materials as listed in Annex II of the Directive

I hereby declare that the equipment named has been designed to comply with the relevant sections of the above referenced specifications, and complies with all applicable Essential Requirements of the Directives.

Signed:  On: 19 January 2022

Name: Danielle Strong

Position: Director of Quality and Compliance

EDC - PCD1K - 2022-01-19



11.4. UKCA Certificate of Conformity



UKCA Declaration of Conformity

Thorlabs Inc.

56 Sparta Avenue, Newton, New Jersey, 07860, USA

Complies with the following UK Legislation:

- 1101 The Electrical Equipment Safety Regulations
- 1091 The Electromagnetic Compatibility (EMC) Regulations
- 3032 Restriction of Use of Certain Hazardous Substances (RoHS)

Model name that:

Model: **PCD1K**

Product: **Pockels Cell Driver**

Complies with the applicable requirements of the following documents:

- | | | |
|-------|---|---|
| 110-1 | Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use. | 2 |
| 126-1 | Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements | 2 |

This declaration, issued under the sole responsibility of Thorlabs, is in conformity with The Restriction of Use of Hazardous Substances in Electrical and Electronic Equipment Regulations 2012, for the reason stated below. There are no substances in excess of the maximum concentration values tolerated by weight in homogeneous materials as listed in Annex II of the Directive.

I hereby declare that the equipment named has been designed to comply with the relevant section of the referenced specifications, and complies with all applicable Essential Requirements of the CE Marking Directive.

On: 19 January 2022

Danielle Strong
Director of Quality and Compliance

EDC - PCD1K -2022-01-19



Chapter 12 Thorlabs Worldwide Contacts

For technical support or sales inquiries, please visit us at www.thorlabs.com/contact for our most up-to-date contact information.



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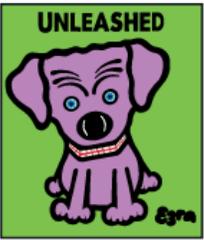
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