PDAPC8
Ge Switchable Gain Photodetector, OEM Package

User Guide



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Chapter 1 Introduction

1.1 Intended Use

This product is intended to be used to monitor near infrared (NIR) light levels and create an appropriate electrical signal in a laboratory environment. The OEM style PCB is intended to be used in tight places, with the Thorlabs 30mm cage systems, or embedded in user systems.

The photodiode is centered on the 30 mm spacing. These mounting holes can be used for mounting into custom housings and devices. A 10-pin header is provided to supply power, retrieve the detector voltage, and set gain control on switchable gain versions.

1.2 Explanation of Safety Warnings

NOTICE Indicates information considered important, but not hazard-related, such as possible damage to the product.


Shock Warning


ESD Component Caution


The wheelie bin symbol on the product, the accessories or packaging indicates that this device must not be treated as unsorted municipal waste but must be collected separately.

1.3 Description

The PDAPC8 is an amplified, switchable-gain, germanium (Ge) photodetector in an OEM package with an operating wavelength range of 800 to 1800 nm. A DIP switch allows the user to vary the gain in 10 dB steps. A buffered output drives 50 Ω load impedances up to 5 V. The output signal is readable from the MMCX connector. MMCX to BNC cables (Item # CA3339) or MMCX to SMA cables (Item # CA3439) are available for purchase separately. Users can also access the digital pins of the gain switch or the output through an on-board header.

NOTICE This product is ESD sensitive. Take all appropriate precautions to discharge personnel and equipment before making any electrical connections to the unit.

1.4 Technical Data

1.4.1 Specifications

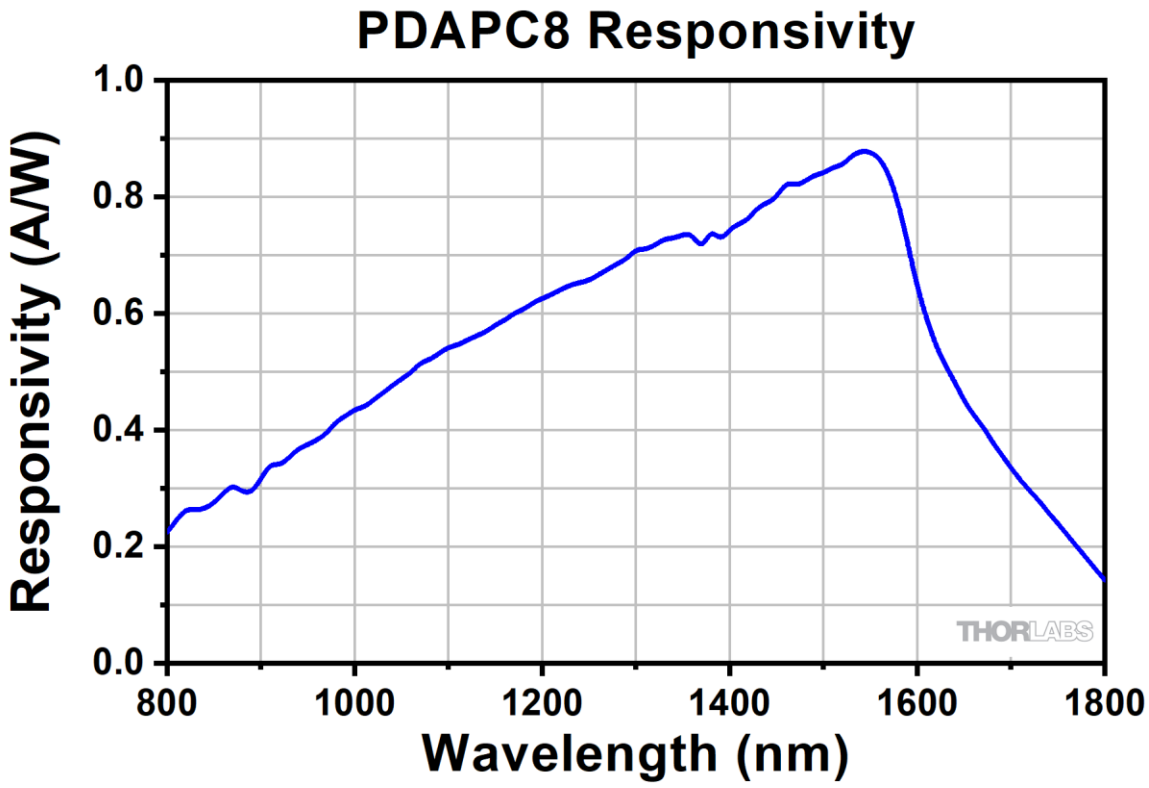
Performance Specifications			
0 dB Setting		**40 dB Setting**	
Gain (Hi-Z)	1.51 x 10^3 V/A ±2%	**Gain (Hi-Z)**	1.51 x 10^5 V/A ±2%
Gain (50 Ω)	0.75 x 10^3 V/A ±2%	**Gain (50 Ω)**	0.75 x 10^5 V/A ±2%
Bandwidth	510 kHz	**Bandwidth**	6.3 kHz
Noise (RMS)	220 µV	**Noise (RMS)**	220 µV
Noise Equivalent Power (@λ_p)	1.76 x 10^{-10} W/√Hz	**Noise Equivalent Power (@λ_p)**	4.63 x 10^{-12} W/√Hz
Offset	±15 mV (Typ.) ±20 mV (Max)	**Offset**	±15 mV (Typ.) ±20 mV (Max)
10 dB Setting		**50 dB Setting**	
Gain (Hi-Z)	4.75 x 10^3 V/A ±2%	**Gain (Hi-Z)**	4.75 x 10^5 V/A ±2%
Gain (50 Ω)	2.38 x 10^3 V/A ±2%	**Gain (50 Ω)**	2.38 x 10^5 V/A ±2%
Bandwidth	270 kHz	**Bandwidth**	2 kHz
Noise (RMS)	233 µV	**Noise (RMS)**	231 µV
Noise Equivalent Power (@λ_p)	8.77 x 10^{-11} W/√Hz	**Noise Equivalent Power (@λ_p)**	4.83 x 10^{-11} W/√Hz
Offset	±15 mV (Typ.) ±20 mV (Max)	**Offset**	±15 mV (Typ.) ±20 mV (Max)
20 dB Setting		**60 dB Setting**	
Gain (Hi-Z)	1.5 x 10^4 V/A ±2%	**Gain (Hi-Z)**	1.5 x 10^6 V/A ±5%
Gain (50 Ω)	0.75 x 10^4 V/A ±2%	**Gain (50 Ω)**	0.75 x 10^6 V/A ±5%
Bandwidth	85 kHz	**Bandwidth**	630 Hz
Noise (RMS)	223 µV	**Noise (RMS)**	247 µV
Noise Equivalent Power (@λ_p)	1.95 x 10^{-11} W/√Hz	**Noise Equivalent Power (@λ_p)**	6.73 x 10^{-12} W/√Hz
Offset	±15 mV (Typ.) ±20 mV (Max)	**Offset**	±15 mV (Typ.) ±20 mV (Max)
30 dB Setting		**70 dB Setting**	
Gain (Hi-Z)	4.75 x 10^4 V/A ±2%	**Gain (Hi-Z)**	4.75 x 10^6 V/A ±5%
Gain (50 Ω)	2.38 x 10^4 V/A ±2%	**Gain (50 Ω)**	2.38 x 10^6 V/A ±5%
Bandwidth	22 kHz	**Bandwidth**	210 Hz
Noise (RMS)	230 µV	**Noise (RMS)**	333 µV
Noise Equivalent Power (@λ_p)	6.41 x 10^{-12} W/√Hz	**Noise Equivalent Power (@λ_p)**	1.04 x 10^{-11} W/√Hz
Offset	±15 mV (Typ.) ±20 mV (Max)	**Offset**	±15 mV (Typ.) ±20 mV (Max)

Electrical Specifications[a]		
Detector	-	Ge
Active Area	-	Ø5.0 mm (19.6 mm^2)
Wavelength Range	λ	800 - 1800 nm
Peak Wavelength (Typical)	λ_p	1550 nm
Peak Response (Typical)	$\Re(\lambda_p)$	0.85 A/W
Max Output Current	I_{OUT}	100 mA
Load Impedance	-	50 Ω to Hi-Z
Gain Adjustment Range	-	0 dB to 70 dB
Gain Steps	-	8 x 10 dB Steps
Output Voltage	V_{OUT}	0 to 5 V (50 Ω) 0 to 10 V (Hi-Z)

a. The PDAPC8 has a 50 Ω series terminator resistor (i.e., in series with the amplifier output). This forms a voltage divider with any load impedance (e.g., 50 Ω load divides signal in half).

General	
PCB Size	1.47" x 1.47" (37.3 mm x 37.3 mm)
Operating Temperature	10 to 40 °C
Storage Temperature	-20 to 70 °C

1.4.2 Graphs



1.4.3 Mechanical Drawing

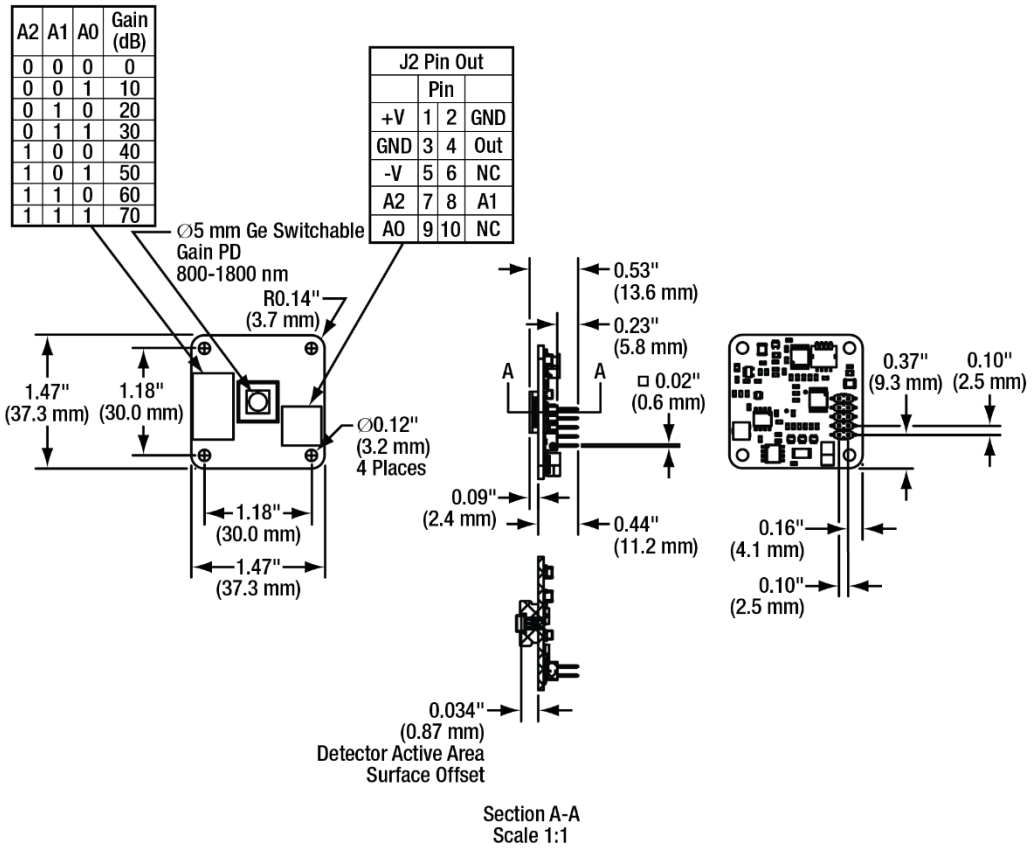


Figure 1 Mechanical Drawing

1.5 Pin Diagrams

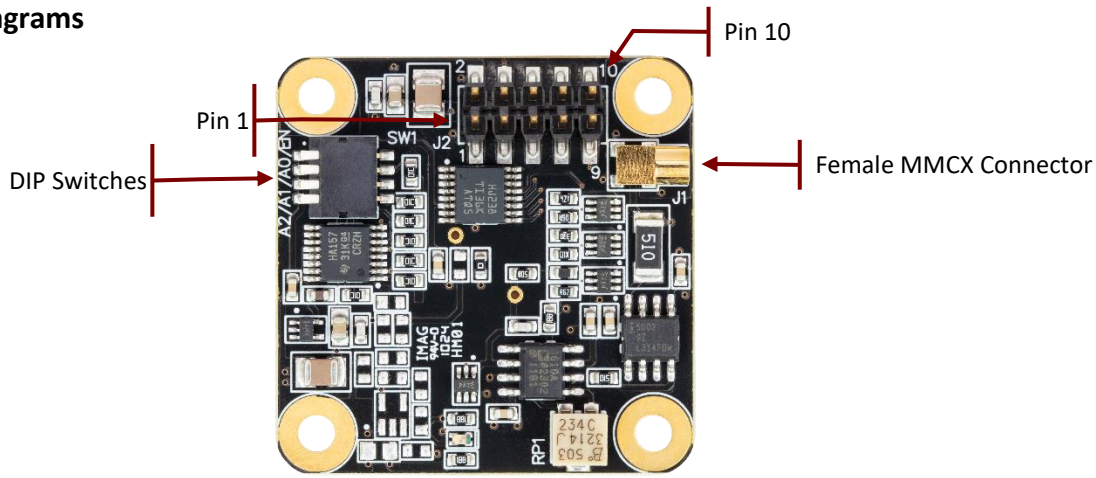


Figure 2 J2 Header

1. The pin out table for the on-board header (J2) is shown in the table below. Connect a power supply to pins 1, 3, and 5 of the J2 header. The required power supply voltages are:

J2 Pin Out[a]			
Pin	**Designation**	**Pin**	**Designation**
1[a]	+12 VDC	**2**	GND
3	GND	**4**	OUTPUT
5[a]	-12 VDC	**6**[b]	NC
7	A2	**8**	A1
9	A0	**10**[b]	NC

a. ±V refers to the power supply positive/negative voltages.

b. No Connection

Gain Switch Table			
A2	**A1**	**A0**	**Gain**
0	0	0	0 dB
0	0	1	10 dB
0	1	0	20 dB
0	1	1	30 dB
0	0	0	40 dB
0	0	1	50 dB
0	1	0	60 dB
0	1	1	70 dB

Chapter 2 Installation

2.1 Installation Instructions

1. Connect a power supply to pins 1, 3, and 5 of the J2 header. The required power supply voltages are:

J2 Pin	Voltage
1	+12 VDC
3	GND
5	-12 VDC

Thorlabs offers the LD1255-SUPPLY as one compatible power supply option. Connection to the board is shown below:

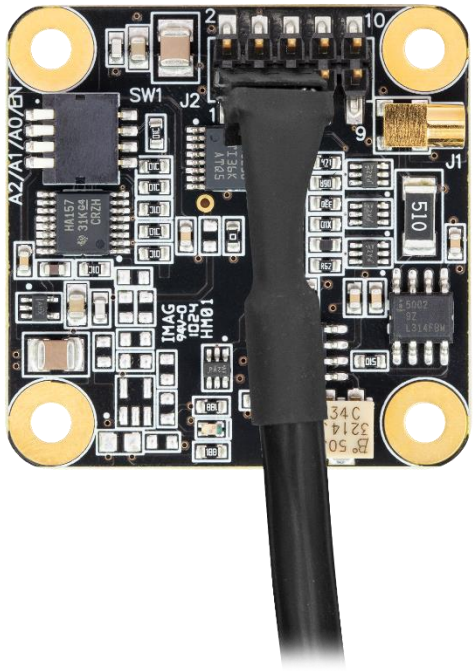


Figure 3 Power Supply Connection

2. Digital gain can be adjusted through the J2 header shown in Figure 1 or using the on-board DIP switch shown below. Each switch is 'Off'/0 when in the up position and 'On'/1 when in the down position.

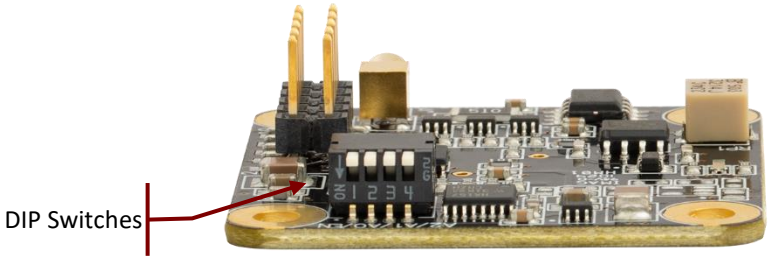


Figure 4 DIP Switches

The following table describes the switch assignment:

Switch Number	Function
1	Enable
2	A1
3	A1
4	A2

To enable the DIP switch settings, set switch #1 to 'On'/1. See the table on page 3 for the corresponding gain settings.

NOTICE

The default DIP switch settings are all in the 'Off'/0 position and in this position the J2 header can be used to set the gain. When the DIP switches are enabled, they will override settings from the J2 header.

3. The side adjusted potentiometer is used to adjust the voltage output offset at high gain settings (e.g. 70 dB). This part is factory pre-adjusted so normally the user does not need to adjust it. However, if the output offset value has fallen out of spec, thermal drift for example, then it is possible to adjust it by turning this potentiometer. Turning the screw head clockwise decreases the offset voltage and turning the screw head counter clockwise increases it.

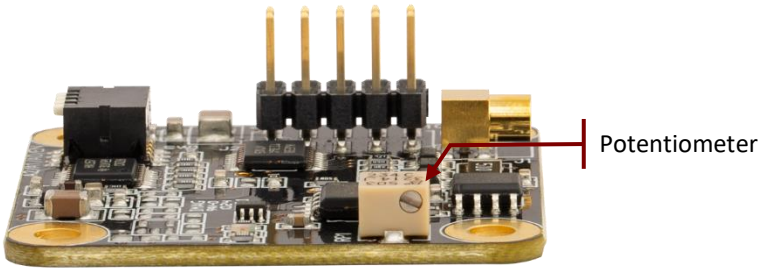


Figure 5 Potentiometer

4. Attach a 50 Ω coax cable to the MMCX output of the PDAPC8 detector. Thorlabs offers two suitable cable options, the CA3339 MMCX to BNC cable or the CA3439 MMCX to SMA cable. When running cable lengths longer than 12", Thorlabs recommends terminating the opposite end of the coax with a 50 Ω resistor for optimal performance. Thorlabs Item # T4119 is suitable for this purpose. Connect the remaining end to a measurement devise such as an oscilloscope or high-speed DAQ card.

NOTICE

Many high speed oscilloscopes have input impedances of 50 Ω. In this case, do not install a 50 Ω terminator. The combined loads will equal 25 Ω which could allow ~135 mA of output current. This will damage the output driver of the PDA.

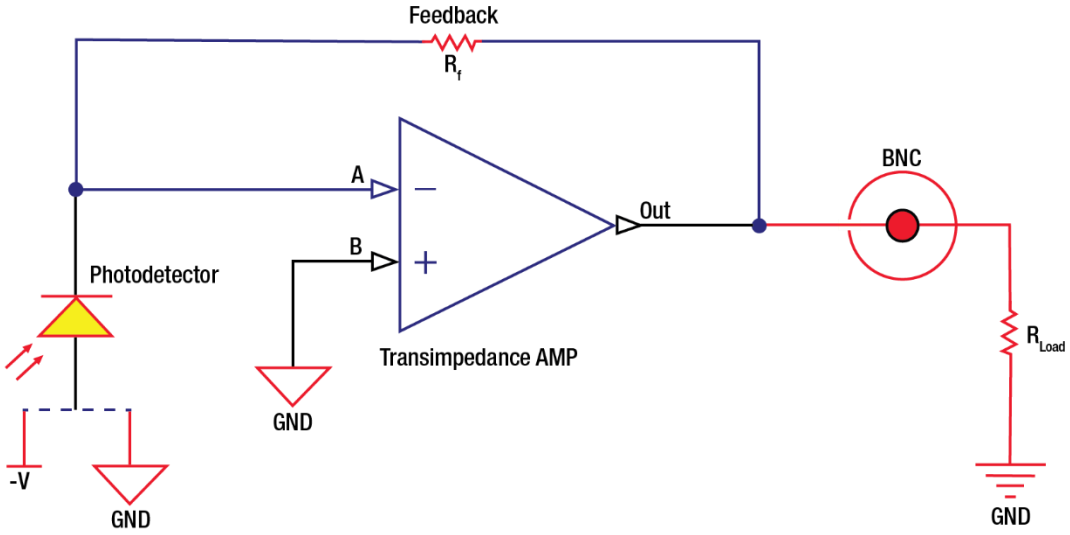
5. Power the PDAPC8 on. When the unit is on, the power indicator LED will be illuminated yellow. If the LED is green or red, this indicates one power rail, either positive or negative, respectively, is connected. In that case, the user would need to check the power inputs to make sure both power rails are on and connected correctly.
6. Apply a light source to the detector.

7. During alignment, the user should take appropriate precautions. For example, ensuring the incident power is within safe operating power. Additionally, the user should have proper eye and skin protection as recommended by the light source manufacturer.

Chapter 3 Operation

3.1 Theory of Operation

Thorlabs PDA series are ideal for measuring both pulsed and CW light sources. The PDAPC8 includes a reverse-biased PIN photodiode, mated to a fixed gain transimpedance amplifier.



3.2 Responsivity

The responsivity of a photodiode can be defined as a ratio of generated photocurrent (IPD) to the incident light power (P) at a given wavelength:

$$R(\lambda) = \frac{I_{PD}}{P}$$

3.3 Dark Current

Dark current is leakage current which flows when a bias voltage is applied to a photodiode. The PDA with Transimpedance Amplifier does control the dark current flowing out. Looking at the figure above, it can be noted that Point B is held at ground and the amplifier will try to hold point A to “Virtual Ground”. This minimizes the effects of dark current present in the system.

The dark current present is also affected by the photodiode material and the size of the active area. Silicon devices generally produce low dark current compared to germanium devices which have high dark currents. The table below lists several photodiode materials and their relative dark currents, speeds, sensitivity, and costs. Please note that sensitivity values in the table are typical values; Thorlabs offers photodetectors with sensitivity ranges that vary from those shown below.

Material	Dark Current	Speed	Sensitivity (nm)[1]	Cost
Silicon (Si)	Low	High	400 - 1000	Low
Germanium (Ge)	High	Low	900 - 1600	Low
Gallium Phosphide (GaP)	Low	High	150 - 550	Med
Indium Gallium Arsenide (InGaAs)	Low	High	800 - 1800	Med
Extended Range: Indium Gallium Arsenide (InGaAs)	High	High	1200 - 2600	High
Lead Sulfide (PbS)	N/A[2]	Low	1000 - 2900	Med
Lead Selenide (PbSe)	N/A[3]	Low	1500 - 4800	Med
Indium Arsenide Antimonide (InAsSb)	N/A[4]	High	1000 - 5300[5]	Med

3.4 Bandwidth and Response

For the PDA detectors, the gain of the detector is dependent on the feedback element (R_f). The bandwidth of the detector can be calculated using the following:

$$f(-3dB) = \sqrt{\frac{GBP}{4\pi R_f \times C_D}}$$

where GBP is the amplifier gain bandwidth product and C_D is the sum of the photodiode junction capacitance and the amplifier capacitance.

3.5 Terminating Resistance

The maximum output of the PDAPC8 is 10 V for high impedance loads (i.e. R_{Load} > 5 kΩ) and 5 V for 50 Ω loads. Adjust the gain so that the measured signal level out of the PDAPC8 is below 10 V (5 V with a 50 Ω load) to avoid saturation.

For low terminating resistors, <5 kΩ or 1% error, an additional factor needs to be considered. The output of the PDA includes a 50 Ω series resistor (R_s). The output load creates a voltage divider with the 50 Ω series resistor as follows:

$$Scale\ Factor\ = \frac{R_{Load}}{R_{Load} + R_s}$$

$$V_{OUT}\ =\ \mathcal{R}(\lambda) * Transimpedance\ Gain * Scale\ Factor * Input\ Power\ (W)$$

Note that we already include the scale factor in our specification for the gain at 50 Ω. Refer to the table in Chapter 6 for additional performance specifications.

[1] *Approximate values; actual wavelength values will vary.*
[2] *These are photoconductive detectors, normally AC coupled.*
[3] *These are photoconductive detectors, normally AC coupled.*
[4] *Photovoltaic detectors, generally unbiased.*
[5] *At 25 °C.*

Chapter 4 Troubleshooting and Repair

Problem	Suggested Solutions
There is no signal response.	Verify that the power is switched on and all connections are secure.
	Verify the proper terminating resistor is installed if using a Voltage measurement device.
	Verify that the optical signal wavelength is within the specified wavelength range.
	Verify that the optical signal is illuminating the detector active area.
Output voltage will not increase. **Detector output is skewed.**	Check to make sure the detector is not saturated. Refer to the Output Voltage specification in the table on page 3.

Chapter 5 Disposal



Thorlabs verifies our compliance with the WEEE (Waste Electrical and Electronic Equipment) directive of the European Community and the corresponding national laws. Accordingly, all end users in the EC may return “end of life” Annex I category electrical and electronic equipment sold after August 13, 2005 to Thorlabs, without incurring disposal charges. Eligible units are marked with the crossed out “wheelie bin” logo (see right), were sold to and are currently owned by a company or institute within the EC and are not dissembled or contaminated. Contact Thorlabs for more information. Waste treatment is your own responsibility. “End of life” units must be returned to Thorlabs or handed to a company specializing in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site. It is the user’s responsibility to delete all private data stored on the device prior to disposal.

Chapter 6 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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