PDA10PT(-EC) Amplified InAsSb Detector

User Guide

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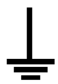
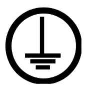
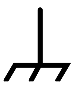
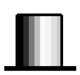
Chapter 1 Warning Symbol Definitions

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 Description

The PDA10PT is an amplified, thermoelectrically cooled, switchable-gain, switchable-bandwidth, InAsSb photoconductive detector. The detector is AC coupled and requires a chopped or pulsed input source. It is sensitive over a wavelength range from 1.0 to 5.8 µm. Two eight-position rotary switches allow the user to vary the gain in 6 dB steps and select low-pass filter bandwidth settings from 12.5 kHz to 1600 kHz. A buffered output drives 50 Ω load impedances up to 5 V.

The detector is mounted on a thermoelectric cooler and factory set to cool the detector to -30 °C with a thermistor providing feedback to maintain a constant temperature. This cooling provides higher detectivity (D*), which results in a lower offset at the output and allows higher gains. It also reduces thermally generated noise. The housing is used as a heat sink and includes a fan to increase the cooling capacity. It is important to note that the cooling fan will keep the heat sink at room temperature. Without it, the heat sink will warm up, causing a higher temperature drop from the heat sink to the detector element, resulting in larger TEC currents. Without the fan, the TEC current will operate at its limit (~820 mA) and the detector element will no longer be temperature stabilized. Offsets will increase and fluctuate, and output noise will increase. For best results do not block, limit airflow to, or stop the cooling fan.

The detector housing has an internally SM1-threaded (1.035"-40) mounting aperture around the diode, which is compatible with any SM1-threaded accessory. The device ships with a SM1RR Retaining Ring allowing convenient mounting of optics, light filters, apertures, etc. The SM1-threaded mount can be easily integrated into our cage and lens tube systems.

The PDA10PT has two 8-32 (M4) tapped holes for mounting the detector on a Ø1/2" optical post in one of two perpendicular directions. The detector includes a 100 - 240 V, 47 - 63 Hz power supply.

Chapter 3 Setup

> **CAUTION**
>
> **Mount the unit in a position that does not block airflow to the fan and heat sink.**

Figure 1 Electrical Connections

1. Unpack the detector head.
2. (*Optional*) Install a Thorlabs Ø1/2" diameter TR Post (n*ot included*) into one of the 8-32 tapped holes (M4 in -EC version) located on the bottom and side of the head, and mount into a optical post holder (sold separately).
3. Connect the 4-pin power supply plug into the power receptacle on the PDA10PT.
4. Plug the power supply into a 47 - 63 Hz, 100 - 240 VAC outlet.
5. Attach a 50 Ω BNC cable to the output of the PDA. When running cable lengths longer than 12", we recommend terminating the opposite end of the coax with a 50 Ω resistor (Thorlabs T4119 BNC in-line terminator) for maximum performance. Connect the remaining end to a measurement device such as an oscilloscope or high-speed DAQ card.

> **CAUTION**
>
> **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 PDA10PT.**

6. Turn on the PDA10PT using the power switch located on the top side of the detector.
7. Install any desired filters, optics, adapters, or fiber adapters to the input aperture.

CAUTION

The PDA10PT was designed to allow maximum accessibility to the photodetector by having the front surface of the diode flush with the outside of the PDA housing. When using fiber adapters, make sure that the fiber ferrule does not crash into the detector. Failure to do so may cause damage to the diode and/or the fiber. Installing an SM1RR Retaining Ring (included) inside the 1" threaded coupler *before* installing the fiber adapter will prevent damage.

8. Apply a light source to the detector. Adjust the gain to the desired setting.

CAUTION

Saturation of the output signal may cause damage to the InAsSb detector element.

Note: Allow a minute for the TEC controller to stabilize the temperature. For best results, allow the unit to warm up for about 30 minutes.

Chapter 4 Operation

This device is a photovoltaic detector and requires a chopped or pulsed input source with a wavelength range from 1.0 to 5.8 µm. The AC-coupled amplifier circuit is designed to minimize noise.

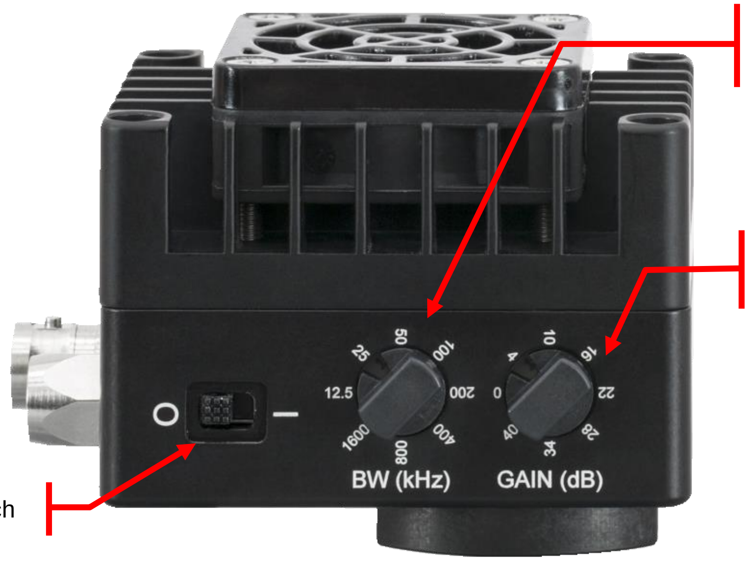


Figure 2 Gain Control, LPF Control, and Power Selector

4.1. Output

The maximum output of the PDA10PT is 10 V for high impedance loads (i.e. $R_{LOAD} \geq 5$ kΩ) and 5 V for 50 Ω loads. Adjust the gain so that the measured signal level out of the PDA10PT is below 10 V (5 V for a 50 Ω load) to avoid saturation. If necessary, use external neutral density filters to reduce the input light level. The BNC output signal is buffered with an amplifier capable of driving 50 Ω loads. A 50 Ω series resistor is included on the output to impedance match a 50 Ω coax cable. For best performance, we recommend operating the PDA10PT with a 50 Ω terminating load located at the end of the coax cable. While this is not necessary, it eliminates ringing and distortion due to impedance mismatches.

4.2. Gain Adjustment

The PDA10PT includes a low-noise, low-offset, high-gain amplifier that allows gain adjustment over a 40 dB range. The gain is adjusted by rotating the gain control knob located on the side of the unit. There are 8 gain positions incremented in 6 dB steps. To adjust the gain, follow the steps below.

1) Set the Gain Switch to 0 dB.
2) Turn on the light source.
3) Adjust the gain setting so the output of the detector is below the saturation level as indicated by section 4.1 above.

4.3. Bandwidth Filter Adjustment

The PDA10PT also includes an adjustable low-pass filter with settings from 12.5 kHz to 1600 kHz in 8 steps. This filter allows the user to optimize the PDA10PT to operate at the lowest amount of high-frequency optical and electrical noise. The filter is adjusted by rotating the filter control knob, located on the side of the unit. To adjust the filter, follow the steps below:

1) Determine the maximum bandwidth required.
2) Set the filter bandwidth switch setting just above the desired bandwidth.

Note that the system signal bandwidth is 800 KHz. The 1600 KHz setting is provided to eliminate high-frequency noise introduced above this limit.

4.4. Thermoelectric Cooler

The thermoelectric cooler built into the detector is factory set to cool the detector to -30 °C with a thermistor providing feedback to maintain a constant temperature. The housing is used as a heat sink and includes a fan to increase the cooling capacity. It is important to note that the cooling fan will keep the heat sink at room temperature. Without it, the heat sink will warm up, causing a higher temperature drop from the heat sink to the detector element, resulting in larger TEC currents. Without the fan, the TEC current will operate at its limit (~820 mA) and the detector element will no longer be temperature stabilized. Offsets will increase and fluctuate, and output noise will increase. For best results do not block, limit airflow to, or stop the cooling fan. This operation is automatic and requires no input or adjustment by the user.

4.5. Light-to-Current Conversion

The Spectral Responsivity, $\Re(\lambda)$, can be obtained from Figure 6 on page 15 to estimate the amount of output voltage to expect. The light-to-Voltage conversion can be estimated by factoring the wavelength-dependent responsivity of the InAsSb detector with the gain as shown below:

$$\mathrm{V_{out}\,(V)} = \mathrm{Gain}\ {}^{V}\!/_{A} * \Re(\lambda)\ {}^{A}\!/_{W} * \mathrm{Input\ Power\ (W)}$$

For terminators with low resistance, <5 kΩ or 1% error, an additional factor needs to be included in the above formula. As described above, the output includes a 50 Ω series resistor (R_S). The output load creates a voltage divider with the 50 Ω series resistor as follows:

$$\text{Scale Factor} = \frac{R_{LOAD}}{(R_{LOAD} + R_S)}$$

Where R_{LOAD} is the terminating resistor and R_S = 50 Ω. For a standard 50 Ω terminator, the gain will be scaled by ½ as shown below:

$$\text{Scale Factor} = \frac{50\ \Omega}{(50\ \Omega + 50\ \Omega)} = 0.5$$

$$V_{out}\,(V) = Gain\ {}^{V}\!/_{A} * \Re(\lambda)\ {}^{A}\!/_{W} * \mathrm{Input\ Power\ (W)} * Scale\ Factor$$

Where gain is specified in V/A and $\boldsymbol{\Re(\lambda)}$ represents the responsivity in A/W.

Chapter 5 Maintenance

There are no serviceable parts in the PDA10PT detector or power supply. The housing may be cleaned by wiping with a soft damp cloth. The window of the detector should only be cleaned using isopropyl alcohol and optical grade wipes. If you suspect a problem with your PDA10PT, please contact your local Thorlabs technical support office and a member of our support team will be happy to assist you.

Chapter 6 Specifications

General Specifications[1]	
Optical Specifications	
Wavelength Range	1.0 - 5.8 µm
Peak Wavelength (λ_p)	4.9 µm
Peak Response (λ_p)	1.6 A/W (Typ.), 0.8 A/W (Min)
Electrical Specifications	
Gain Adjustment Range	40 dB
Gain Steps	8
Gain Settings (dB)	0, 4, 10, 16, 22, 28, 34, 40
Filter Steps	8
Filter Settings (kHz)	12.5, 25, 50, 100, 200, 400, 800, 1600
Output Voltage[2]	0 - 5 V (50 Ω)
	0 - 10 V (Hi-Z)
Output Impedance	50 Ω
Max Output Current	100 mA
Load Impedance	50 Ω - Hi-Z
Offset[3]	20 mV (Typ.) 45 mV (Max)
Offset Drift (40 dB)	2.7 mV/°C
TEC Temperature	-30 °C
Physical Specifications	
Detector	InAsSb
Active Area	Ø1 mm
Surface Depth	0.12" (3.1 mm)
Output	BNC
Package Size	3" x 2.2" x 2.2" (76.2 mm x 55.9 mm x 55.9 mm)
Weight (Detector / Power Supply)	0.42 lbs / 0.82 lbs (191 g / 372 g)
Power Supply	30 W
Input Power	100 - 240 VAC, 47 - 63 Hz
Storage Temperature	0 to 60 °C
Operating Temperature	0 to 30 °C

[1] *All measurements performed with a 50 Ω load unless stated otherwise. The PDA10PT has a 50 Ω series terminator resistor (i.e., in series with amplifier output). This forms a voltage divider with any load impedance (e.g., 50 Ω load divides signal in half).*
[2] *Saturation of the output voltage may cause damage to the InAsSb detector element.*
[3] *After the temperature has stabilized on all gain steps. Also note that the worst-case offset is on the 40 dB gain step.*

Gain (Hi-Z)[4]		Low-Pass Filter Bandwidth		NEP Values (@ DC - 1.6 MHz)[5]	
0 dB	100 V/A	**1600 k**	1600 kHz	**0 dB**	1.91 x 10^{-9} W/√Hz
4 dB	160 V/A	**800 k**	800 kHz	**4 dB**	1.21 x 10^{-9} W/√Hz
10 dB	320 V/A	**400 k**	400 kHz	**10 dB**	6.24 x 10^{-10} W/√Hz
16 dB	630 V/A	**200 k**	200 kHz	**16 dB**	3.48 x 10^{-10} W/√Hz
22 dB	1260 V/A	**100 k**	100 kHz	**22 dB**	2.27 x 10^{-10} W/√Hz
28 dB	2510 V/A	**50 k**	50 kHz	**28 dB**	1.83 x 10^{-10} W/√Hz
34 dB	5010 V/A	**25 k**	25 kHz	**34 dB**	1.63 x 10^{-10} W/√Hz
40 dB	10000 V/A	**12.5 k**	12.5 kHz	**40 dB**	1.49 x 10^{-10} W/√Hz

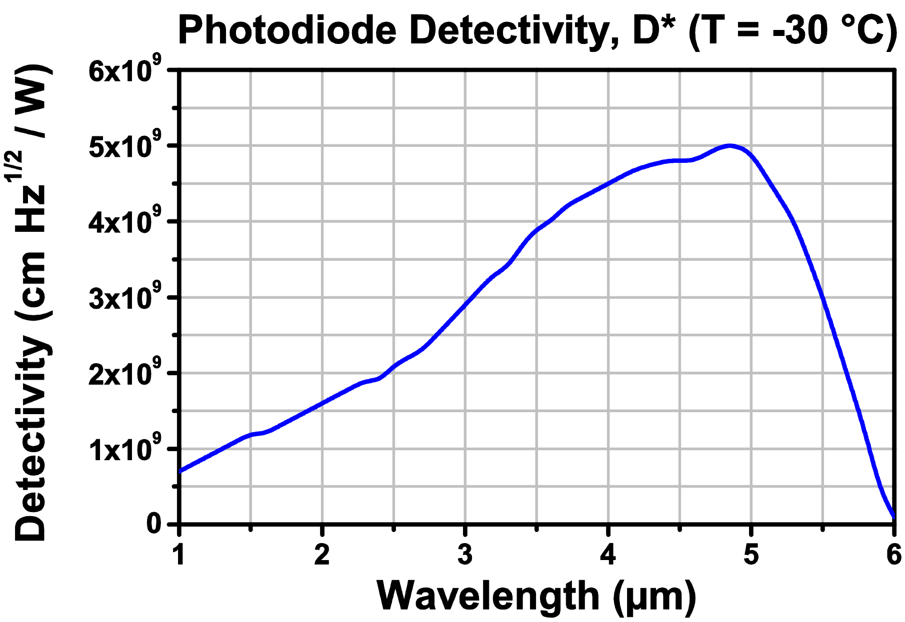


Figure 3 PDA10PT Photodiode Detectivity (D*) at 0 dB Gain Setting

[4] *Gain with a 50 Ω load is one-half the Hi-Z gain.*
[5] *NEP values measured using a 50 Ω load and a low-pass filter setting of 1600 kHz; calculated at the detector's 4.9 µm peak wavelength.*

Detectivity of the Detector (D*) is defined as is defined as:

$$D^* = \frac{\sqrt{A \cdot \Delta f}}{NEP}$$

Where A is the area of the photosensitive region of the detector, Δf is the effective noise bandwidth, and NEP is the noise equivalent power of the photodiode.

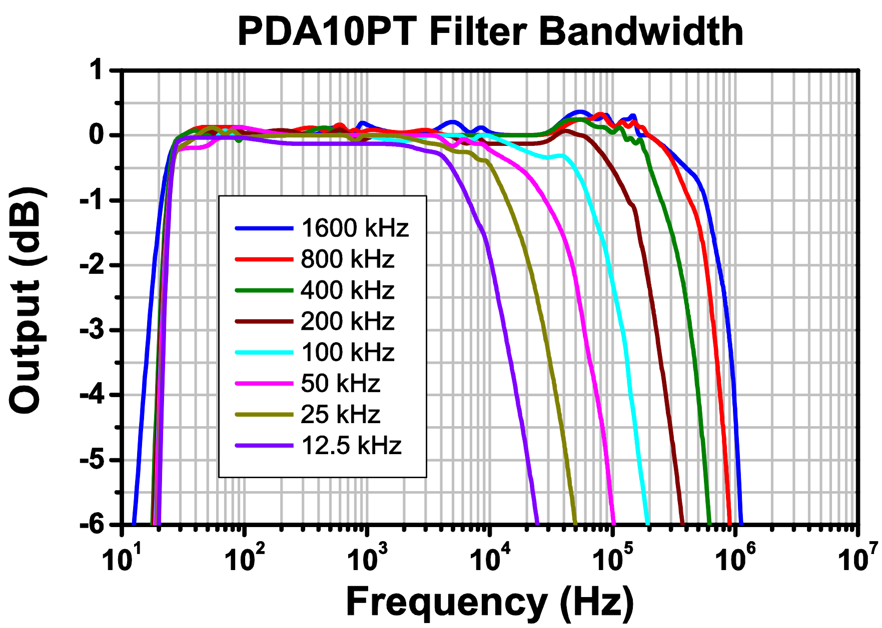


Figure 4 PDA10PT Filter Bandwidth (50 Ω Load)

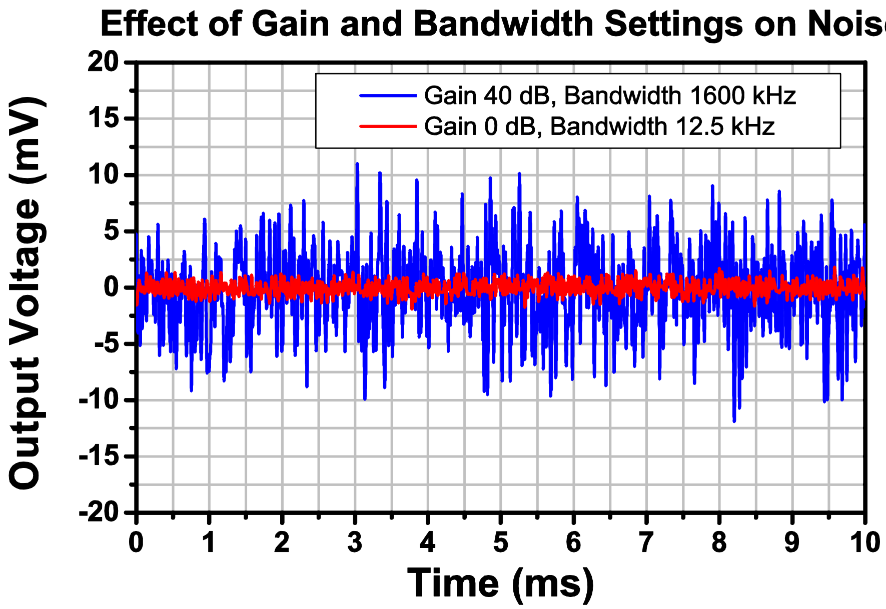


Figure 5 Noise Comparison at Min and Max Gain and Filter Settings

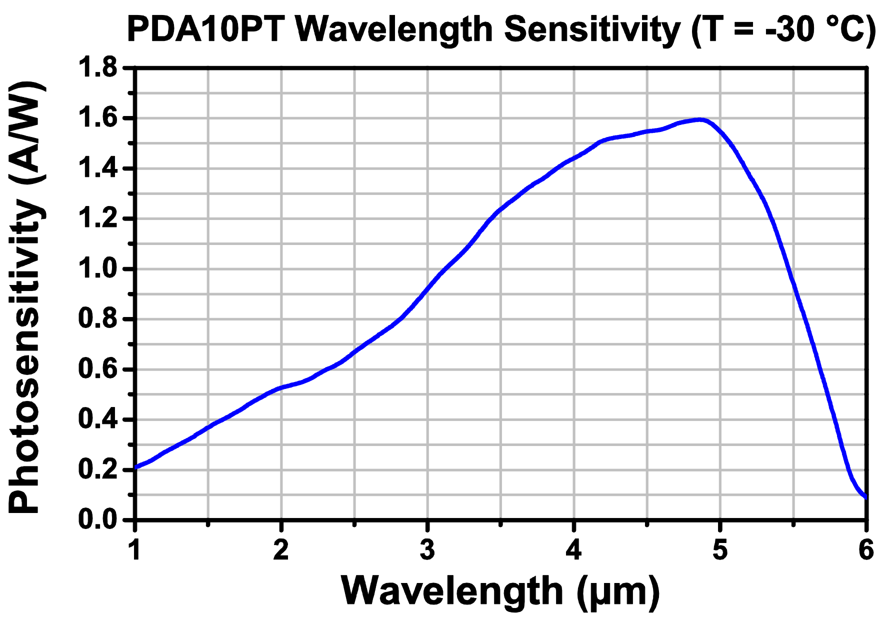
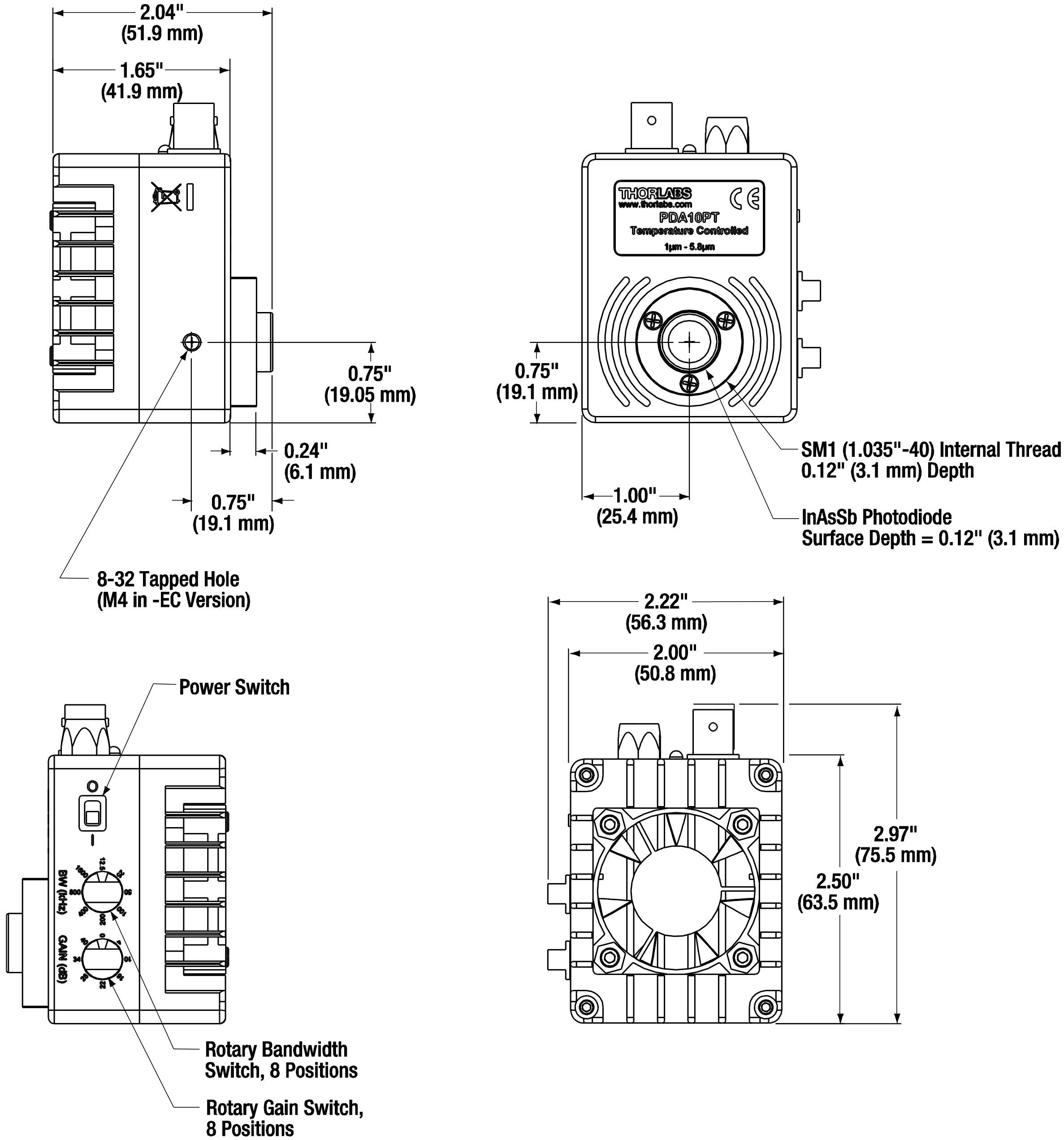


Figure 6 Wavelength Sensitivity of the Detector at 0 dB Gain Setting

Chapter 7 Drawings



Chapter 8 Regulatory

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.

Chapter 9 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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