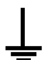
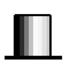
PDA10DT(-EC)
Amplified InGaAs Detector

User Guide

Table of Contents

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 PDA10DT is an amplified, thermoelectrically cooled, switchable-gain, switchable-bandwidth, InGaAs photoconductive detector. The detector is DC coupled. It is sensitive over a wavelength range of 0.9 to 2.57 µm. Two eight-position rotary switches allow the user to vary the gain in 10 dB steps and select low-pass filter bandwidth settings from 500 Hz to 1 MHz. A buffered output drives 50 Ω load impedances up to 5 V. The first two gain steps (0 dB and 10 dB) are biased to -2 V for best high-speed performance while the remaining gain steps are unbiased for high precision measurements.

The detector is mounted on a thermoelectric cooler and factory set to cool the detector to -10 °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 acts 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, which is compatible with any SM1-threaded accessory. The device ships with an 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 PDA10DT(-EC) 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.

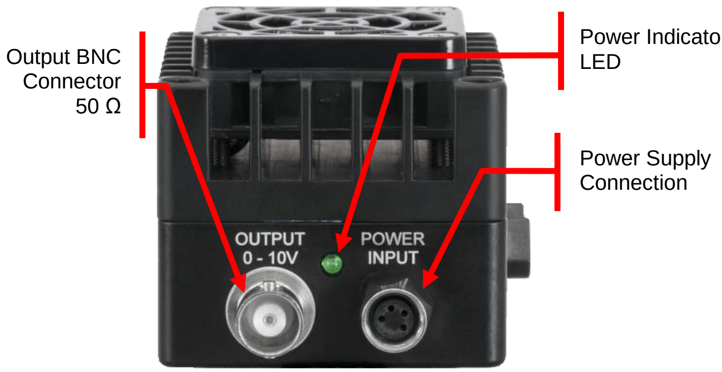


Figure 1 Electrical Connections

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 PH Post Holder *(not included*).
3. Connect the 4-pin power supply plug into the power receptacle on the PDA10DT.
4. Plug the power supply into a 47 to 63 Hz, 100 to 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 PDA10DT.

6. Turn on the PDA10DT 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 PDA10DT 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. **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.

CAUTION

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

Chapter 4 Operation

The PDA10DT is an amplified InGaAs photoconductive detector. The DC-coupled amplifier circuit is designed to minimize noise.

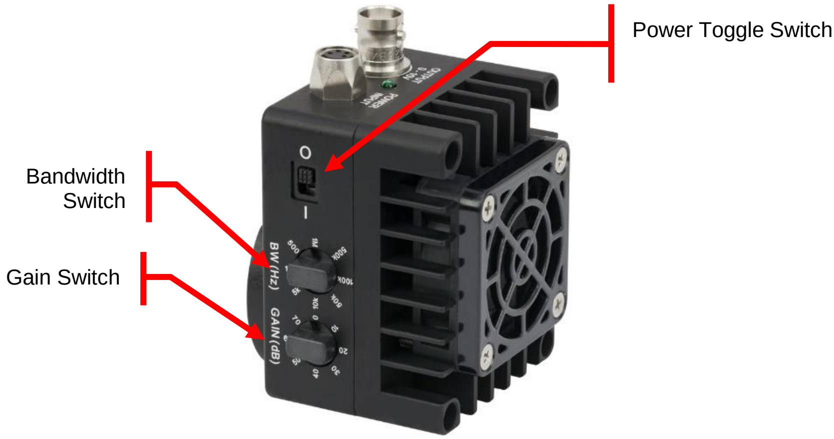


Figure 2 Gain Control, LPF Control, and Power Selector

4.1. Output

The maximum output of the PDA10DT 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 PDA10DT 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 PDA10DT 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 PDA10DT includes a low-noise, low-offset, high-gain amplifier that allows gain adjustment over a 70 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 10 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 making sure the output of the detector is below the saturation level as indicated by section 4.1 above.

4.3. Bandwidth Filter Adjustment

The PDA10DT also includes an adjustable low-pass filter with settings from 500 Hz to 1 MHz in 8 steps. This filter allows the user to optimize the PDA10DT 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.

4.4. Thermoelectric Cooler

The thermoelectric cooler built into the detector is factory set to cool the detector to -10 °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-Voltage Conversion

The Spectral Responsivity, $\Re(\lambda)$, can be obtained Spectral Response Curve 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 InGaAs detector with the gain as shown below:

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

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:

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

Where R_{LOAD} is the terminating resistor and R_S = 50 Ω. For a standard 50 Ω terminator, the gain will be scaled by 0.5 as shown below:

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

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

Chapter 5 Maintenance

There are no serviceable parts in the PDA10DT 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 PDA10DT, please contact your local Thorlabs technical support office and a member of our support team will be happy to assist you.

Chapter 6 Troubleshooting

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
	Ensure, not to block, limit airflow to or stop the cooling fan. It will overheat the devise and it will affect its functionality.
Output Voltage will not increase. **Detector Output is skewed.**	Check to make sure the detector is not saturated. Refer to the Output Voltage spec. in the Specifications table. Install a 1" Lens Tube (SM1L10) to the thread coupler (SM1T1) to baffle any external light sources to see if this improves the response.

Chapter 7 Specifications

Specifications[1]	
Optical Specifications	
Wavelength Range	0.9 - 2.57 µm
Peak Wavelength (λ_p)	2.3 µm
Peak Response (λ_p)	1.3 A/W (Typ.)
Electrical Specifications	
Gain Adjustment Range	70 dB
Gain Steps	8
Gain Settings (dB)	0, 10, 20, 30, 40, 50, 60, 70
Filter Steps	8
Filter Settings (kHz)	0.5, 1, 5, 10, 50, 100, 500, 1000
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 (70 dB)	2.7 mV/°C
TEC Temperature	-10 °C
Bias Voltage	-2 V (0 dB and 10 dB) 0 V (20 dB - 70 dB)

[1] *All measurements performed with a 50 Ω load unless stated otherwise. The PDA10DT 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 InGaAs detector element.*
[3] *After the temperature has stabilized on all gain steps. Also note that the worst case offset is on the 10 dB gain step.*

General Specifications	
Detector	Extended InGaAs PIN
Active Area	0.8 mm^2 (Ø1.0 mm)
Surface Depth	0.08" (2.0 mm)
Output	BNC
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 85 °C
Operating Temperature	0 to 30 °C
Accessories	SM1RR
Optical Head Size	3" x 2.2" x 2.2" (76.2 mm x 55.9 mm x 55.9 mm)
Gain/LPF Switches	8-Pos Rotary
Gain Steps	8 x 10 dB steps
Filter Steps	8
Gain Adjustable Range	70 dB

Gain (Hi-Z)[4]		Low-Pass Filter Bandwidth		NEP (pW/√Hz)[5]	
0 dB	1.51 kV/A	**1M**	1 MHz	**0 dB**	15.9 @ DC - 2 MHz
10 dB	4.75 kV/A	**500k**	500 kHz	**10 dB**	8.27 @ DC - 1.5 MHz
20 dB	15.0 kV/A	**100k**	100 kHz	**20 dB**	2.8 @ DC - 700 kHz
30 dB	47.5 kV/A	**50k**	50 kHz	**30 dB**	1.68 @ DC - 250 kHz
40 dB	151 kV/A	**10k**	10 kHz	**40 dB**	1.33 @ DC - 150 kHz
50 dB	475 kV/A	**5k**	5 kHz	**50 dB**	1.88 @ DC - 20 kHz
60 dB	1500 kV/A	**1k**	1 kHz	**60 dB**	2.22 @ DC - 7 kHz
70 dB	4750 kV/A	**500**	500 Hz	**70 dB**	2.11 @ DC - 2.5 kHz

[4] Gain with a 50 Ω load is one-half the hi-Z gain. All values are ±2%.
[5] NEP values measured using a 50 Ω load and a low-pass filter setting of 1MHz; calculated at the detector's peak responsivity wavelength.

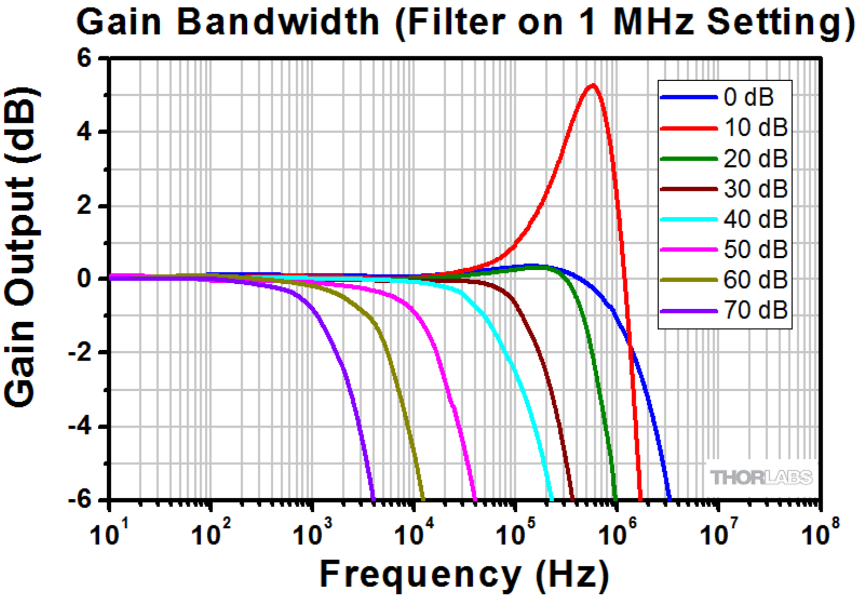


Figure 3 PDA10DT Gain Bandwidth

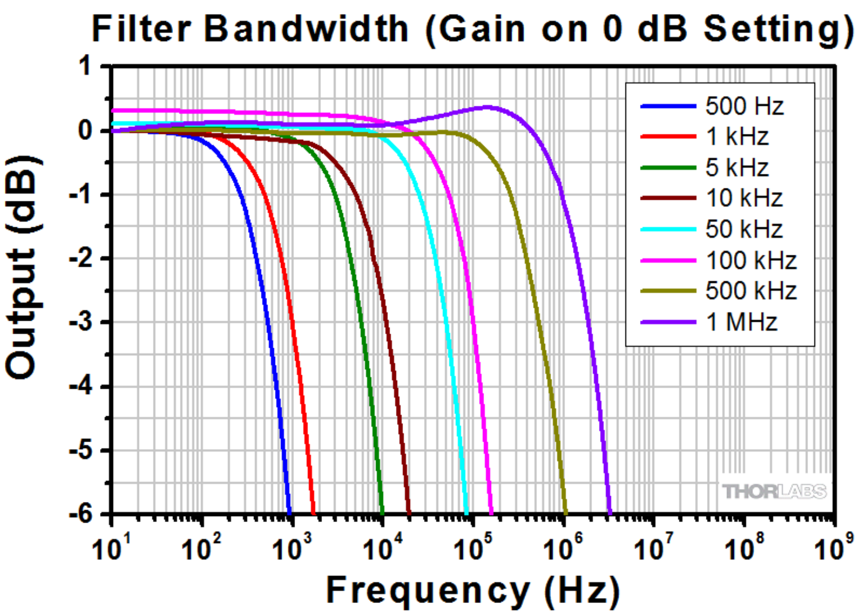


Figure 4 PDA10DT Filter Bandwidth

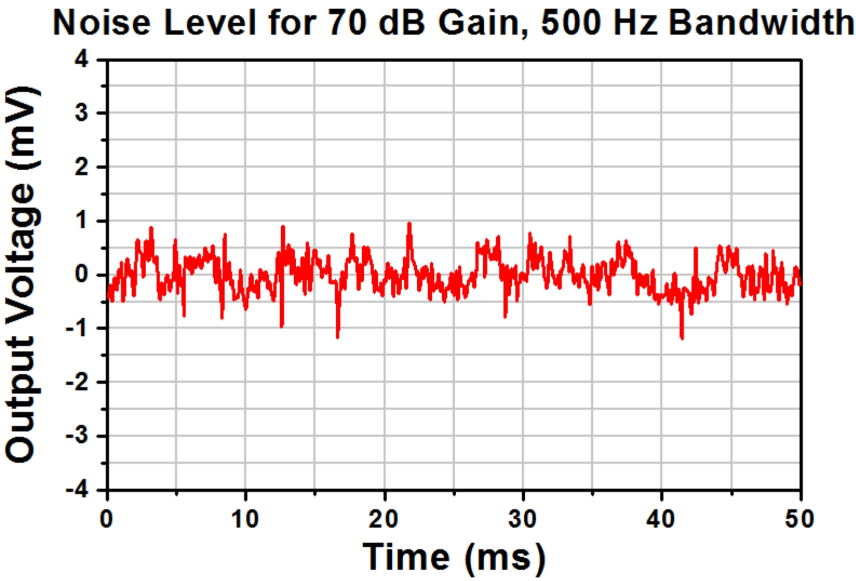
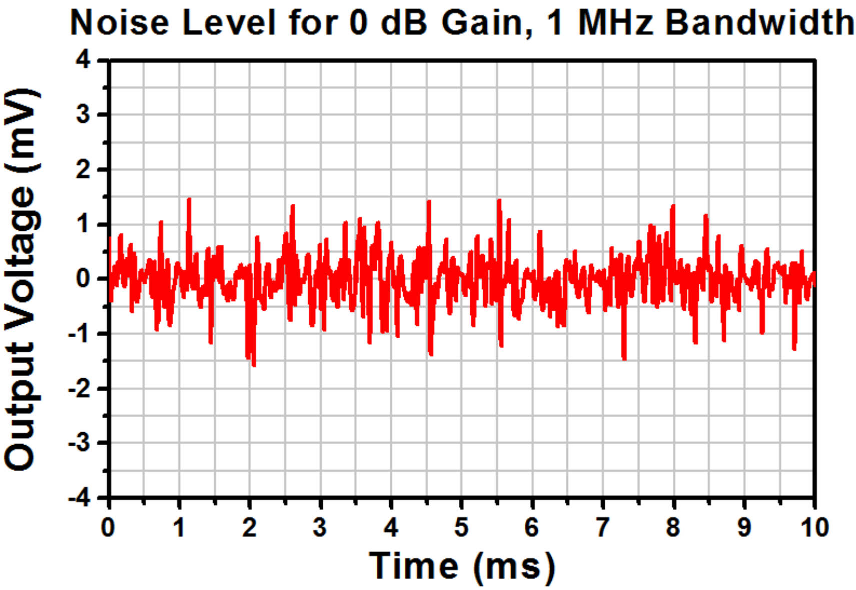


Figure 5 Noise at 70 dB Gain amd 500 Hz Bandwidth



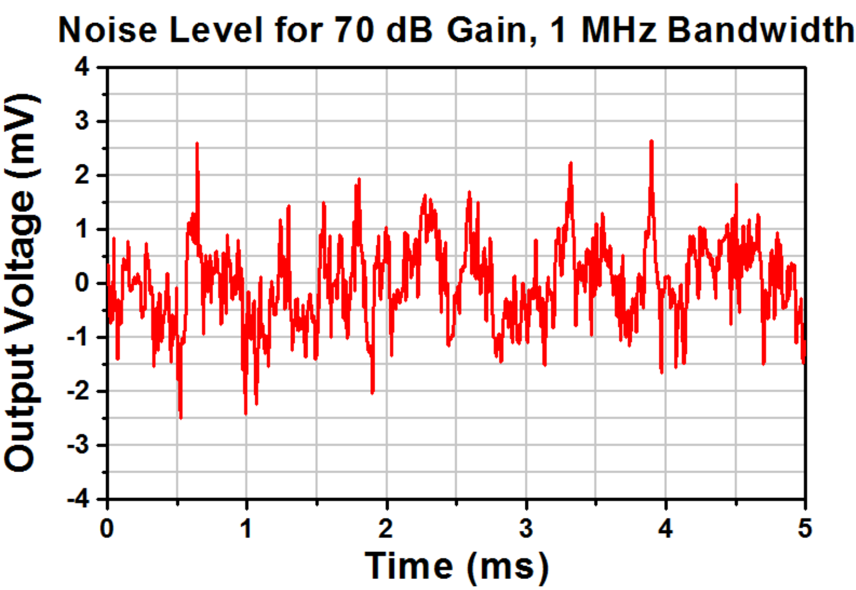


Figure 6 Noise at 0 and 70 dB Gain and 1 MHz Bandwidth

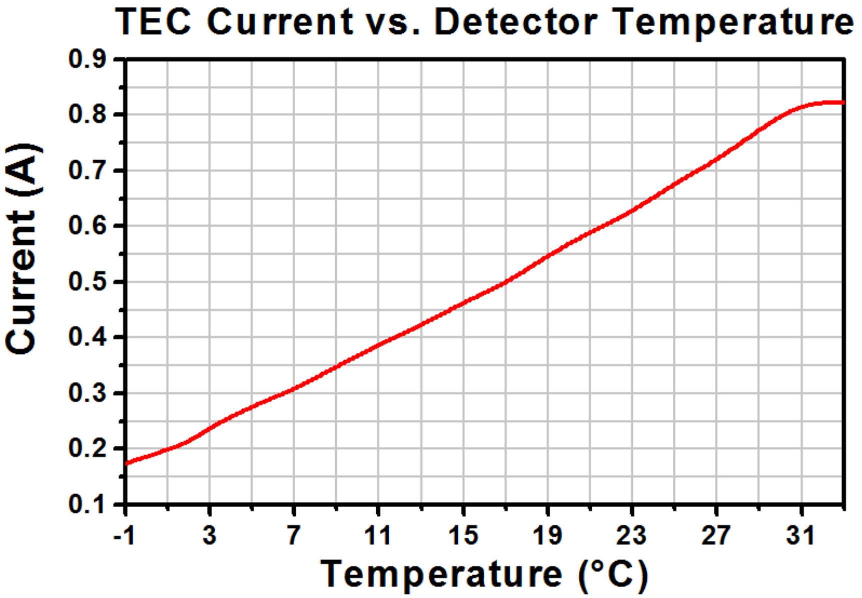


Figure 7 TEC Current vs. Temperature

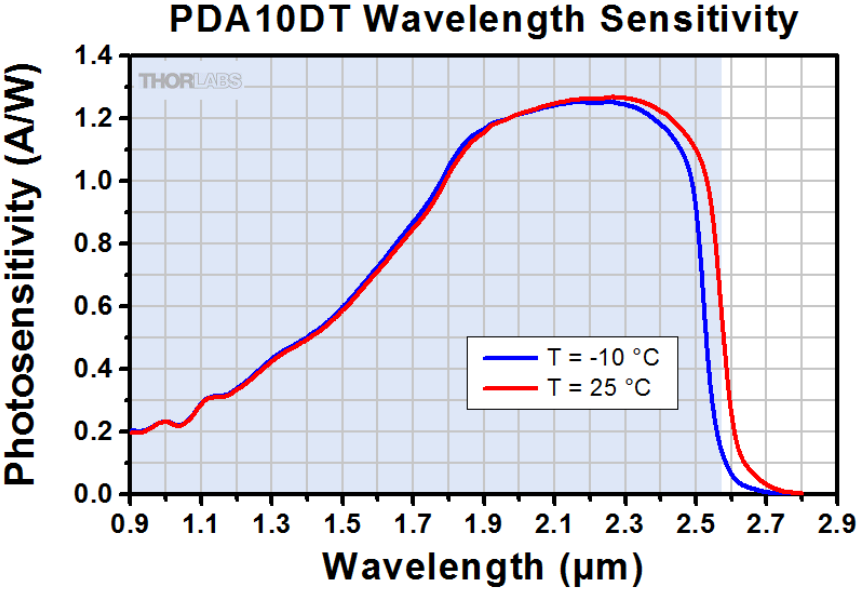
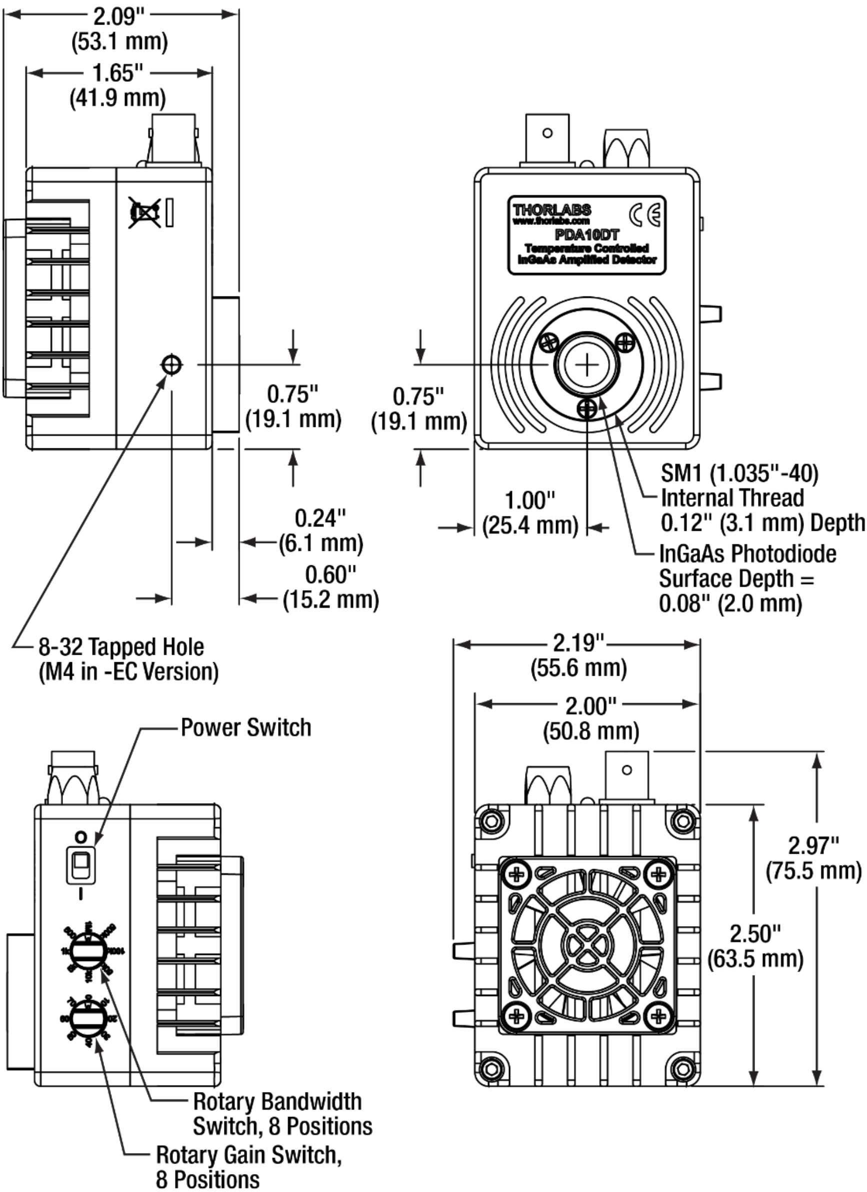


Figure 8 Photosensitivity at -10 °C and 25 °C

Chapter 8 Drawings



Chapter 9 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 10 Certificate of Conformance

Konformitätserklärung
Declaration of Conformity
Déclaration de Conformité

Thorlabs Inc
56 Sparta Ave.
Newton, NJ
USA

erklärt in alleiniger Verantwortung, dass das Produkt:
declares under it's own responsibility, that the product:
declare sous notre seule responsabilité, que le produit:

PDA10JT, PDA10DT and PDA10PT

mit den Anforderungen der Normen
fulfills the requirements of the standard
satisfait aux exigences des normes

2006/95 EC	Low Voltage Directive 12.Dec. 2006
EMC 2004/108/EC	Electromagnetic Compatibility Directive
EN 61010-1:2001	Safety of Test and Measurement Equipment
EN 61326-1:2006	EMC of Test and Measurement Equipment
CISPR 11 Edition 4:2003	Conducted Emissions
CISPR 11 Edition 4:2003	Radiated Emissions
IEC 61000-3-2,	Harmonics
IEC 61000-3-3	Voltage Fluctuation and Flicker
IEC 61000-4-2	Electrostatic Discharge
IEC 61000-4-3	Radiated Immunity
IEC 61000-4-4	Electrical Fast Transient/Burst, Power Leads
IEC 61000-4-4	Electrical Fast Transient/Burst, I/O Leads
IEC 61000-4-5	Surge Immunity, Power Leads
IEC 61000-4-6	Conducted Immunity, Power Leads
IEC 61000-4-6	Conducted Immunity, I/O Leads
IEC 61000-4-11	Voltage Dips, Interrupts and Variations

übereinstimmt und damit den Bedingungen entspricht.
and therefore corresponds to the regulations of the directive.
et répond ainsi aux dispositions de la directive.

Dachau, 10. Mai 2013 ....

Ort und Datum der Ausstellung	Name und Unterschrift des Befugten
Place and date of issue	Name and signature of authorized person
Lieu et date d'établissement	Nom et signature de la personne autorisée

Chapter 11 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.

USA, Canada, and South America
Thorlabs, Inc.
sales@thorlabs.com
techsupport@thorlabs.com

Europe
Thorlabs GmbH
europe@thorlabs.com

France
Thorlabs SAS
sales.fr@thorlabs.com

Japan
Thorlabs Japan, Inc.
sales@thorlabs.jp

UK and Ireland
Thorlabs Ltd.
sales.uk@thorlabs.com
techsupport.uk@thorlabs.com

Scandinavia
Thorlabs Sweden AB
scandinavia@thorlabs.com

Brazil
Thorlabs Vendas de Fotônicos Ltda.
brasil@thorlabs.com

China
Thorlabs China
chinasales@thorlabs.com

THORLABS

www.thorlabs.com