PDB250D

Switchable Gain Free-Space Balanced Detector

User Guide



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Chapter 1 Introduction

The Thorlabs PDB250D Free-Space Balanced Amplified Photodetector consists of two well-matched photodiodes and it generates an output voltage (RF Output) proportional to the difference between the photocurrents in the two photodiodes, i.e. the two optical input signals. The gain of the amplifier can be adjusted in 8 steps over about 2 optical decades.

Additionally, the unit has two fast monitor outputs (MONITOR + and MONITOR -) to measure the individual optical input power level as well as low frequency modulated signals on each photodetector separately. The PDB250D detector slim line housing has two tapped holes with combination threads of 8-32 and M4 x 0.7, for convenient mounting to the optical setup with imperial or metric posts.

The input apertures for free space beams have both external SM1 and internal SM05 threads that are compatible with Thorlabs' SM1- and SM05-threaded accessories. The included SM1T1 lens tube coupler allows mounting of external SM1-threaded accessories (e.g. external optics, filters, apertures, or fiber adapters).

The PDB250D detector is shipped with an external linear power supply LDS12B. For more information on this device, please refer to the operating instructions available on the website.

The PDB250D detector operates from DC up to 1 MHz and features photodiodes with a large active area. AC-coupling is available upon request. These photodiodes show excellent Noise Equivalent Power (NEP) and Common-Mode Rejection Ratio (CMRR).

Please find all safety information and warnings concerning this product in the chapter Safety.

1.1 Intended Use

The PDB250D detector is a free-space balanced amplified photodiode which detects signals from two input light sources and acts as balanced receiver by subtracting the two optical input signals from each other, resulting in the cancellation of common mode noise. The PDB250D detector is used in photonics research and development applications.

The PDB250D detector is designed for laboratory use only. The PDB250D detector may not be used or integrated into equipment that is applied in pharmaceutical, medical or military applications.

Thorlabs, Inc. Life Support and Military Use Application Policy is stated below:

Thorlabs' products are not authorized for use as critical components in life support devices or systems or in any military application without the express written approval of the president of Thorlabs, Inc. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system or to affect its safety or effectiveness.
3. The Thorlabs products described in this document are not intended nor warranted for usage in military applications.

1.2 Explanation of Safety Warnings

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



Warning indicates a hazard with a medium level of risk that, if not avoided, could result in death or serious injury.



Caution indicates a hazard with a low level of risk that, if not avoided, could result in minor or moderate injury.

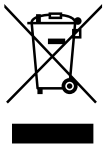


Shock Warning





The CE/UKCA markings on the product are the manufacturer's declaration that the product complies with the essential requirements of the relevant European health, safety, and environmental protection legislation.



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.

1.4 Technical Data

Details about the individual specifications:

- Typical Responsivity (Max) is the peak responsivity $\Re(\lambda)_{MAX}$ of the photodiode.
- Transimpedance Gain [V/A] is the ratio of the output voltage to the photo current:

$$G_{TI} = \frac{U_{RF,OUT}}{I_{PD}}$$

  While the photo current depends on the wavelength, the transimpedance gain is wavelength-independent. The transimpedance gain values are always given for a high impedance load at the RF Output; for 50 Ω loads these values need to be divided by 2.85.
- Conversion Gain [V/W] is the ratio of output voltage to input optical power:

$$G_{CONV} = \frac{U_{RF,OUT}}{P_{IN}} = G_{TI} \; x \; \Re(\lambda)$$

  This formula shows that the conversion gain is dependent on the actual wavelength as well. In the specifications, the conversion gain is given only for the peak responsivity wavelength of the photodiode. The conversion gain values are always given for a high impedance load at the RF Output; for 50 Ω loads these values need to be divided by 2.85.
- Noise Equivalent Power (NEP) is the minimum input optical power to generate a photo current, equal to the RMS noise current in a 1 Hz bandwidth. NEP is essentially the minimum detectable power. It is stated for the PDB250D free-space balanced amplified photodetectors from DC to the RF Output cut frequency.
- Maximum Input Power is the damage threshold of the photodiode.
- Typical Noise Spectra: These spectra were measured using an electrical spectrum analyzer (resolution bandwidth 10 kHz, video bandwidth 1 kHz unless otherwise noted). The inputs of the balanced detectors under test were blocked. The lower curve in the diagram was measured with the same setup and the balanced detectors switched off, i.e., it represents the measurement system's noise floor.
- Monitor Outputs are designed for use with high impedance loads (e.g., high-Z scope input etc.), but can also drive 50 Ω loads. Monitor outputs conversion gain is 10 V/mW, given at the detectors peak responsivity and high impedance load.
- Typical Frequency Response Curves are measured using the setup described in section CMRR and Frequency Response.

1.4.1 Specifications

All technical data are valid at 23 ± 5 °C and 45 ± 15% relative humidity (non-condensing).

Detector	
Detector Type	X-InGaAs/PIN
Optical Inputs	Free-Space
Wavelength Range	900 - 2600 nm
Responsivity @ λ_{Peak}	1.3 A/W (Max) @ 2300 nm
Photodiode Damage Threshold	20 mW
Diameter of Active Detector Area	Ø1 mm
RF Output	
RF Electrical Output	BNC, 100 Ω
Bandwidth (3dB)[a]	DC to 1 MHz
Common Mode Rejection Ratio (CMRR)	30 dB (Typ)
Gain Adjustment Range	42 dB
Gain Steps	8
Transimpedance Gain **High Z Load** **50 Ω Load**	 3750 V/A - 500 x 10^3 V/A 1315 V/A - 175 x 10^3 V/A
Conversion Gain @ Gain = 8, λ_{Peak} **High Z Load** **50 Ω Load**	 650 x 10^3 V/W 225 x 10^3 V/W
Conversion Gain @ Gain = 1, λ_{Peak} **High Z Load** **50 Ω Load**	 4.87 x 10^3 V/W 1.69 x 10^3 V/W
CW Saturation Power @ Gain = 1	2 mW @ 2300 nm
Minimum NEP @ Gain = 8	18 pW/√Hz (DC to 0.3 MHz)
Voltage Swing **High Z Load** **50 Ω Load**	 ±10 V ±2.5 V
MONITOR Outputs	
Electrical Monitor Outputs	BNC, 200 Ω
Outputs Bandwidth (3 dB)	DC - 3 MHz
Output Conversion Gain **High Z Load** **50 Ω Load**	 10 V/mW @ 2300 nm 1.5 V/mW @ 2300 nm
Output Voltage Swing **High Z Load** **50 Ω Load**	 10 V (Max) 1.5 V (Max)
Overall Output Voltage Noise	<1 mV (RMS)
DC Offset	<±5 mV

a. Bandwidth for Gain 1 - 6: 1 MHz, Gain 7: 800 kHz; Gain 8: 500 kHz. AC-coupled PDB250x detectors are available upon request.

General	
Operating Temperature Range[b]	5 °C to 40 °C
Storage Temperature Range	-40 °C to 70 °C
Dimensions (W x H x D)[c]	88.2 mm x 65.3 mm x 21.1 mm (3.47" x 2.57" x 0.83")
Weight[d]	0.13 kg (0.29 lbs)
Included Power Supply	±12 V @ 250 mA (100/120/230 VAC, 50 - 60 Hz, Switchable)

b. Non-Condensing
c. Minimum Depth with Removed SM1T1 Adapters
d. Weight of the PDB250D detector Excluding all Shipped Accessories

Table 1 Specifications for the PDB250D Free-Space Balanced Amplified Photodetector

1.4.2 Graphs

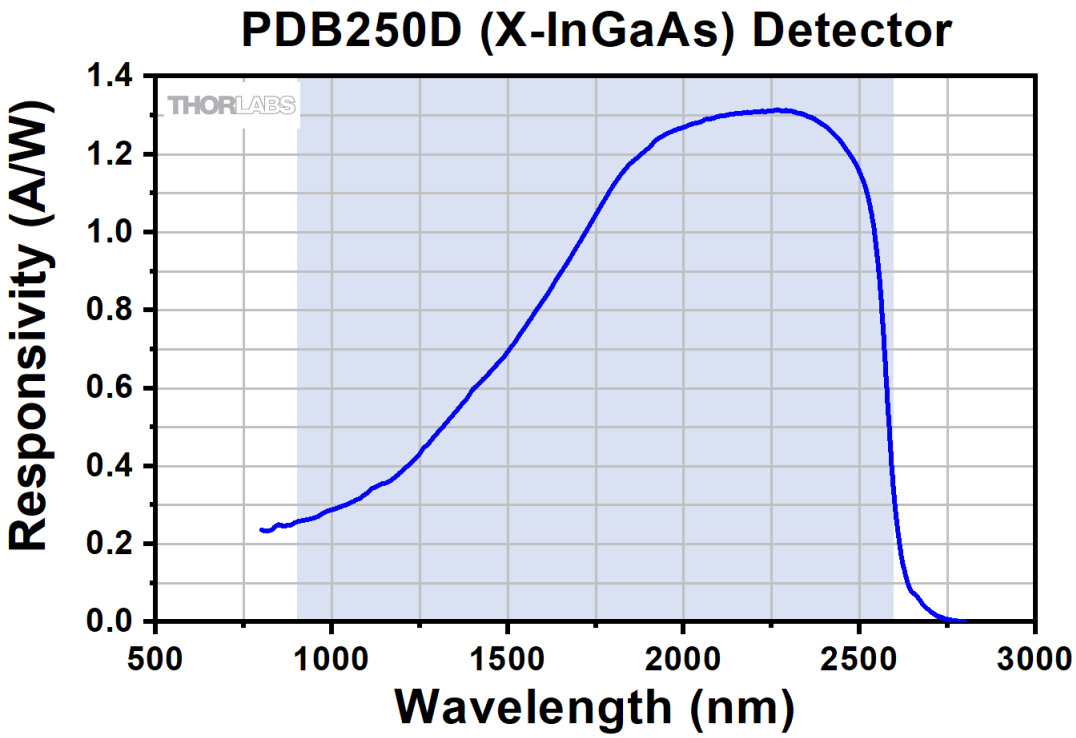


Figure 1 Responsivity of the PDB250D Detector

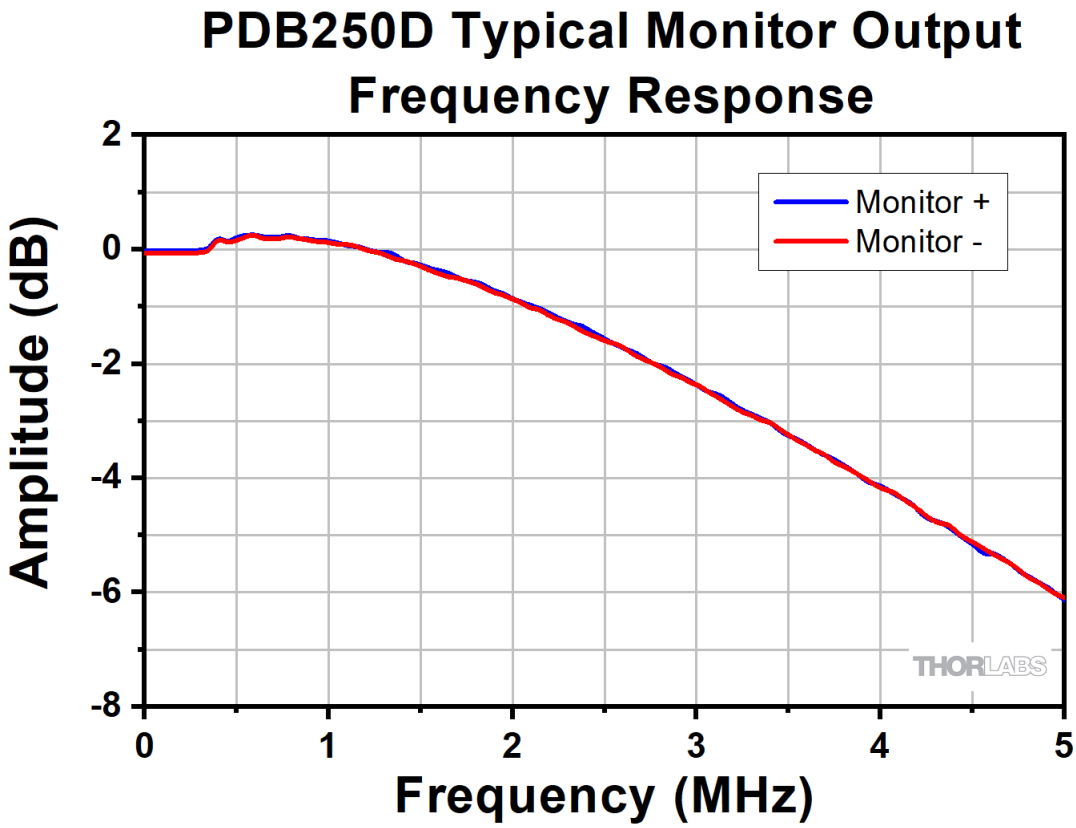


Figure 2 *Typical Monitor Output Frequency Response of the PDB250D Detector*

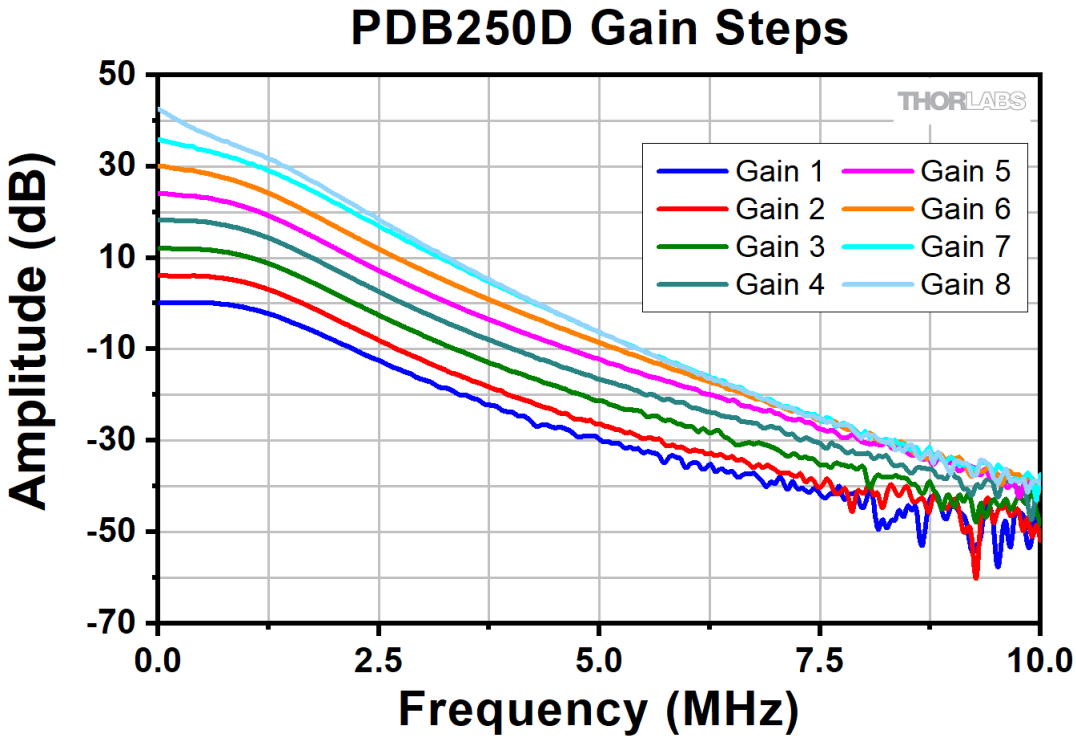


Figure 3 *Gain Steps of the PDB250D Detector*

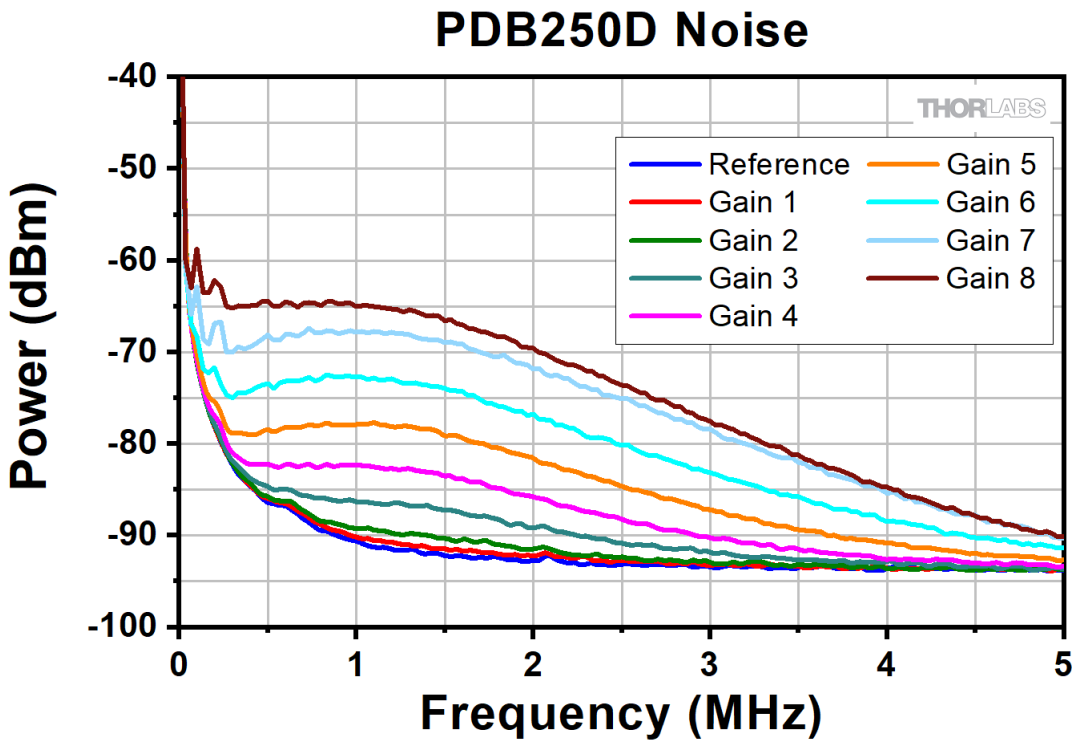


Figure 4 Typical Noise Spectra of the PDB250D Detector

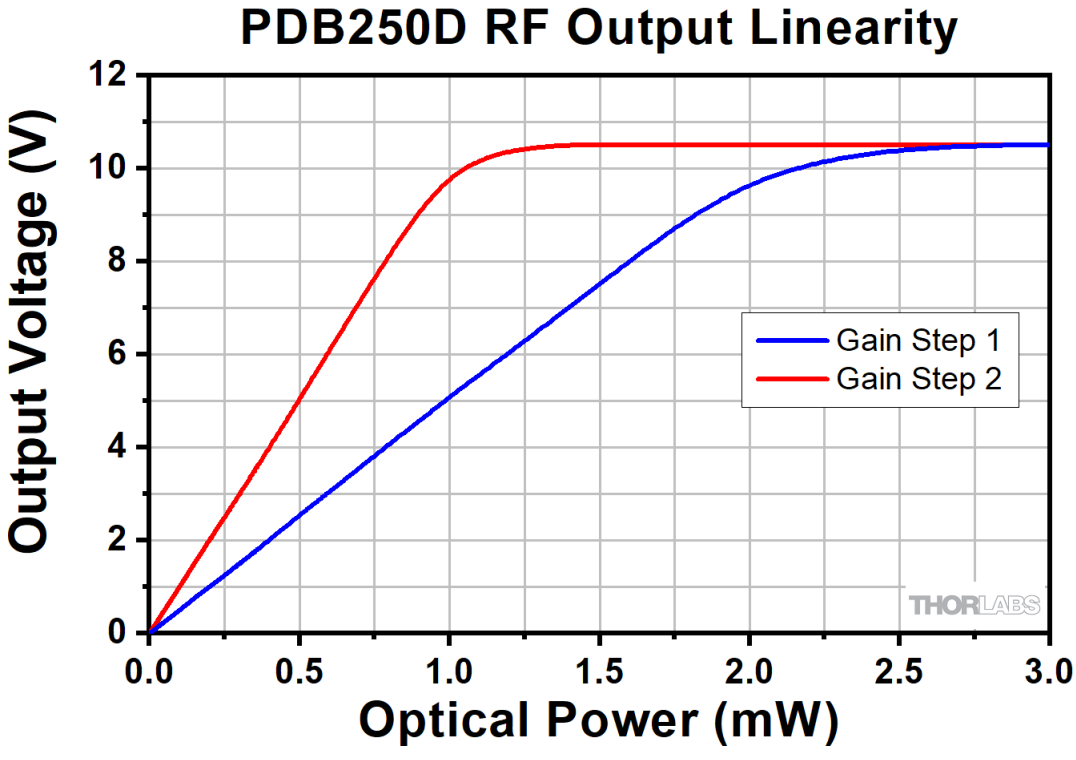


Figure 5 RF Output Linearity of the PDB250D Detector

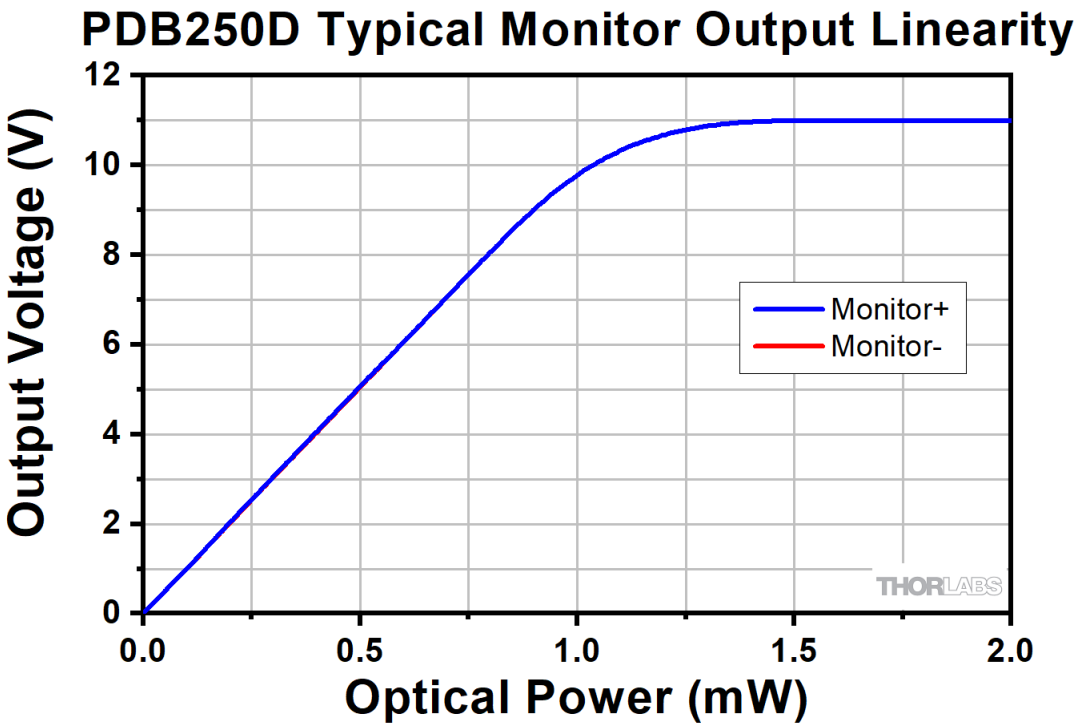


Figure 6 *Typical Monitor Output Linearity of the PDB250D Detector*

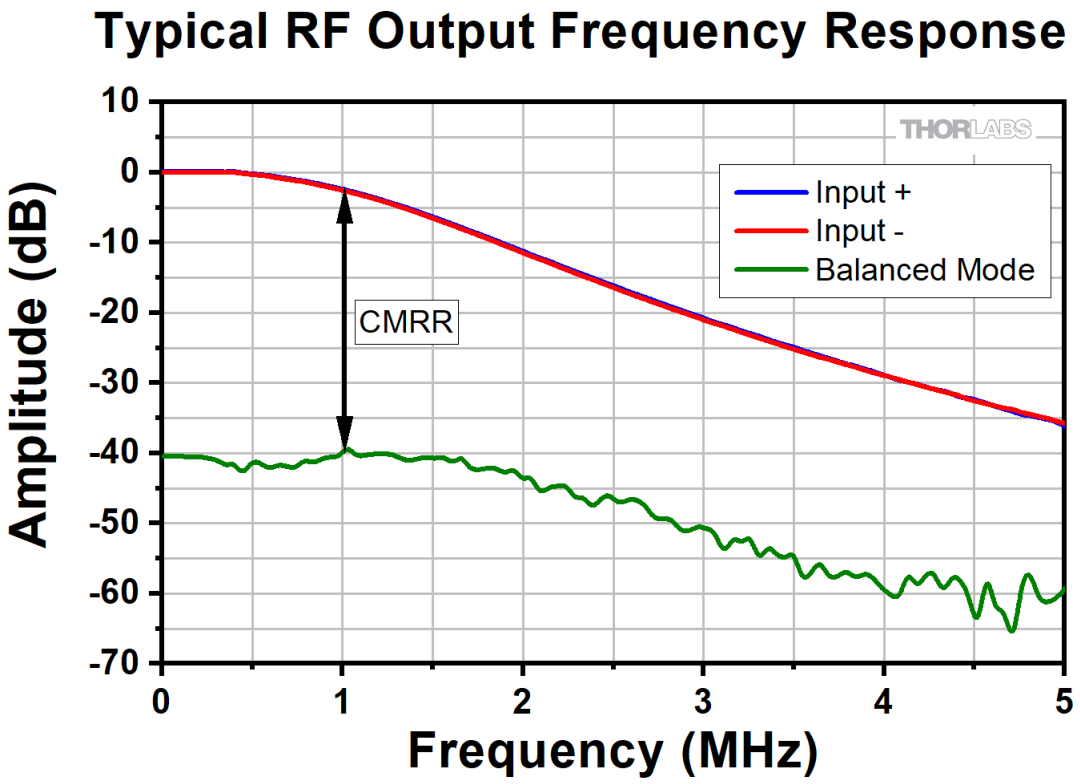


Figure 7 *Typical RF Output Frequency Response of the PDB250D Detector*

1.4.3 Mechanical Drawing

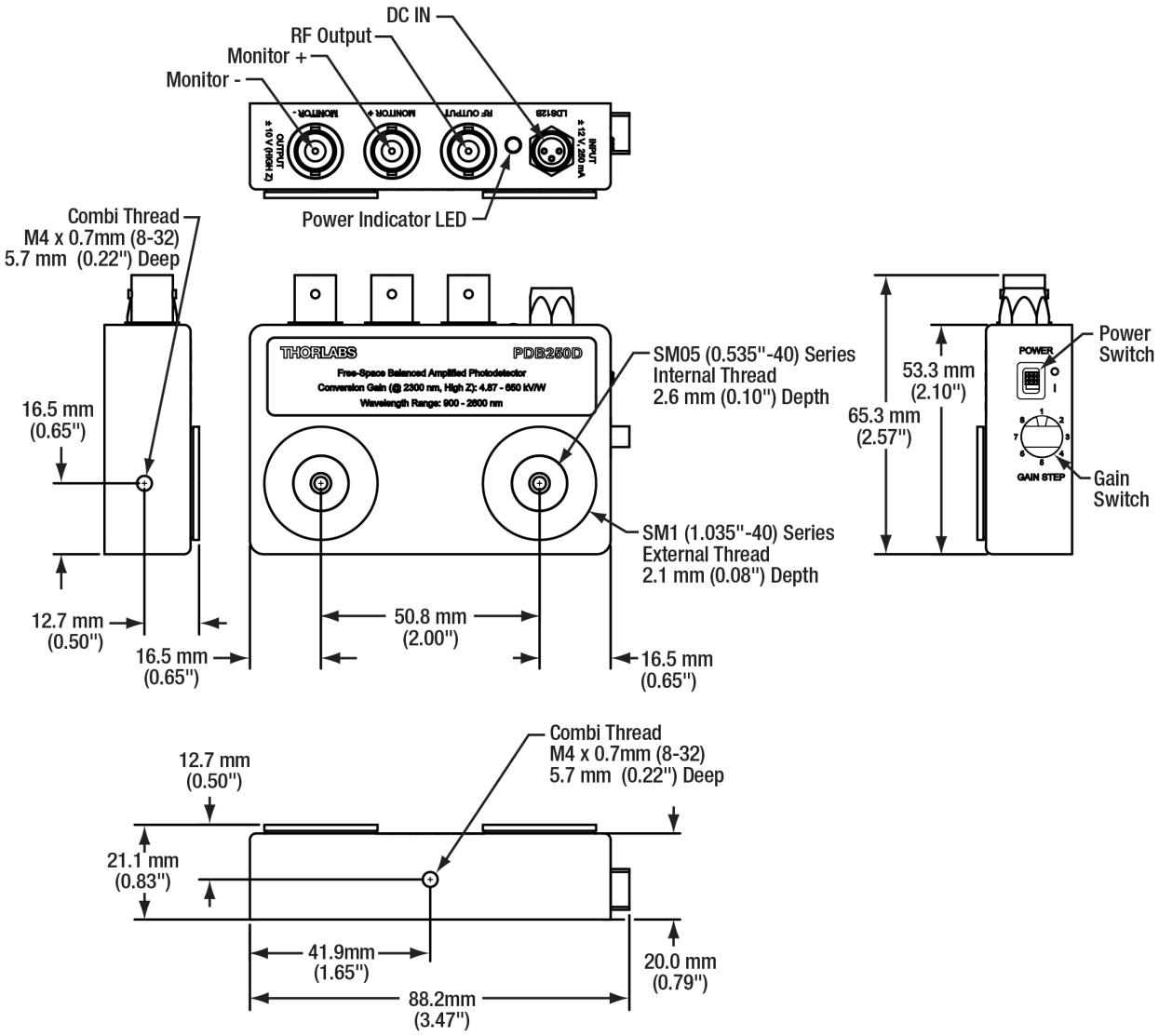


Figure 8 Mechanical Drawing of the PDB250D Detector

1.5 Components

Front Panel



Figure 9 Front Panel of the PDB250D Free-Space Balanced Amplified Photodetector

Front Panel		
Callout	**Feature**	**Description**
1	**Input Aperture -**	Active Detector Area Ø1 mm
2	**Internal Thread**	SM05 (0.535"-40)
3	**External Thread with Adapter**	SM1 (1.035"-40)
4	**Input Aperture +**	Active Detector Area Ø1 mm

Table 2 Components of the PDB250D Free-Space Balanced Amplified Photodetector

Top Panel

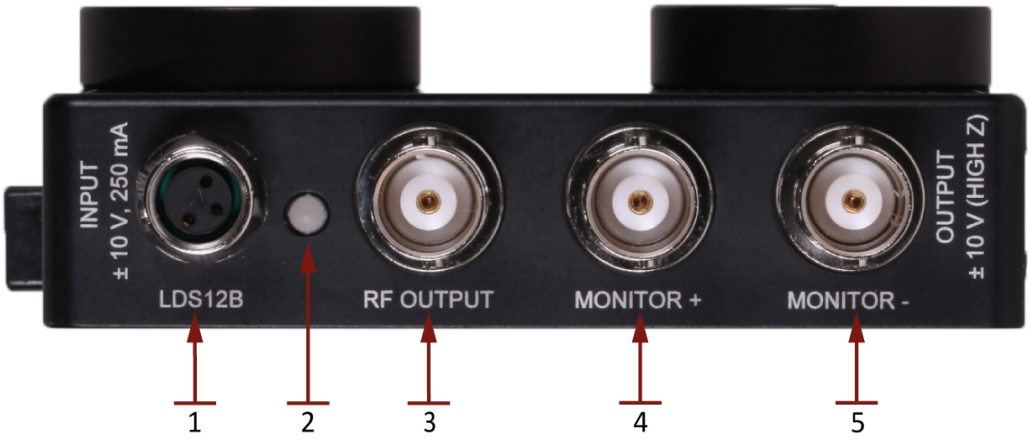


Figure 10 Top Panel of the PDB250D Free-Space Balanced Amplified Photodetector

Top Panel		
Callout	**Feature**	**Description**
1	**DC Input**	Power Supply Connector for Connecting LDS12B Power Supply (Included)
2	**Power Indicator LED**	LED for Indication of Device Power Status
3	**BNC Connector**	RF Output
4	**BNC Connector**	MONITOR +
5	**BNC Connector**	MONITOR -

Table 3 Top Panel of the PDB250D Free-Space Balanced Amplified Photodetector

Side Panel



Figure 11 Side Panel of the PDB250D Free-Space Balanced Amplified Photodetector

Side Panel		
Callout	**Feature**	**Description**
1	Power Switch	Slide Switch for Power On/Off
2	Gain Switch	Switch for Gain Adjustment (8 Steps)

Table 4 Side Panel of the PDB250D Free-Space Balanced Amplified Photodetector

1.6 Simplified Declaration of Conformity

The full text of the EU declaration of conformity is available at the following internet adress:
https://www.thorlabs.com/newgrouppage9.cfm?objectgroup_id=1299

1.7 FCC Designation

The following statement applies to the products covered in this manual, unless otherwise specified herein. The statement for other products will appear in the accompanying documentation.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures: Reorient or relocate the receiving antenna.—Increase the separation between the equipment and receiver.—Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.—Consult the dealer or an experienced radio/TV technician for help.

Chapter 2 Safety

The safety of any system incorporating the equipment is the responsibility of the assembler of the system.

All statements regarding safety of operation and technical data in this instruction manual will only apply when the unit is operated correctly as it was designed for.



WARNING: Risk of Serious Injury and Even Death Due to Electrical Shock

Improper grounding and connecting the power supply to the mains can cause electric shock.

Electric shock results in damage to your health or even death.

Observe the following instructions when applying power to the power supply:

- Make sure that the protective conductor for the 3 conductor mains power cord is correctly connected to the protective earth ground contact of the socket outlet.
- Before connecting the power supply to the mains make sure that the line voltage range marked on the power supply agrees with your local supply.



CAUTION: Risk of Serious Injuries if Used Incorrectly

Pay attention to the following aspects during use:

- Do not remove covers or open the device! There are no user-serviceable parts inside.
- Refer servicing to qualified personnel.
- No changes may be made to the device or components used that were not supplied by Thorlabs without written authorization from Thorlabs.



WARNING: Risk of Serious Injury and Even Death Due to Explosion

The device must not be operated in explosion endangered environments.

Chapter 3 Installation

3.1 Warranty and RMA Information

Thorlabs warrants material and production of the PDB250D detector for a period of 24 months starting with the date of shipment in accordance with and subject to the terms and conditions set forth in Thorlabs' General Terms and Conditions of Sale which can be found at:

General Terms and Conditions:

https://www.thorlabs.com/Images/PDF/LG-PO-001_Thorlabs_terms_and_%20agreements.pdf

and

https://www.thorlabs.com/images/PDF/Terms%20and%20Conditions%20of%20Sales_Thorlabs-GmbH_English.pdf

3.2 Packing List

The following items are included in the PDB250D detector package:

- PDB250D Balanced Amplified Photodetector
- Two SM1T1 Adapters (SM1 Internal Thread)
- Two SM1EC2B Snap-On Plastic Dust Caps for Input Aperture (Replacements Sold in Packs of Five)
- Power Supply LDS12B (±12 V, 250 mA), Switchable to 100 V, 120 V, or 230 V Line Voltage
- Printed Quick Reference

3.3 Unpacking Instructions

Please inspect the shipping container for damage. Please do not cut through the cardboard, as the box might be needed for storage or returns.

If the shipping container appears to be damaged, keep it until you have inspected the contents for completeness and tested the PDB250D detector mechanically and electrically.

Verify that you have received the items listed in the chapter Packing List within the package.

3.4 Power Supply AC Voltage Setting

Safety Information



WARNING: Risk of Serious Injury and Even Death Due to Electrical Shock

Improper grounding and connecting the power supply to the mains can cause electric shock.

Electric shock results in damage to your health or even death.

Observe the following instructions when applying power to the power supply:

- Make sure that the protective conductor for the 3 conductor mains power cord is correctly connected to the protective earth ground contact of the socket outlet.
- Make sure that the socket is properly grounded.



WARNING: Risk of Serious Injury and Even Death Due to Explosion

The power supply must not be operated in explosion endangered environments.



WARNING: Risk of Serious Injury to Electrical Shock

Changing the mains voltage may result in serious injury to the user due to high voltages in the power supply.

Observe the following instructions when changing the mains volt:

- Switch off the power supply.
- Disconnect the power supply from the mains power source and from all external devices.
- Switch off the power supply, pull the plug out of the socket and disconnect all external devices before changing the mains voltage.

NOTICE

NOTICE: Risk of Damaging the Power Supply

Covering and improper maintenance of the power supply can cause damage to the power supply.

To avoid damage to the power supply, note the following:

- Do not remove any covers.
- Do not cover the power supply.
- Maintain the power supply only by qualified personnel.

NOTICE

NOTICE: Risk of Damaging the Power Supply

Shorting issues can cause damage to the power supply and the PDB250D detector under test.

To avoid possible damage due to short-circuit problems, make sure that the output plug is connected to the PDB250D detector under test before switching on the power supply.

AC Line Voltage Setting

Your LDS12B Regulated Power Supply has been shipped from Thorlabs configured for 120 VAC operation. If you plan to operate this unit at 100 VAC or 230 VAC, please refer to steps below and heed the safety warnings mentioned in the section Safety Information.



Figure 12 Voltage Selector Switch of the LDS12B Power Supply

To change the line voltage, locate the voltage selector switch below the power input connector. Select the appropriate line voltage by adjusting the voltage selector switch to either 100, 120, or 230 VAC.

1. Remove the AC line cord from the LDS12B Regulated Power Supply.
2. Slide the voltage selector switch to the desired setting using a flat-blade screwdriver.
3. Verify the correct voltage is shown on the switch.
   ➤ If not, please repeat the above steps.
4. To set switch back to 120 VAC, slide the switch back with a flat head screwdriver

Common Causes of Fuse Failure

This particular unit does not give access to change the fuse. Listed below are common causes of fuse failure:

- Output Short Circuit
- Output Overload

There are two elements utilized to provide safety protection:

- **Short-Circuit Current Limit**
  Uses a Low Dropout Regulator with internal current limit circuit to protect against high-load current faults or shorting events.
- **Thermal Fuse**
  Uses a thermally sensitive element, which melts and opens the circuit when high temperature is present.

3.5 Installing Hardware



WARNING: Risk of Electric Shock or Equipment Damage

If the input voltage does not match the specified range, this may result in electrical hazards or permanent damage to the device.

Before operating the device, verify that the line voltage indicated on the power supply matches your local mains voltage.

Thorlabs provides appropriate power connector cables for use with alternative power supplies.

Prior to operation, please check if the indicated line voltage range on the power supply matches with your local mains voltage! For alternative power supplies, Thorlabs offers appropriate power connector cables.

1. Carefully unpack the unit and accessories.
   ➤ If any damage is noticed, do not use the unit. Contact Thorlabs and have us replace the defective unit.
2. If required, mount the unit on an optical table or application.
   ➤ The unit has two tapped mounting holes (see section Mechanical Drawings) on the side and bottom of the device.
   ➤ The mounting holes are compatible with metric and imperial threads.
3. Remove the plastic cover caps on the optical inputs to detect your optical signal.
4. If required, mount external optics, filters, apertures or fiber adapters.
5. Set the LDS12B power supply to your local mains voltage (100 VAC, 120 VAC, or 230 VAC) as described in the section Setting the LDS12B AC Line Voltage.
6. Connect the included DC output cable of the LDS12B power supply to the POWER IN jack.
7. Connect the LDS12B power supply to the AC outlet
8. Turn the LDS12B power supply on.
9. Connect RF Output with coaxial cable to the data acquisition device.
10. If necessary, connect monitor outputs (MONITOR +, MONITOR -).
    ➤ Measure the optical input power for each channel individually.

3.6 Return of Devices

This precision device is only serviceable if returned and properly packed into the complete, original packaging including the cardboard insert that holds the enclosed devices.

Chapter 4 Operation

4.1 Operation Principle

The PDB250D free-space balanced amplified photodetector consists of two well-matched photodiodes and an ultra-low noise, high-speed transimpedance amplifier that generates an output voltage (RF Output) proportional to the difference between the photocurrents of the two photodiodes, i.e. the difference between the two optical input signals. The gain of the amplifiers can be adjusted in 8 steps.

Additionally, the unit has two monitor outputs (MONITOR + and MONITOR -) to observe the optical input power level on each photodiode separately. Due to the increased cut-off frequency, the output from MONITOR + and MONITOR - can also be used to measure low frequency modulated signals on each photodetector separately.

The PDB250D detector is powered by the LDS12B power supply, ±12 V, 250 mA external linear power supply via a PICO M8 power connector.

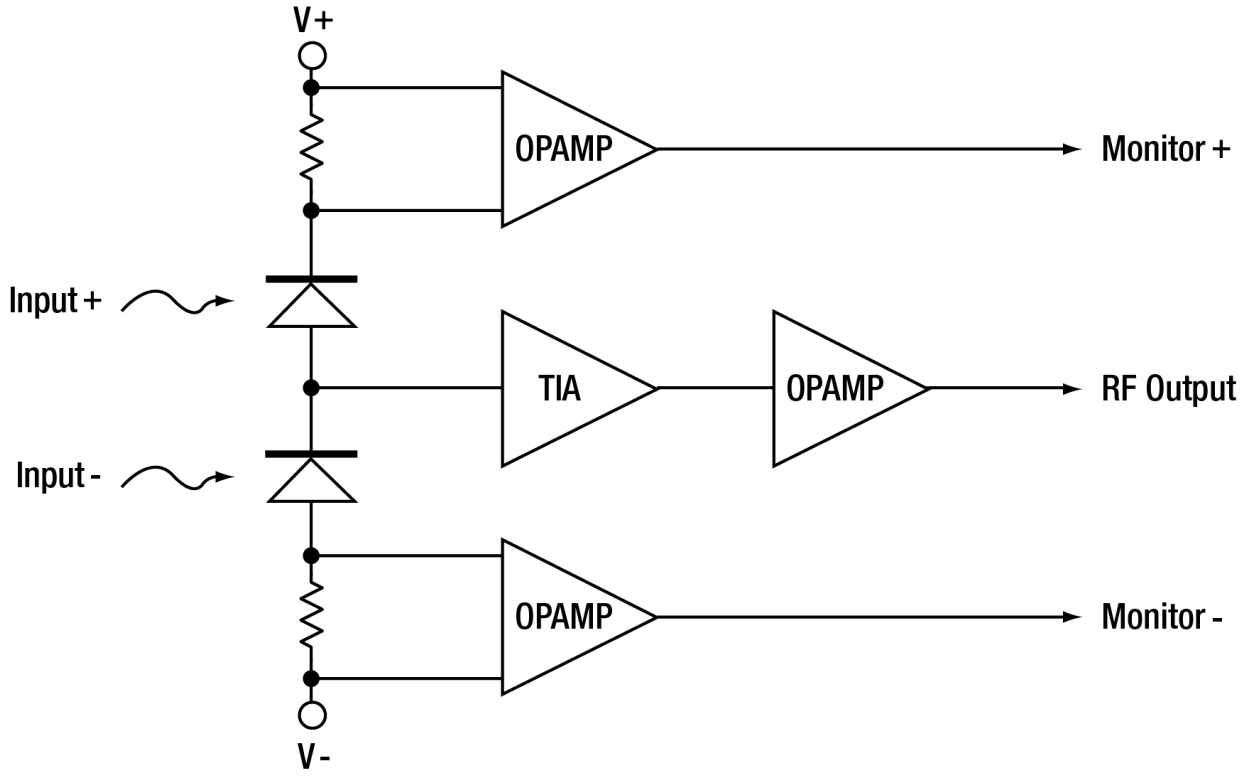


***Figure 13 Functional Block Diagram of the* PDB250D Detector**

4.2 Optical Input

The PDB250D detector has two free-space optical input ports. Open beams should be carefully aligned to both photodetectors. When working with large beam diameters, additional focusing lenses can be placed in front of the optical inputs to avoid overfilling the active photodetector area. For this, Thorlabs offers a large variety of lenses and mounting accessories. The housing is compatible with any number of Thorlabs SM1- and SM05-threaded accessories, allowing for easy integration with external optics, filters, apertures, or fibers adapters as well as Thorlabs cage assembly accessories.

For fiber coupled applications, the S120-XX Series Fiber Adapters can be easily mounted to the optical input ports. Thorlabs offers such adapters for single-mode fibers (connector styles FC, SC, ST and LC) and for multi-mode fibers (connector SMA).

The RF Output will saturate at an optical input power greater than the CW Saturation Power listed in the Specifications. If necessary, use external neutral density filters or attenuators to reduce the input light level. Please note that the PDB250D free-space balanced amplified photodetectors are very sensitive to unwanted stray light. It is important to carefully shield the input apertures from any unwanted light sources. Common techniques include the use of baffling or other opaque barriers, such as black cloth or lens tubes, and placing appropriate bandpass filters in front of the photodetector to minimize the influence of stray light.

NOTICE

NOTICE: Risk of Damaging the PDB250D Detector

The optical damage threshold is 20 mW. If the optical damage threshold exceeds the value of 20 mW, this will result in permanent damage to the photodiodes!

To avoid damaging the PDB250D detector, do not exceed the value of 20 mW of the optical damage threshold.

To achieve maximum linearity, do not exceed a maximum power density of 4 W/cm^2 when measuring focused beams or beams with a small diameter! Always try to illuminate the entire active area of the detector to avoid non-linearities. Equal power densities on both photodetectors are important for maximum CMRR.

The PDB250D detector can be used in balanced mode (both inputs are illuminated) as well as in single detector mode. In single detector mode, the RF Output swing depends on which input is used: it is positive for INPUT + and negative for INPUT -.

In single detector mode, the optical input power should be below the specified CW Saturation Power (see the section Specifications) to avoid saturation of the RF Output amplifier.

In balanced mode the power difference between the optical inputs should be less than the CW Saturation Power. If necessary, use external neutral density filters or attenuators to reduce the input light level.

4.3 Electrical Output

The PDB250D detector has the following three BNC output connectors:

- MONITOR +
- MONITOR -
- RF Output

4.3.1 RF Monitor

The signal monitor output ports (MONITOR + and MONITOR -) allow measurements of the input power level of the two input ports separately. MONITOR + and MONITOR - can therefore be used to assess low frequency modulated signals at the individual detectors. The maximum output voltage swing of the MONITOR output is +10 V for high impedance loads (+1.5 V into 50 Ω). Saturation of MONITOR output will occur at optical input power levels greater than 1 mW, depending on the detector wavelength response.

Monitor output can be used to roughly adjust equal input power levels on each detector for balanced operation. Monitor outputs of the unit are also convenient to use for free-space beam alignment.

The amplifier offset voltage is factory set to zero at 23 °C ambient temperature. A small drift during a short warm-up period (~5 min) may occur. For exact DC light level measurements a constant temperature environment is recommended.

4.3.2 RF OUTPUT

The RF Output delivers an output voltage proportional to the difference between the photo currents of the two photodiodes. This voltage can be calculated by:

$$U_{RF,OUT} = (P_{opt,1} - P_{opt,2}) \; x \; \Re(\lambda) \; x \; G$$

$\Re(\lambda)$	Responsivity of the Photodiode at Given Wavelength λ
$P_{opt,1}, P_{opt,2}$	Optical Input Power as Measured at the 2 Photodetector Ports
G	Transimpedance Gain of the RF Output

The responsivity $\Re(\lambda)$ for a given wavelength can be read from the individual curves in the section Graphs to estimate the RF Output voltage. Please note that the given responsivity curves represent typical values and individual responsivity may deviate. The maximum output voltage swing of the RF Output can be found in the section Specifications.

The optical input saturation power of the balanced detector is the minimum value, as it is given for the wavelength with the highest detector responsivity. At other wavelengths, saturation will be reached at higher input power levels. The output signal should not exceed the maximum output voltage to avoid saturation. Therefore the optical input power (or the power difference between the optical input ports 1 and 2) should not exceed CW Saturation Power listed in the section Specifications.

4.4 Mounting

As shown in the section Components, the PDB250D detector is housed in a rugged, shielded aluminum enclosure. This slimline housing has two tapped holes for convenient mounting to the optical setup. The PDB250D detector features tapped holes which are compatible for both imperial and metric threads (8-32 and M4 x 0.7).

The input aperture is fitted with both an external SM1 and an internal SM05 thread that is compatible with any number of Thorlabs' SM1- and SM05-threaded accessories. The included SM1T1 allows externally SM1-threaded accessories (e.g. external optics, filters, apertures, or fiber adapters) to be mounted to the input aperture.

4.5 CMRR and Frequency Response

An important specification for balanced amplifiers is the Common Mode Rejection Ratio (CMRR) that reflects the ability to suppress common mode noise.

In the setup described below, the Device under Test (DuT) - here a PDB250D detector - is tested for CMRR. A common mode signal is generated, which is canceled out when the amplifier is in balanced mode.

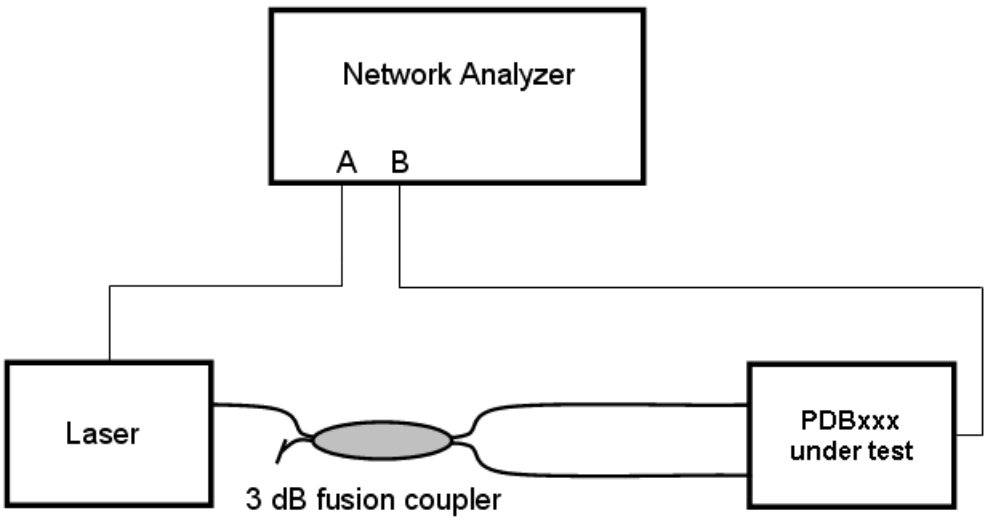


Figure 14 DuT Setup

A network analyzer is used as signal generator (output A) and receiver (input B). The receiver is synchronized with the signal generator and measures selectively at the same frequency. A laser light source is modulated by the signal generator (port A) and acts as a transmitter. A 3 dB fusion coupler is connected to the laser output, splitting the modulated light signal into two paths. Depending on the measurement task, one or both coupler outputs are connected to the input ports of the DuT. One of the DuT output ports is connected to the network analyzer Port B.

Frequency Response Measurements

The frequency response of each signal path can be measured by connecting only one coupler output to the appropriate input. In this way, the frequency response curves of the RF Output from INPUT + and INPUT- can be measured, as well as the frequency responses of the Monitor output ports, as shown in the section Technical Data.

CMRR Measurement

For CMRR measurement, both output ports of the fusion coupler are connected to both input ports of the DuT. The optical power level at both inputs must be well matched ("balanced") in order to achieve the optimal common mode suppression. Now the common mode rejection can be measured as a function of the frequency. The frequency response of the RF Output must be considered when calculating the CMRR - it is the difference between the RF Output signal at a given frequency and the measured common mode or balanced output signal - at the same frequency. Typical measurement curves can be found in the section Graphs.

4.6 Recommendations

Thorlabs' PDB250D detector can eliminate noise sources to allow precise measurements. The PDB250D detector is designed for use in a dual beam setup: one optical path for measurement and one invariant reference path. If set up properly, the PDB250D detector can reduce common mode noise for more than 35 dB over the specified frequency range. Please find recommendations to achieve an optimal common mode suppression below:

- Equal power levels on each photodetector are essential. Any power imbalance will be amplified and hence decrease the possible noise reduction.

- Equal power densities on both detectors is important to obtain maximum possible common mode rejection. Always try to illuminate the whole active area of the detectors to prevent nonlinearities. Focused high power beams may lead to frequency response degradation, resulting in dramatically reduced common mode rejection.
- Equal optical path lengths are critical for common mode noise suppression, especially at higher frequencies. Any path length difference will introduce a phase difference between the two signals, which will decrease the noise reduction capability of the balanced detector. The figure below shows the maximum allowed path length difference in air to obtain a desired CMRR. For fiber-based applications the maximum path length difference must divided by 1.5.

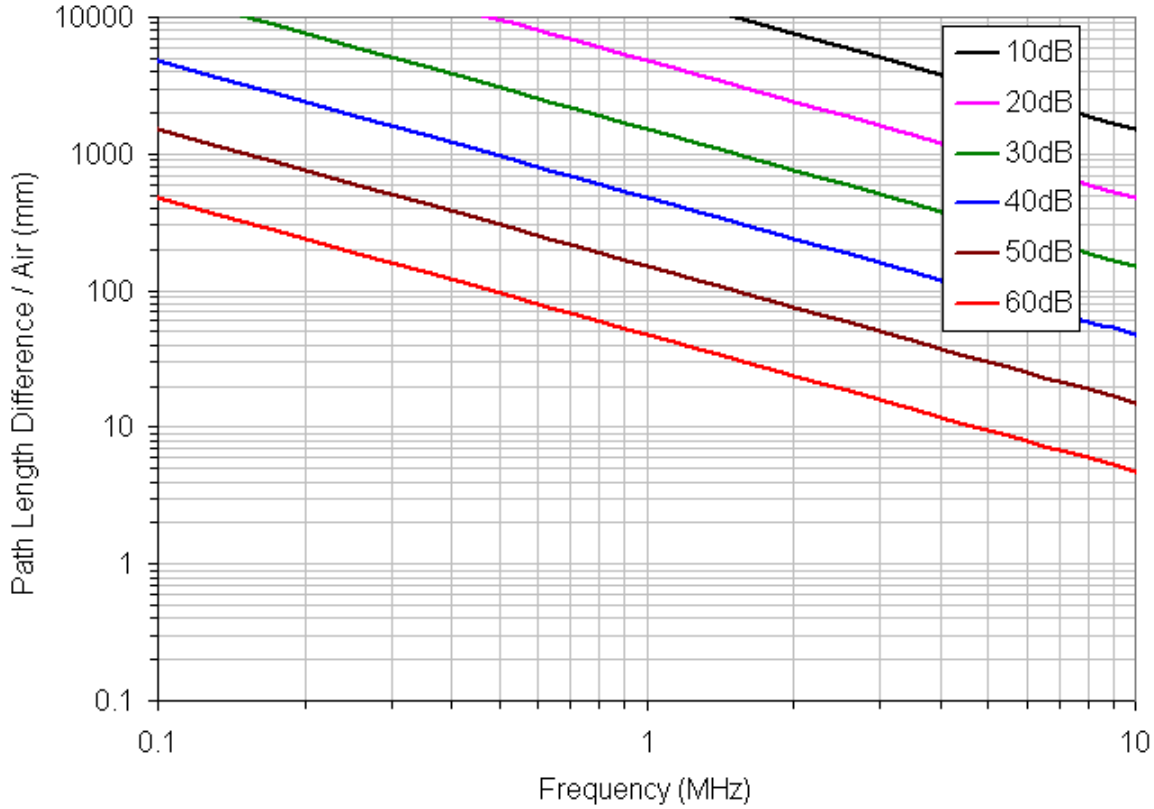


Figure 15 Graph of the Maximum Permissible Path Length Difference in Air to Achieve a Desired CMRR

- Avoid etalon effects (interference fringes caused between two optical surfaces) in optical paths. Using angle polished optical connectors will greatly reduce etalon effects in a fiber-based setup. Effects like residual frequency modulation, polarization noise, polarization wiggle or spatial modulation can also degrade common mode noise suppression. For further details contact Thorlabs. In general, reducing sources of differential losses in the optical paths (other than the measurement itself) will improve the common mode noise reduction.
- Please note, that the PDB250D free-space balanced amplified photodetector is very sensitive to unwanted stray light. Carefully shielding the PDB250x detectors from any unwanted light sources is essential.
- Electrostatic coupling of electrical noise associated with ground loops will introduce electrical noise. In most cases an electrically isolated post (see Thorlabs parts TRE or TRE/M) will suppress electrical noise coupling. Always try to identify the electrical noise sources and increase the distance to the PDB250D free-space balanced amplified photodetector. Different common ground points can also be tested.

Chapter 5 Maintenance and Cleaning

NOTICE*:* Risk of Damaging the PDB250D Detector

NOTICE

The PDB250D detector is not water resistant. If the PDB250D detector gets into contact with fluids, the PDB250D detector can be damaged.
To avoid damaging, do not expose the PDB250D detector to:

- Spray
- Liquids
- Solvents
- Adverse weather conditions

NOTICE*:* Risk of Damaging the PDB250D Detector

NOTICE

When connecting the fibers to the optical input ports, there is a risk of damaging the glass window that protects the photodiode.

The photodiodes are mounted in such a way that the gap between the diode glass and the fiber tip is as small as possible. For this reason, be careful when tightening the fiber connection to avoid damaging the glass window of the photodiode.

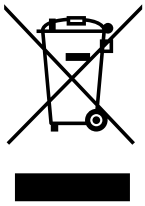
To clean the PDB250D detector housing, use a mild detergent and damp cloth. Do not soak the unit in water or use solvent based cleaners.

When cleaning the windows of the photodetectors, please remember that it is a sensitive optical device. Gently blow off any dust using compressed air and wipe gently with an optic tissue moistened with isopropanol or alcohol.

The unit does not need regular maintenance by the user. It does not contain any modules and/or components that could be repaired by the user himself. If a malfunction occurs, please see the Return of Devices section and contact Thorlabs for return instructions.

Do not remove covers!

Chapter 6 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 7 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.



Corporate Headquarters
Thorlabs, Inc.
43 Sparta Ave
Newton, New Jersey 07860
United States

sales@thorlabs.com
techsupport@thorlabs.com

Product Manufacturer
Thorlabs GmbH
Münchner Weg 1
D-85232 Bergkirchen
Germany

sales.de@thorlabs.com
europe@thorlabs.com

EU Importer
Thorlabs GmbH
Münchner Weg 1
D-85232 Bergkirchen
Germany

sales.de@thorlabs.com
europe@thorlabs.com

UK Importer
Thorlabs Ltd.
204 Lancaster Way Business Park
Ely CB6 3NX
United Kingdom

sales.uk@thorlabs.com
techsupport.uk@thorlabs.com



THORLABS
www.thorlabs.com