THORLABS

Amplified Balanced Photodetectors

PDB210A(/M), PDB210C(/M), PDB220A2(/M), PDB230A, PDB230C
Operation Manual

2021

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Contents

We aim to develop and produce the best solutions for your applications in the field of optical measurement techniques. To help us to live up to your expectations and constantly improve our products, we need your ideas and suggestions. We and our international partners are looking forward to hearing from you.

Thorlabs GmbH

Warning

Sections marked by this symbol explain dangers that might result in personal injury or death. Always read the associated information carefully before performing the indicated procedure.

Attention

Paragraphs preceded by this symbol explain hazards that could damage the instrument and the connected equipment or may cause loss of data.

Note

This manual also contains "NOTES" and "HINTS" written in this form.

Please read this advice carefully!

1 General Information

The Thorlabs PDB2xx Series of Balanced Amplified Photodetectors consist 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 photo currents in the two photodiodes, i.e. the two optical input signals. 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 detector separately.

The PDB2xx Series slim line housing has three tapped holes (8-32 or M4) for convenient mounting to the optical setup. 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 lense tube coupler allows mounting of external SM1-threaded accessories (e.g. external optics, filters, apertures, or fiber adapters).

The PDB2xx Series is shipped with an external linear power supply.

The PDB210A(/M) and PDB210C(/M) as well as PDB220A2(/M) operate from DC up to 1 MHz and feature photodiodes with a large active area and are available as imperial or metric versions. Here, the tapped mounting holes have different threads for imperial and metric version: 8-32 or M4, respectively.

PDB230A and PDB230C operate from DC up to 100 MHz with a active area of the photodiodes being smaller compared to PDB210x(/M) and PDB220A2(/M). The mounting holes have combi threads for both 8-32 and M4 threads for mounting with imperial or metric posts.

1.1 Ordering Codes and Accessories

The following models of the PDB2xx Series are available:

PDB210A	1 MHz, Fixed Gain, Large Area Balanced Amplified Photodetectors with Si PIN Photodiodes, Imperial 8-32 Mounting Threads
PDB210A/M	1 MHz, Fixed Gain, Large Area Balanced Amplified Photodetectors with Si PIN Photodiodes, Metric M4 Mounting Threads
PDB220A2	1 MHz, Fixed Gain, Large Area Balanced Amplified Photodetectors with UV enhanced Si PIN Photodiodes, Imperial 8-32 Mounting Threads
PDB220A2/M	1 MHz, Fixed Gain, Large Area Balanced Amplified Photodetectors with UV enhanced Si PIN Photodiodes, Metric M4 Mounting Threads
PDB210C	1 MHz, Fixed Gain, Large Area Balanced Amplified Photodetectors with InGaAs PIN Photodiodes, Imperial 8-32 Mounting Threads
PDB210C/M	1 MHz, Fixed Gain, Large Area Balanced Amplified Photodetectors with InGaAs PIN Photodiodes, Metric M4 Mounting Threads
PDB230A	100 MHz, Fixed Gain, Large Area Balanced Amplified Photodetectors with UV enhanced Si PIN Photodiodes, Combi-Thread Mounting Holes Compatible with 8-32 and M4 Threads
PDB230C	100 MHz, Fixed Gain, Large Area Balanced Amplified Photodetectors with InGaAs PIN Photodiodes, Combi-Thread Mounting Holes Compatible with 8-32 and M4 Threads

According to Thorlabs general detector part numbering system, the suffix “A” indicates Si photodiodes while the suffix “C” indicates InGaAs photodiodes.

AC-coupled versions as well as special versions with an open detector (cover glass removed) are available upon request. Please contact Thorlabs 21 for details.

2 Getting Started

2.1 Parts List

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 PDB2xx Series mechanically and electrically.

Verify that you have received the following items within the package:

PDB210A(/M)

1. PDB210A Balanced Amplified Photodetector, Imperial or Metric Threads
2. 2 pcs. SM1T1 (SM1 internal thread) adapter
3. 2 pcs. metal cover caps for input aperture
4. Power supply LDS12B (±12V, 250 mA), switchable to 100 V, 120 V or 230 V line voltage
5. Quick Reference

PDB210C(/M)

1. PDB210C Balanced Amplified Photodetector, Imperial or Metric Threads
2. 2 pcs. SM1T1 (SM1 internal thread) adapter
3. 2 pcs. metal cover caps for input aperture
4. Power supply LDS12B (±12V, 250 mA), switchable to 100 V, 120 V or 230 V line voltage
5. Quick Reference

PDB220A2(/M)

1. PDB220A1 Balanced Amplified Photodetector, Imperial or Metric Threads
2. 2 pcs. SM1T1 (SM1 internal thread) adapter
3. 2 pcs. metal cover caps for input aperture
4. Power supply LDS12B (±12V, 250 mA), switchable to 100 V, 120 V or 230 V line voltage
5. Quick Reference

PDB230A

1. PDB230A Balanced Amplified Photodetector
2. 2 pcs. SM1T1 (SM1 internal thread) adapter
3. 2 pcs. metal cover caps for input aperture
4. Power supply LDS12B (±12V, 250 mA), switchable to 100 V, 120 V or 230 V line voltage
5. Quick Reference

PDB230C

1. PDB230C Balanced Amplified Photodetector
2. 2 pcs. SM1T1 (SM1 internal thread) adapter
3. 2 pcs. metal cover caps for input aperture
4. Power supply LDS12B (±12V, 250 mA), switchable to 100 V, 120 V or 230 V line voltage
5. Quick Reference

3 Operating Instructions

- Turn the power switch of the power supply and on the PDB2xx Series to I. The status LED next to the DC input connector will turn green to indicate that the power supply is operating correctly.
- Align the optical sources such that they are incident to the input apertures. The MONITOR output ports can be used to check the detected signal from each free space input beam. The maximum output voltage swing of the MONITOR outputs is 10V for high impedance loads (1.5 V into 50 Ω loads). Saturation of the MONITOR output ports will occur at optical input power greater than 1 mW.
- The RF output signal must not exceed the maximum RF OUTPUT voltage swing (see Technical Data 12) to avoid saturation. External neutral density filters or attenuators are recommended to reduce the input light level.
- For balanced operation, illuminate both photodetectors simultaneously and use either the RF OUTPUT or the MONITOR output ports to fine-tune the optical power balance by observing voltage on a digital voltmeter or other low-frequency measurement device.
- Do not exceed a maximum power density of 4 W/cm^2 for maximum linearity performance when measuring focused beams, fiber outputs, or small diameter beams.
- For use in fiber coupled applications, Thorlabs S120-xx series fiber adapters can be easily mounted to the optical input ports. Thorlabs offers such adapters as well for single-mode fibers (connector styles FC, SC, ST and LC) and for multi-mode fibers (connector SMA).
- After finishing measurements, turn off the power with the ON/OFF switch (see Operating Elements 4).

Note

To prevent saturation of the balanced amplifier make sure that the power difference between the optical input ports is less than the saturation power level (see "RF OUT CW Saturation Power" in the Technical Data section 12).

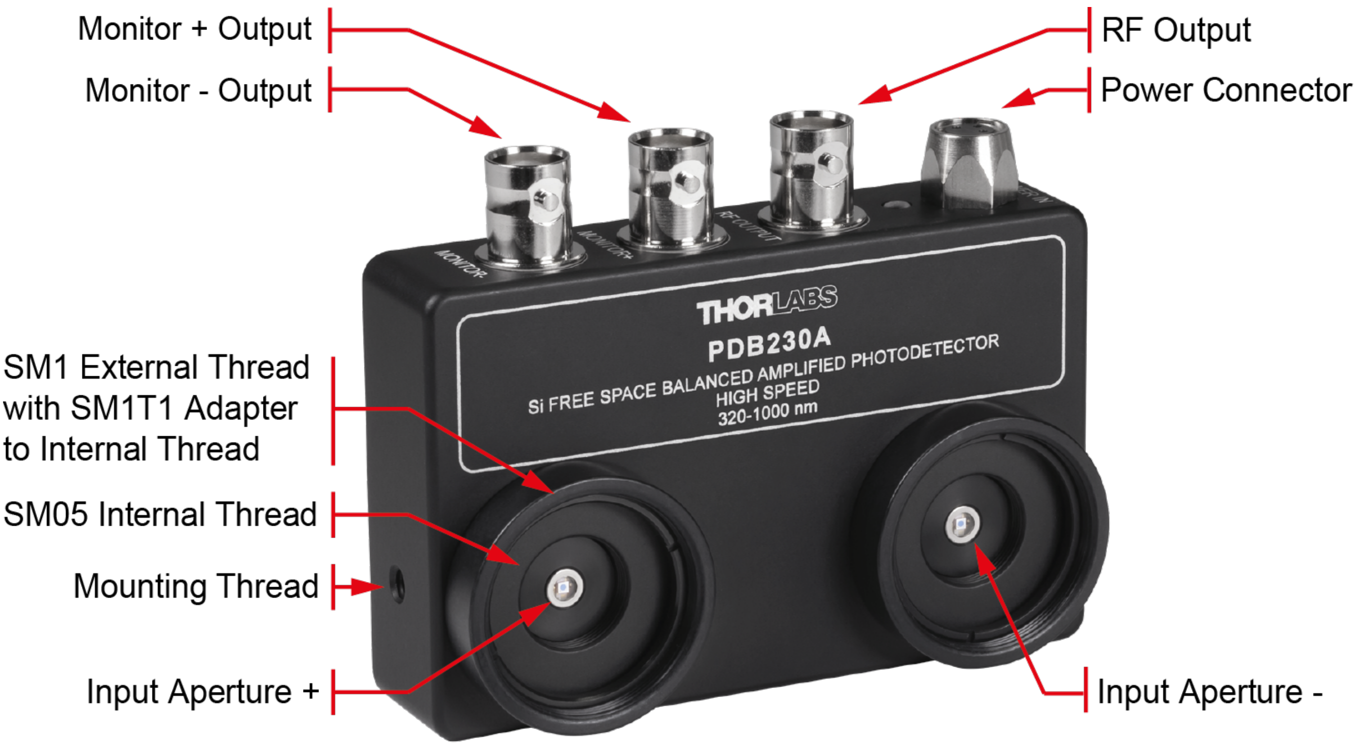
Attention

The damage threshold of the photodiodes is 20 mW! Exceeding this value will permanently destroy the detector!

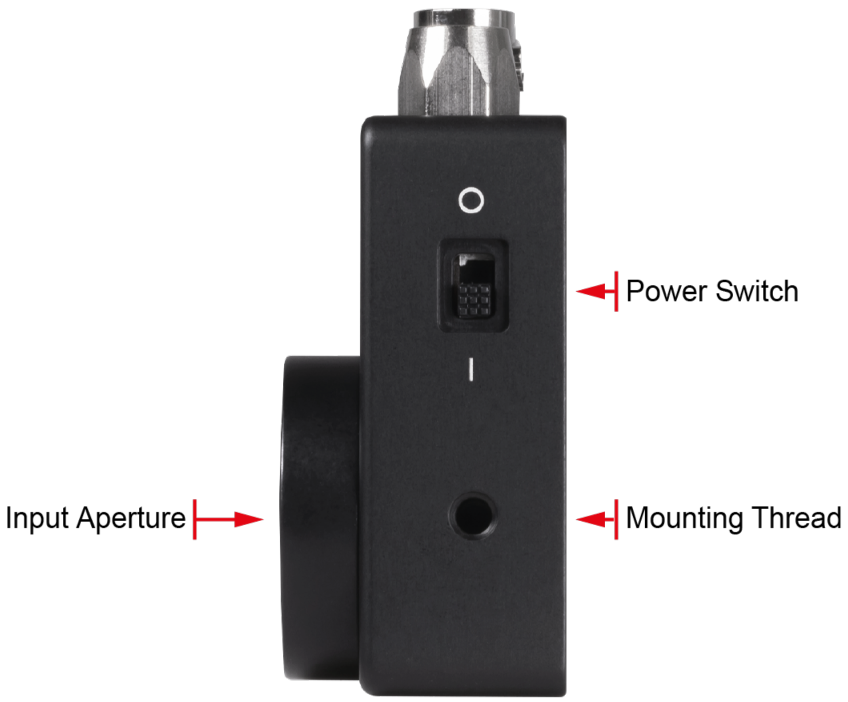
3.1 Operating Elements

PDB230A operating elements are identical in all products of the PDB2xx Series described in this manual.

PDB230A



Right Side of PDB230A:



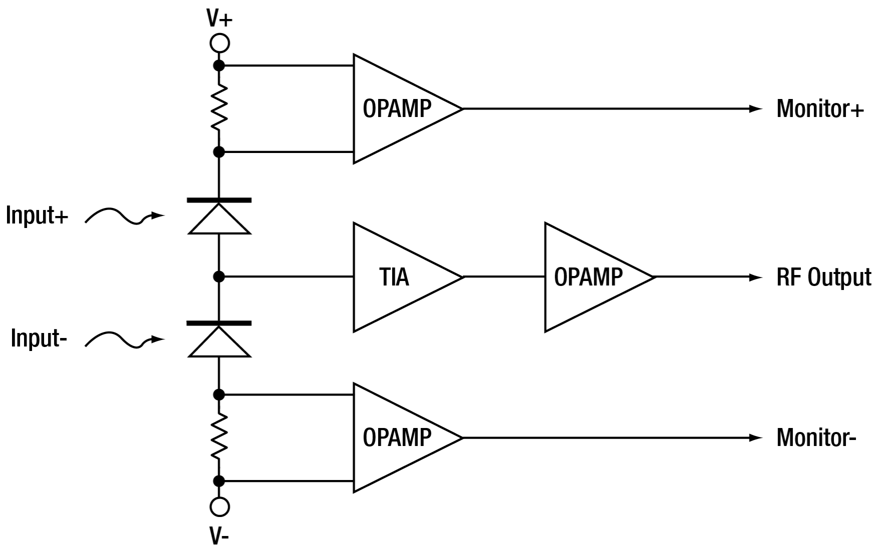
3.2 Operating Principle

Thorlabs PDB2xx Series Balanced Amplified Photodetectors consist 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 photo currents of the two photodiodes, i.e. the difference of between the two optical input signals.

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 detector separately.

The PDB2xx Series is powered by an external linear power supply (included; ±12 V, 250 mA) via a PICO M8 power connector.

Below is a functional block diagram of the PDB2xx Series Balanced Amplified Photodetectors:



3.3 Optical Input

The PDB2xx Series detectors have two free-space optical input ports. Open beams should be carefully aligned to both detectors. This is particularly critical for PDB230A and PDB230C, which have a smaller photodiode active area. When working with large beam diameters, additional focusing lenses can be placed in front of the optical inputs to avoid overfilling the active detector 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, Thorlabs 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 Specifications 12. If necessary, use external neutral density filters or attenuators to reduce the input light level. Please note, that the PDB2xx Series 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 band pass filters in front of the detector to minimize the influence of stray light.

Note

Do not exceed a maximum power density of 4 W/cm² for maximum linearity performance when measuring focused or small diameter beams. Always try to illuminate the whole detector active area to prevent nonlinearities. Equal power densities on both detectors are important for maximum common mode noise suppression (CMRR).

The PDB2xx Series 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 Technical Data 12) 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.

Attention

The optical damage threshold is 20 mW. Exceeding this value will permanently damage the photodiodes!

3.4 Electrical Output Ports

The Thorlabs PDB2xx Series has three BNC output connectors:

- **MONITOR +**
- **MONITOR -**
- **RF OUTPUT**

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

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

with: $\Re(\lambda)$ - responsivity of the photodiode at given wavelength

$P_{opt,1}$ and $P_{opt,2}$ - optical input power

G - transimpedance gain of the RF output

The responsivity $\Re(\lambda)$ for a given wavelength can be read from the individual curves in section Performance Plots in the Appendix 15 to estimate the **RF OUTPUT** voltage. Please note that the given responsivity curves represent typical values - individual responsivity may deviate. The maximum output voltage swing of the **RF OUTPUT** can be found in the Technical Data 12 section.

The optical input saturation power (see Technical Data 12) 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 Technical Data 12.

MONITOR Output Ports

The signal monitor output ports (**MONITOR+** and **MONITOR-**) allow to measure 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 level 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 (~5min) may occur. For exact DC light level measurements a constant temperature environment is recommended.

3.5 Mounting

As shown in the chapter Operating Element 4, the PDB2xx Series is housed in a rugged shielded aluminum enclosure. This slim line housing has three tapped holes for convenient mounting to the optical setup. PDB210A, PDB201C and PDB220A2 can be purchased as imperial or metric versions (/M) with the tapped mounting holes 8/32 or M4, respectively. PDB230A and PDB230C feature tapped holes which are compatible for both imperial and metric threads.

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.

The PDB2xx Series has three tapped mounting holes 4 to mount the unit to a imperial or metric post or pedestal, depending on the PDB2xx model.

3.6 AC Coupling of the Output Signals

Beside the standard DC coupling of the **RF OUTPUT**, AC coupled versions for any model of PDB2xx Series are available on request. AC coupling blocks the CW component (the unmodulated part) of the optical input signal. However, large CW components of the optical input signal will decrease linearity of the detectors.

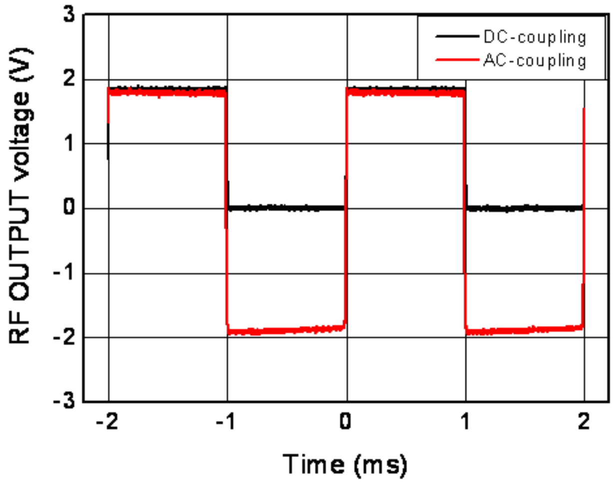
AC coupling helps to improve the measurement capabilities in applications, where a comparably weak frequency modulated signal is measured on a strong CW background signal, which could saturate the amplifier. With AC coupling, equalizing of CW power levels of both input signals is not mandatory for noise cancellation. However, for optimal noise suppression the signal of interest (e.g. the modulated part) should be well balanced. AC coupling is also recommended when using the balanced detector in combination with a chopper and lock-in amplifier to further decrease noise level.

The lower cut-off frequency of the AC coupled versions is typically below 5 Hz.

Please note, that AC coupling slightly increases noise figures at lower frequencies. The measurement bandwidth of the RF OUTPUT is not affected by AC coupling.

The figure below shows the comparison of AC and DC coupled RF Output signals when modulating the input signal with a mechanical chopper at a frequency of 500 Hz.

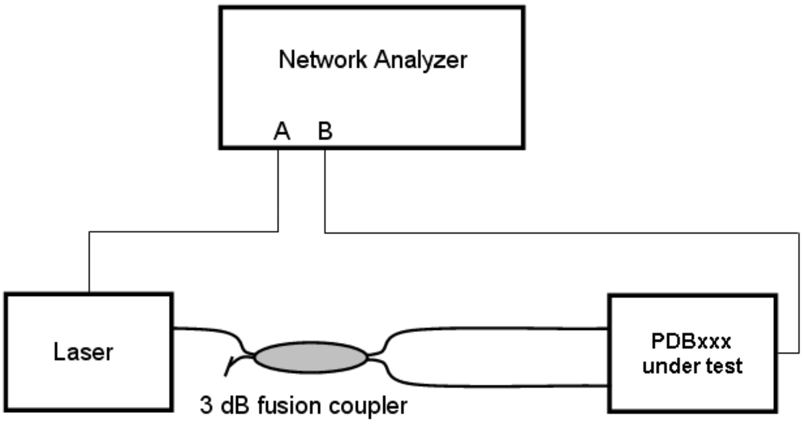
Note Input signal for AC coupling was increased by factor 2 to allow direct waveform comparison



3.7 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 PDB2xx Series balanced detector - is tested for CMRR. A common mode signal is generated, which is canceled out when the amplifier is in balanced mode.



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 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 individual technical data.

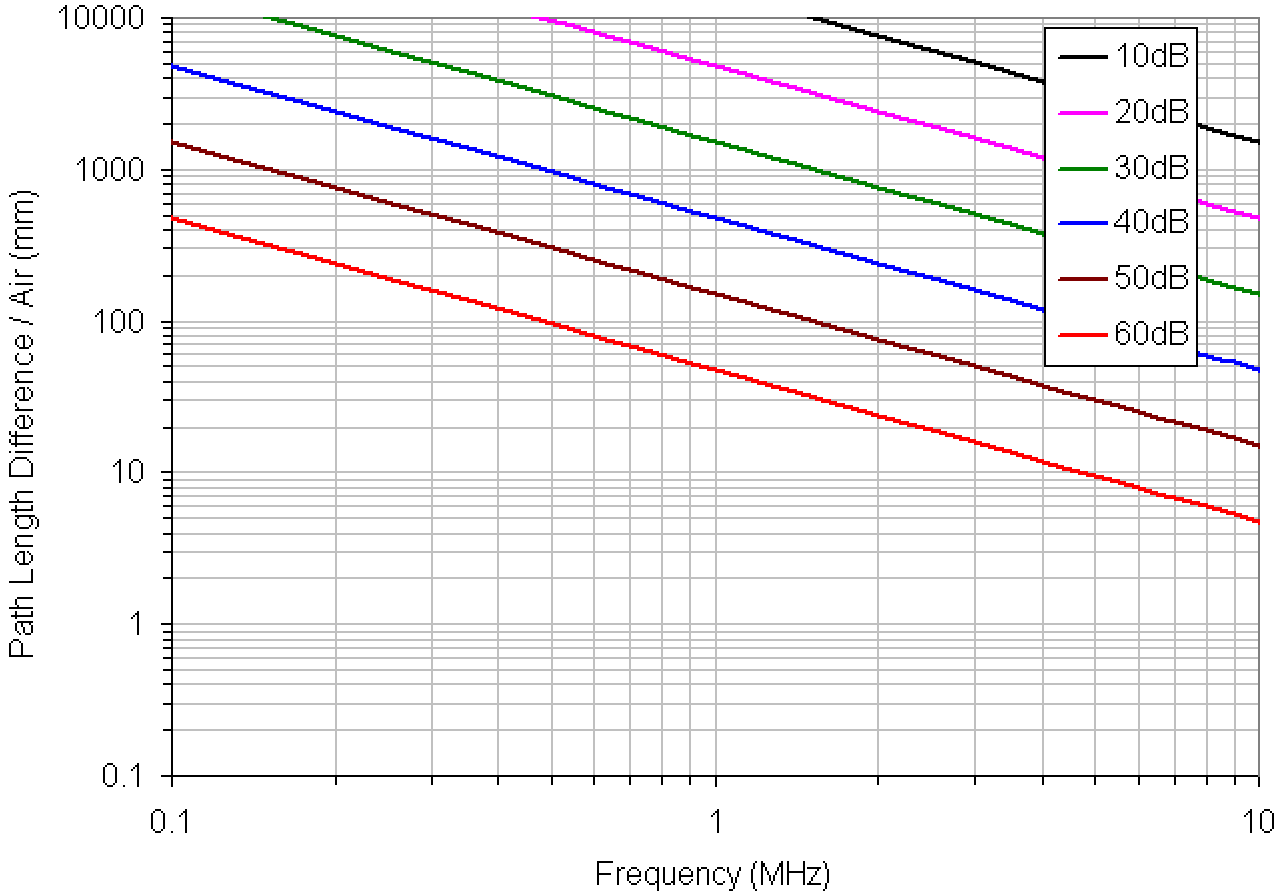
CMRR Measurement

For Common Mode Rejection 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 respective Performance Plots 15.

3.8 Recommendations

Thorlabs PDB2xx Series Balanced Amplified Photodetectors can eliminate noise sources to allow precise measurements. The PDB2xx Series is designed for use in a dual beam setup: one optical path for measurement and one invariant reference path. If set up properly, the PDB2xx Series 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 are 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 application the maximum path length difference must divided by 1.5.



- 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 PDB2xx Series Balanced Amplified Photodetectors are very sensitive to unwanted stray light. Carefully shielding of the Balanced Amplified Photodetectors 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 PDB2xx Series Balanced Detector. Different common ground points can also be tested.

4 Maintenance and Service

Protect the PDB2xx Series from adverse weather conditions. The PDB2xx Series is not water resistant.

Attention

Be very careful when connecting the fibers to the optical input ports! The photodiodes are mounted such that the gap between the protective diode glass and the fiber tip is as small as possible. For this reason, be careful when tightening the fiber connector in order to avoid damage to the glass window that protects the photodiode.

Attention

To avoid damage to the instrument, do not expose it to spray, liquids or solvents!

The unit does not require regular maintenance by the user. It does not contain any modules and/or components that could be repaired by the user. If a malfunction occurs, please contact Thorlabs 21 for return instructions.

Do not remove covers!

To clean the PDB2xx Series series 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 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.

5 Appendix

5.1 Technical Data

Model	PDB220A2	PDB210A	PDB210C
Detector			
Detector Type	UV Enhanced Si/PIN	Si/PIN	InGaAs/PIN
Wavelength Range	190 to 1100 nm	320 to 1060 nm	800 to 1700 nm
Max. Responsivity, typ.	0.5 A/W @ 960 nm	0.6 A/W @ 920 nm	1.0 A/W @ 1550 nm
Diameter of Active Detector Area	4.1 mm	5 mm	3 mm
RF OUTPUT Bandwidth (3dB)	DC to 1 MHz		
Common Mode Rejection Ratio (Typ.)	30 dB	40 dB	30 dB
RF OUTPUT Transimpedance Gain High Z load 50 Ω load	500 x 10^3 V/A 175 x 10^3 V/A		
RF OUTPUT Conversion Gain High Z load 50 Ω load	250 x 10^3 V/W 85 x 10^3 V/W	300 x 10^3 V/W 100 x 10^3 V/W	500 x 10^3 V/W 175 x 10^3 V/W
RF OUTPUT CW Saturation Power	36 µW @ 960 nm	33 µW @ 920 nm	20 µW @ 1550 nm
RF OUTPUT Voltage Swing High Z load 50 Ω load	max. 10 V max. 3.5 V		
MONITOR Output Conversion Gain High Z load 50 Ω load	@ 960 nm 10 V/mW 1.5 V/mW	@ 920 nm 10 V/mW 1.5 V/mW	@ 1550 nm 10 V/mW 1.5 V/mW
MONITOR Output Voltage Swing High Z load 50 Ω load	max. 10 V max. 1.5V		
Min. NEP (DC to 1 MHz)	3.6 pW/√Hz	2.2 pW/√Hz	16 pW/√Hz
Optical Inputs	free space		
Photo Diode Damage Threshold	20 mW		
General			
Electrical Outputs	BNC, 100Ω impedance		
RF OUT Coupling	DC (AC coupling on request)		
Operating Temperature Range [1])	0 - 40 °C		
Storage Temperature Range	-40 - 70 °C		
Dimensions (W x H x D)	83.8 mm x 65.3 mm x 21.1 mm (3.30" x 2.57" x 0.83")		
Weight	0.15 kg (w/o power supply)		
Included Power Supply	± 12 V @ 250 mA (100/120/230 VAC, 50-60 Hz, Switchable)		

[1]) non-condensing

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

Model	PDB230A	PDB230C
DETECTOR		
Detector Type	Si/PIN	InGaAs/PIN
Optical Input Ports	Freespace	
Wavelength Range	320 to 1000 nm	800 to 1700 nm
Max. Responsivity, typ.	0.53 A/W @ 820 nm	1.0 A/W @ 1550 nm
Diameter of Active Detector Area	0.8 mm	0.3 mm
Photo Diode Damage Threshold	20 mW	
RF OUTPUT		
RF OUTPUT Bandwidth (3dB)	DC-100 MHz	
Common Mode Rejection Ratio	>30 dB (35 dB typ.)	>30 dB (40 dB typ.)
RF OUTPUT Transimpedance Gain High Z load 50 Ω load	50×10^3 V/A 24.5×10^3 V/A	
RF OUTPUT Conversion Gain	26.5×10^3 V/W @ 820 nm	50×10^3 V/W @ 1550 nm
RF OUTPUT CW Saturation Power	150 µW @ 820 nm	80 µW @ 1550 nm
RF OUTPUT Voltage Swing High Z load 50 Ω load	±4.0 V ±1.9 V	
Min. NEP (DC to 100 MHz)	12 pW/√Hz	7.5 pW/√Hz
Overall Output Voltage Noise	< 6.5 mV_{RMS}	
DC Offset	< ±10 mV	
MONITOR OUTPUT		
MONITOR Output Impedance	200 Ω	
MONITOR Output Bandwidth (3dB)	DC - 100 MHz	
MONITOR Output Conversion Gain High Z load	10 V/mW @ 820 nm	10 V/mW @ 1550 nm
MONITOR Output Voltage Swing High Z load 50 W load	10 V 1.55 V (Max)	
General		
Electrical Outputs	BNC, 50 Ω	
RF OUT Coupling	DC, AC-Coupling upon Request	
Operating Temperature Range [1])	0 - 40 °C	
Storage Temperature Range	-40 - 70 °C	
Dimensions (W x H x D)	84.5 mm x 65.3 nm x 21.1 mm (3.33" x 2.57" x 0.83")	
Weight	0.2 kg (w/o power supply)	
Included Power Supply	± 12 V @ 250 mA (100/120/230 VAC, 50-60 Hz, Switchable)	

[1]) non-condensing

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

5.2 Technical Data Explained

Comments and explanations to the individual specifications

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

$$G_{TI} = \frac{U_{RF,OUT}}{I_{PD}} = \frac{U_{RF,OUT}}{P_{IN} \times \Re(\lambda)}$$

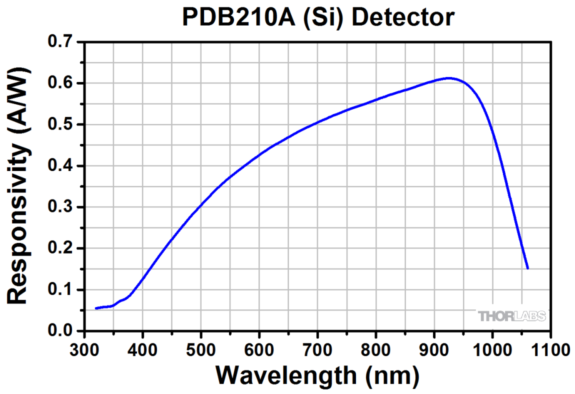
  As the photo current depends on the wavelength, the transimpedance gain is wavelength-independent as well. The transimpedance gain values are always given for a high impedance load at the RF Output; for 50 Ω loads these values are divided by two.
- **Conversion Gain [V/W]** is the ratio of output voltage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

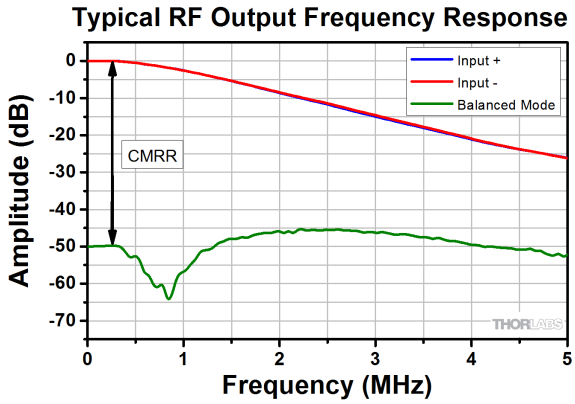
$$G_{CONV} = \frac{U_{RF,OUT}}{P_{IN}} = G_{TI} \times \Re(\lambda)$$

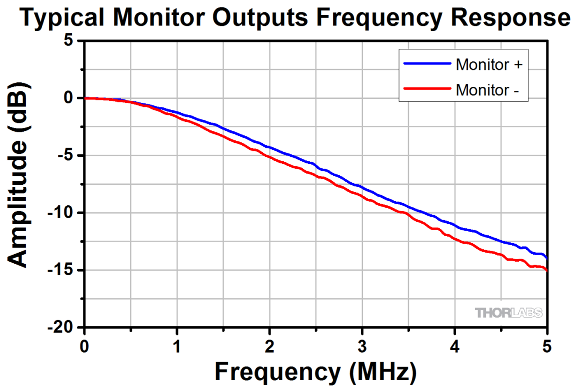
  This formula shows, that the conversion gain is dependent on the actual wavelength, as well. In the specifications, the conversion gain is given only for the peak responsivity wavelength of the photo diode. The conversion gain values are always given for a high impedance load at the RF Output; for 50 Ω loads these values are divided by two.
- **NEP** (Noise Equivalent Power) 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 PDB2xx Series balanced detectors from DC to the RF Output cut frequency.
- **Maximum input power** is the damage threshold of the photo diode.
- **Typical noise spectra** (diagrams): These spectra were measured using an electrical spectrum analyzer (resolution bandwidth 100 kHz, video bandwidth 10 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 under test 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" 8

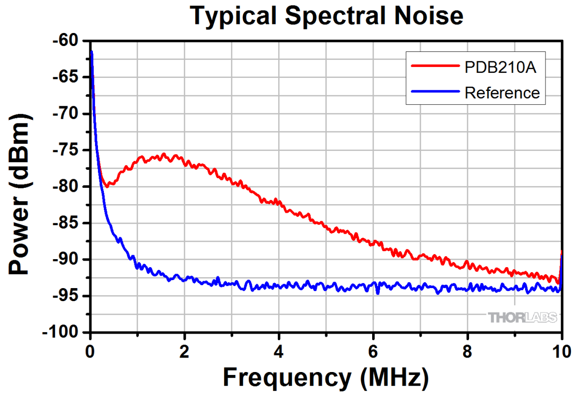
5.3 Performance Plots

5.3.1 PDB210A Performance Plots

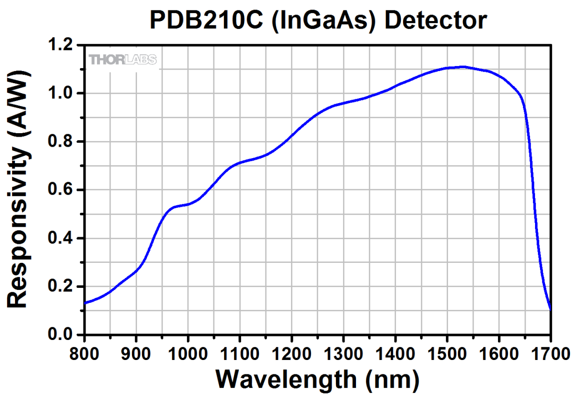


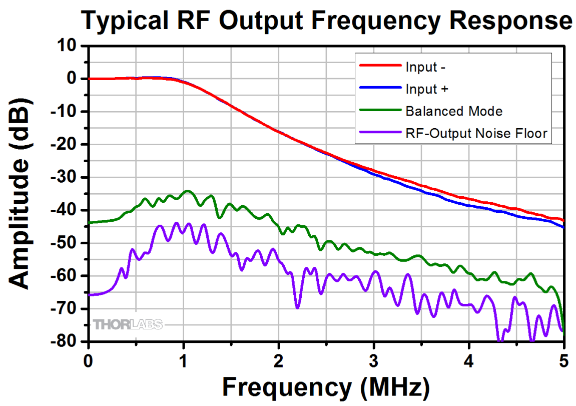


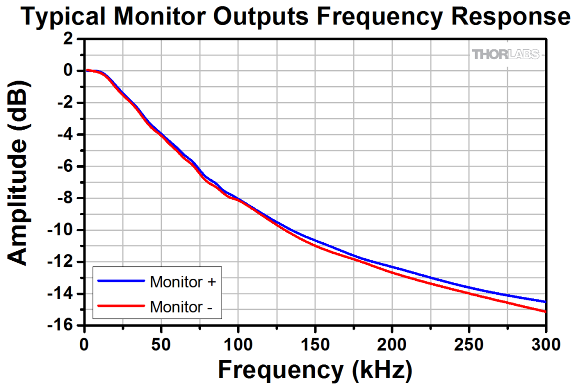


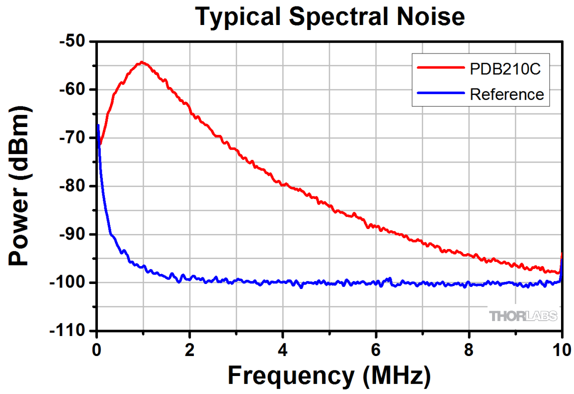


5.3.2 PDB210C Performance Plots

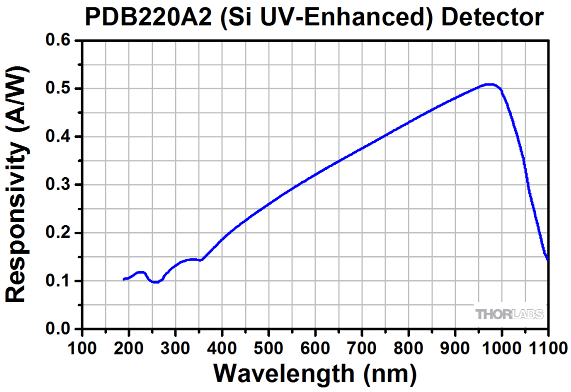


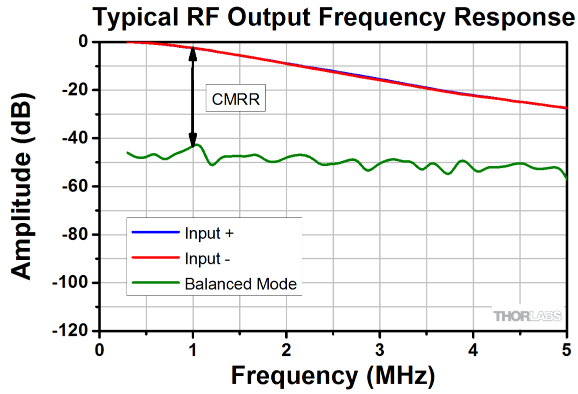


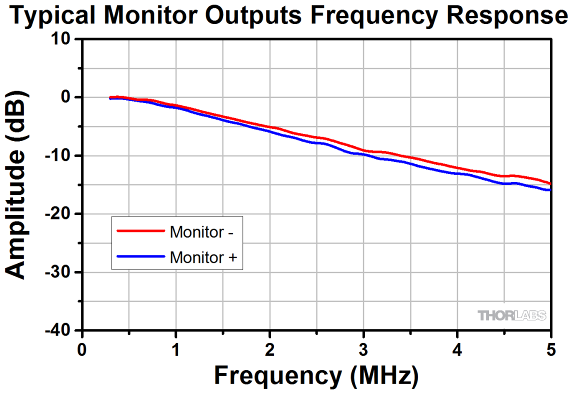


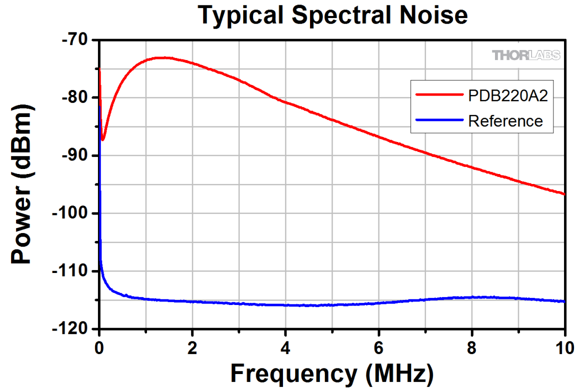


5.3.3 PDB220A2 Performance Plots

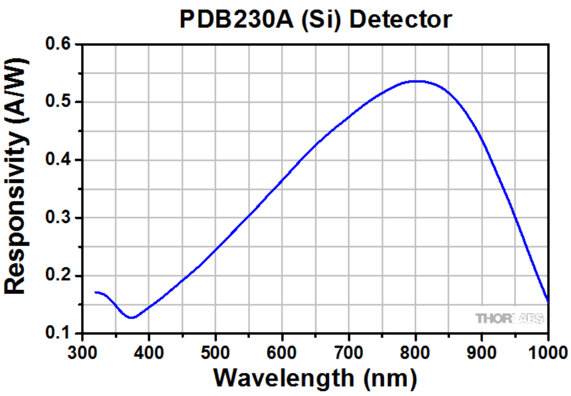


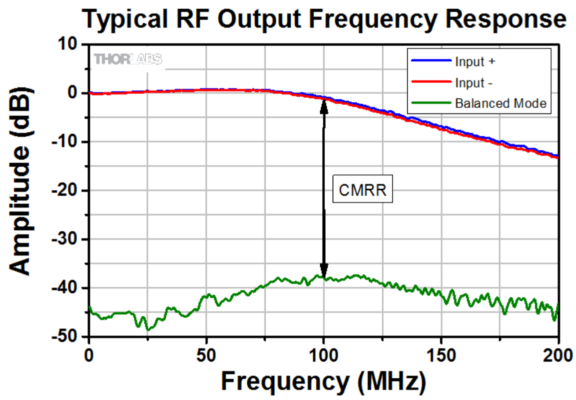


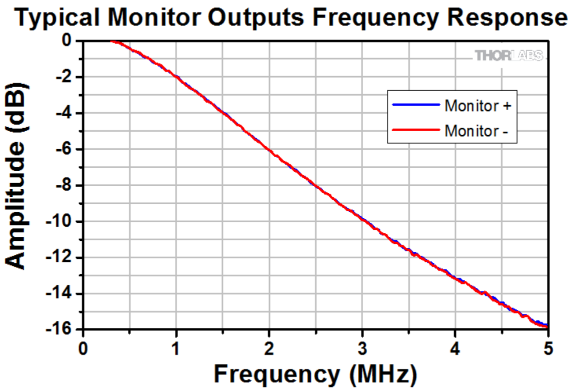


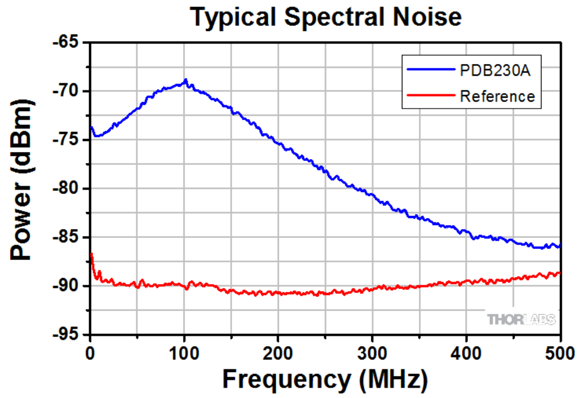


5.3.4 PBD230A Performance Plots

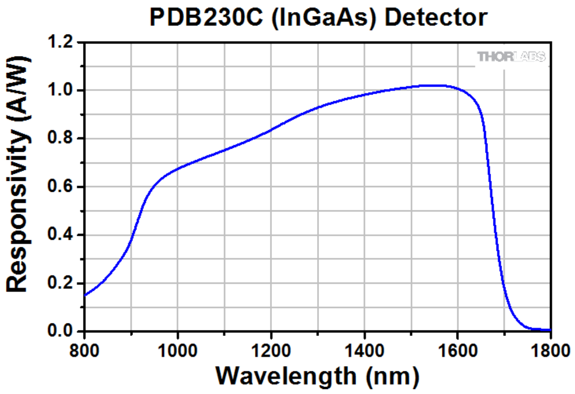


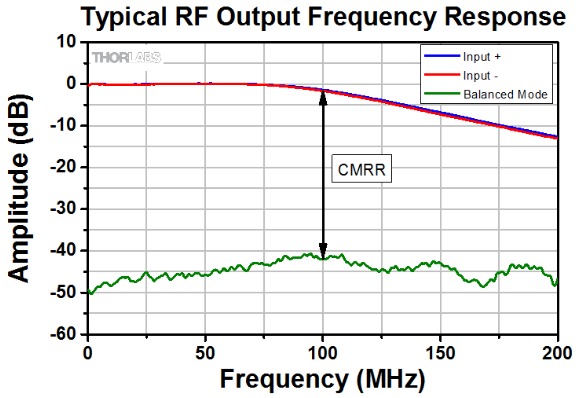


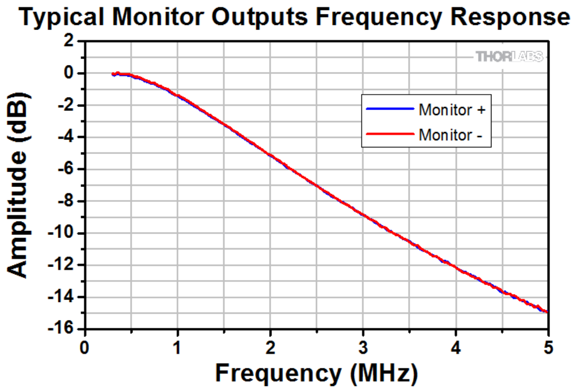


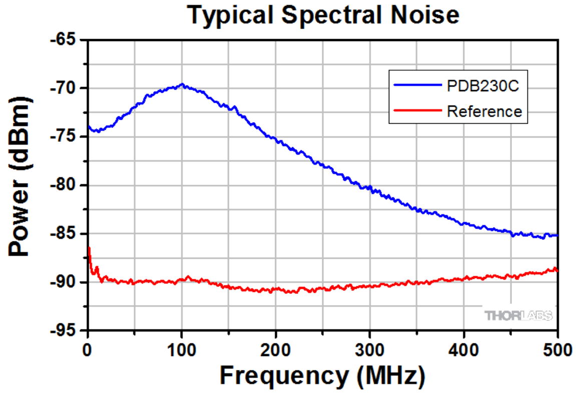


5.3.5 PBD230C Performance Plots







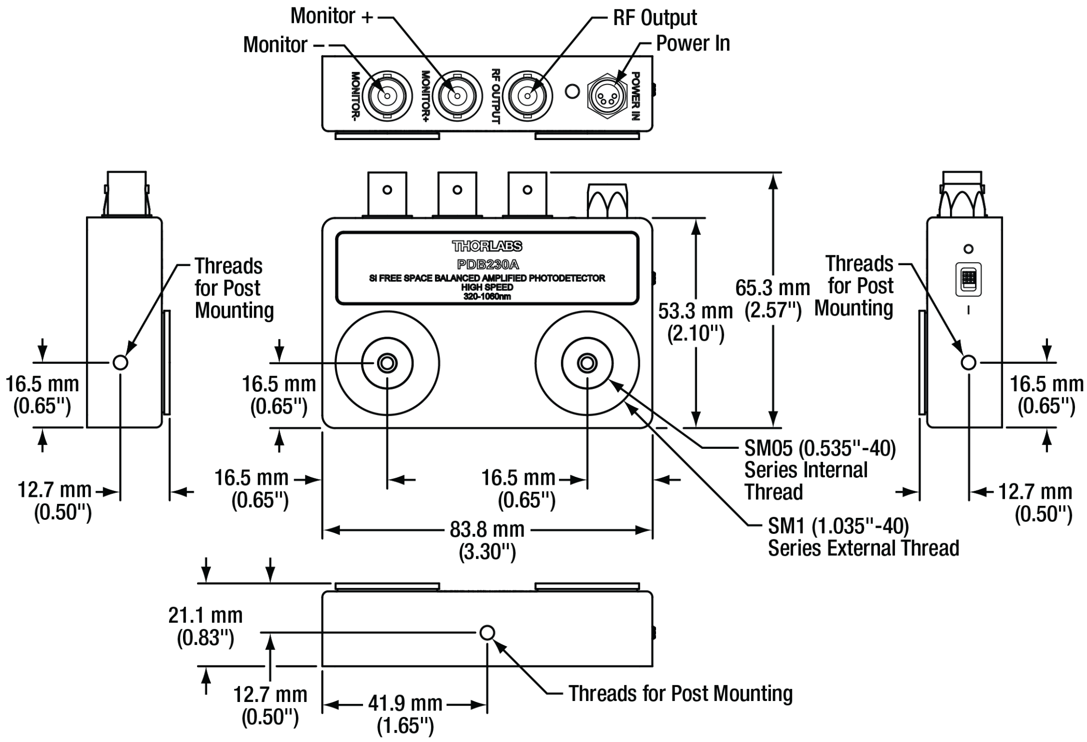


5.4 Dimensions

PDB230A, representing all other models of the PDB2xx Series.

The threads for post mounting are metric (M4), imperial (8-32) or universal (M4 and 8-32) depending on the model as listed in the table below.

Outer dimensions may vary slightly. Please have a look at the respective technical drawings on the Thorlabs website.



Item#	Threads for Post Mounting
PDB210A	8-32 TAP
PDB210A/M	M4 TAP
PDB220A2	8-32 TAP
PDB220A2/M	M4 TAP
PBD210C	8-32 TAP
PDB210C/M	M4 TAP
PDB230A	Universal 8-32/M4 Tap (imperial and metric)
PDB230C	Universal 8-32/M4 Tap (imperial and metric)

5.5 Certifications and Compliances

EU Declaration of Conformity

in accordance with EN ISO 17050-1:2010

We: Thorlabs GmbH

Of: Münchner Weg 1, 85232 Bergkirchen, Deutschland

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: ***PDB2*, PDB4*, PDB5****

Equipment: ***Fixed and switchable gain balanced amplifiers***

is 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 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:

does not contain 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:* 22 November 2019

Name: Bruno Gross

Position: General Manager *EDC - PDB2*, PDB4*, PDB5* -2019-11-22*

CE

5.6 Safety

Attention

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.

All modules must only be operated with proper shielded connection cables.
Only with written consent from *Thorlabs* may changes to single components be carried out or components not supplied by *Thorlabs* be used.
This precision device is only serviceable if properly packed into the complete original packaging including the plastic foam sleeves. If necessary, ask for a replacement package.

5.7 Return of Devices

This precision device is only serviceable if returned and properly packed into the complete original packaging including the complete shipment plus the cardboard insert that holds the enclosed devices. If necessary, ask for replacement packaging. Refer servicing to qualified personnel.

5.8 Manufacturer Address

Manufacturer Address Europe
Thorlabs GmbH
Münchner Weg 1
D-85232 Bergkirchen
Germany
Tel: +49-8131-5956-0
Fax: +49-8131-5956-99
www.thorlabs.de
Email: europe@thorlabs.com

EU-Importer Address
Thorlabs GmbH
Münchner Weg 1
D-85232 Bergkirchen
Germany
Tel: +49-8131-5956-0
Fax: +49-8131-5956-99
www.thorlabs.de
Email: europe@thorlabs.com

5.9 Warranty

Thorlabs warrants material and production of the PDB2xx Series 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

5.10 Copyright and Exclusion of Liability

Thorlabs has taken every possible care in preparing this document. We however assume no liability for the content, completeness or quality of the information contained therein. The content of this document is regularly updated and adapted to reflect the current status of the product.

Please refer to the general terms and conditions linked under Warranty 20.

5.11 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.

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Thorlabs China
chinasales@thorlabs.com

Thorlabs 'End of Life' Policy (WEEE)

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 users responsibility to delete all private data stored on the device prior to disposal.

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