THORLABS

Balanced Amplified Photodetectors

PDB440A, PDB440A-AC, PDB440C, PDB440C-AC, PDB450A, PDB450A-AC, PDB450C, PDB450C-AC Operation Manual

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Contents

We aim to develop and produce the best solution for your application in the field of optical measurement technique. To help us to live up to your expectations and constantly improve our products we need your ideas and suggestions. Therefore, please let us know about possible criticism or ideas. 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

Thorlabs PDB440x and PDB450x detectors 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.

To the PDB440x and PDB450x detectors housing an adapter can be attached to the bottom or side surface for post mounting. This adapter supports #8-32 as well as M4 post mounts.

The PDB440x and PDB450x detectors is supplied with an external linear power supply.

The "Getting Started" 4 section gives an overview of how to set up the PDB440x and PDB450x detectors Balanced Amplified Photodetectors. Subsequent sections contain detailed information about principle of operation, operating suggestions, and technical specifications.

1.1 Safety

Attention

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.

The PDB440x and PDB450x detectors must not be operated in explosion endangered environments!

Do not remove covers!

Do not open the cabinet. There are no parts serviceable by the operator inside!

This precision device is only serviceable if properly packed into the complete original packaging including the plastic foam sleeves. If necessary, ask for replacement packaging.

Refer servicing to qualified personnel!

Only with written consent from Thorlabs may changes to single components be made or components not supplied by Thorlabs be used.

1.2 Ordering Codes and Accessories

The following models of the PDB440x and PDB450x detectors are available:

PDB440 15 MHz, OCT-proved fixed gain Balanced Amplified Photodetectors with active aliasing filter

PDB450 up to 150 MHz, gain switchable Balanced Amplified Photodetectors

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

Thorlabs offers AC-coupled versions. on request Special versions (open detector - cover glass removed) are available as well - please contact Thorlabs 26 for details.

2 Getting Started

This section is intended to provide information that explains how to quickly set up the PDB440x and PDB450x detectors Balanced Amplified Photodetectors. More details and advanced features are described in further sections.

2.1 Parts List

Inspect the shipping container for damage.

If the shipping container seems to be damaged, keep it until you have inspected the contents and you have inspected the item mechanically and electrically.

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

1. PDB440x or PDB450x Balanced Amplified Photodetector
2. Adapter Plate with four M2x8 screws and a hex key 1.5, for post-mounting the unit on a optical table
3. LDS12B power supply (±12V, 250 mA), switchable to 100 V, 120 V, or 230 V line voltage
4. Operation manual

2.2 Preparation

Note

Prior to operation, please check, if the indicated line voltage range on the power supply matches with your local mains voltage! If you want use your own power supply, Thorlabs offers an appropriate power connector cable.

- Carefully unpack the unit and accessories. If any damage is noticed, do not use the unit and contact Thorlabs 26.
- Mount the unit on your optical table or application. Please see the chapter mounting 9 for detailed information.
- If necessary, mount external optics, filters, apertures or fiber adapters.
- Adjust the power supply to accommodate your local mains voltage (100 VAC, 120 VAC, or 230 VAC):

Voltage Selector Switch

- Connect the DC output cable of the power supply to the Power IN jack (DC INPUT).
- Plug the power supply into a 50-60 Hz, 100 VAC, 120 VAC, or 230 VAC outlet.
- Switch on the power supply.
- Connect RF OUTPUT to your data acquisition device using a coaxial cable.
- If desired, connect the monitor outputs (MONITOR+, MONITOR-) to measure the optical input power for each channel individually.

3 Operating Instruction

- Connect the optical source(s) to the optical input(s). The FC adapter will accommodate multi-mode as well as single-mode fiber.

Attention

Please note that for PDB440X the INPUT- is on top and INPUT+ is on the bottom.

Attention

Be very careful about the force when connecting the fibers to the optical inputs! 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 very careful when tightening the fiber connector, in order to avoid damages to the glass window that protects the photodiode.

- The MONITOR output can be used to conveniently check the detected signal from each 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 outputs 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 14) to avoid saturation.
- For balanced operation illuminate both photodetectors simultaneously and use either the RF OUTPUT or the MONITOR outputs to fine-tune the optical power balance by observing voltage on a digital voltmeter or other low-frequency measurement device.
- After finishing measurements, turn the power supply off.

Note

To prevent saturation of the balanced amplifier make sure that the power difference between the optical inputs remains less than the saturation power level (see "RF OUT CW Saturation Power" in the Technical Data section 14).

Attention

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

Note

For free-space beam applications, the FC adapters can be removed in order to have direct access to the photodetectors.

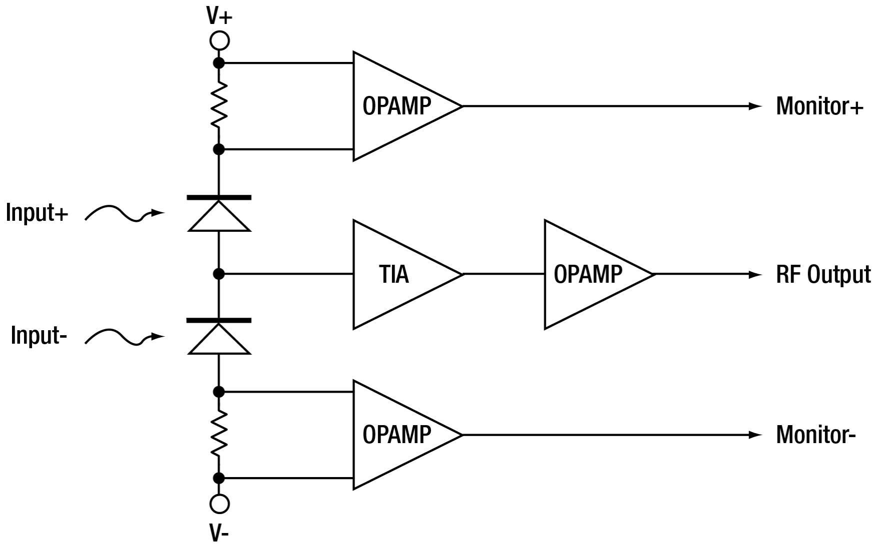
3.1 Operating Principle

Thorlabs product family of PDB440x and PDB450x detectors 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 their increased cut-off frequency, these outputs can also be used to measure low frequency modulated signals on each detector separately.

The PDB440x and PDB450x detectors is powered by an external linear power supply (±12 V, 250 mA - included) via a PICO M8 power connector.

Below is a functional block diagram of the PDB440x and PDB450x detectors Balanced Amplified Photodetectors:



3.2 Optical Inputs

For all models the fiber inputs are coupled to the photodiodes using two removable FC adapters. These FC receptacles accommodate either single-mode or multi-mode fiber with FC/PC or FC/APC connectors.

Attention

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

For all **PDB4xxC** models the FC adapters are aligned for Corning SMF28™ single mode fibers with PC connectors. When using FC/APC connectors, minimal alignment errors may occur due to the small detector size, this may result in reduced output signal. In this case, the FC receptacle can be rotated from its original position in steps of 90° to check for an improved alignment. For this process use optical input power below the saturation level while observing the RF OUTPUT voltage on a digital voltmeter or other low-frequency measurement device. If you have an AC-coupled version, use either MONITOR output (CW signal) or RF OUTPUT (modulated optical signal) with a connected oscilloscope for measurement.

In general, a multi-mode fiber can be used. However, please be aware that the light beam spot diameter exceeds the detector's active area which results in a reduced output signal.

For free-space beam applications it is recommended to remove the FC adapter (receptacle) to have direct access to the photodiodes as shown below on a drawing of the PDB410C. This is identical to PDB440 and PDB450. Please be aware the INPUT+ and INPUT- are reversed in PDB440x versus PDB450x.

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 PDB440x and PDB450x detectors 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-. Please be aware that PDB440 and PDB450 have opposite optical input connectors for + and - (see drawings).

In single detector mode, the optical input power should be below the specified CW saturation power (see Technical Data 14) 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!

3.3 Electrical Outputs

The Thorlabs PDB440x and PDB450x detectors has three SMA 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 photo diode 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 Technical Data 14 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 14 section.

The optical input saturation power (see the PDB440x and PDB450x detectors individual technical data in the appendix) of the balanced detector is the minimum value, as it is given for the wavelength with the detector highest 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 inputs) should not exceed CW Saturation Power listed in Specifications.

MONITOR Outputs

The signal monitor outputs (**MONITOR+** and **MONITOR-**) allow to observe the input power level and can be used as individual power indicators. These outputs can also be used to measure low frequency modulated signals on each detector separately. 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** outputs will occur at optical input power level greater than 1 mW, depending on the detector's wavelength response.

MONITOR outputs can be used to roughly adjust equal input power levels on each detector for balanced operation. While the DC component of the **RF OUTPUT** in balanced mode is zero, the **MONITOR** outputs provide capability to independently observe the individual optical input power. **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.

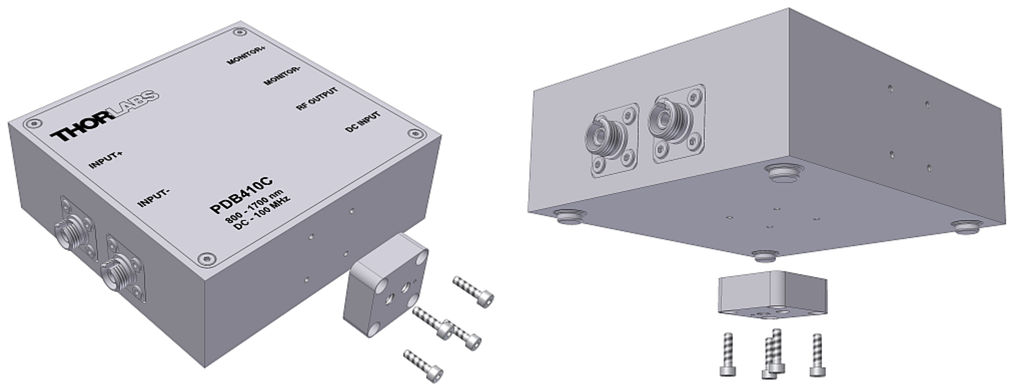
3.4 Mounting

The PDB440x and PDB450x detectors is housed in a rugged shielded aluminum enclosure.

For post mounting an adapter can be attached to the bottom or side surface using four M2x8 screws (see below). This adapter supports #8-32 as well as M4 post mounts. The M4 tread is marked.

Attention

Please note that for PDB440X the INPUT- is on top and INPUT+ is on the bottom.



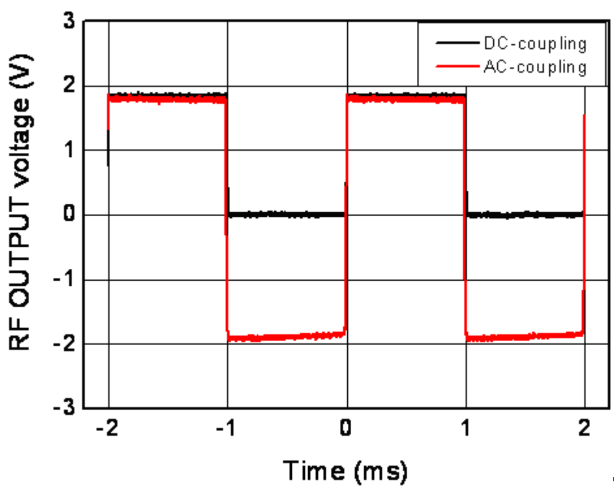
3.5 AC Coupling of the Outputs

Beside the standard DC coupling of the **RF OUTPUT**, AC coupled versions for any model of PDB440x and PDB450x detectors 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 shall be measured on a strong CW background signal, which could saturate the amplifier. With AC coupling, equalizing of CW power levels on both inputs 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 ≤ 100 Hz; 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.



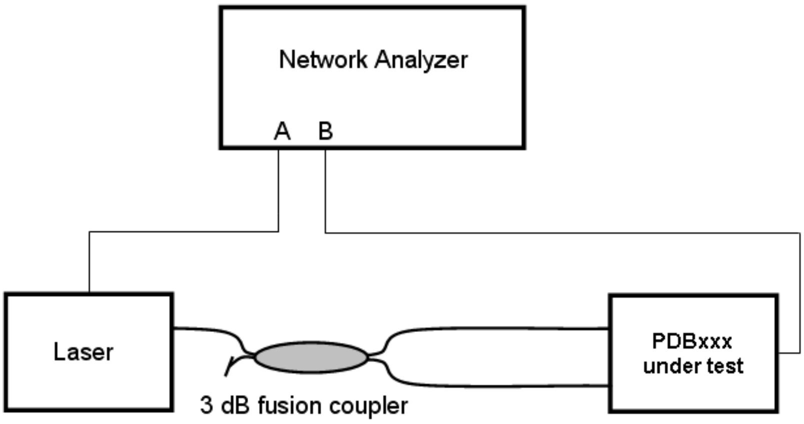
The figure below shows the comparison of AC and DC coupled RF Output signals when modulating the input signal with a mechanical chopper at a frequency of 500 Hz.

Note: The input signal for AC coupling was increased by factor 2 to allow direct waveform comparison.

3.6 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 as described below, the Device under Test (DuT) - here a PDB440x and PDB450x detectors 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. To the laser output a 3 dB fusion coupler is connected, splitting the modulated light signal into two paths.Depending on the measurement task, one or both coupler outputs are connected to the inputs of the DuT, for example using S120-FC adapters. One of the DuT's outputs is connected to the network analyzers 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. 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 outputs, as shown in the individual technical data.

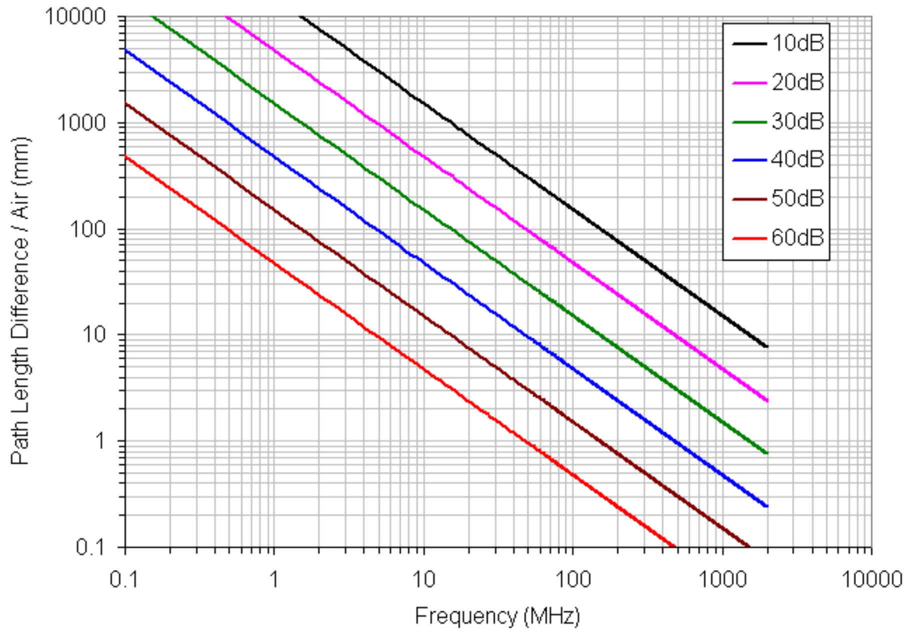
CMRR measurement

For Common Mode Rejection measurement, both outputs of the fusion coupler are connected to both inputs 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 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 individual technical data.

3.7 Recommendations

Thorlabs PDB440x and PDB450x detectors Balanced Amplified Photodetectors can eliminate noise sources to allow precise measurements. The PDB440x and PDB450x detectors is designed to be used in a dual beam setup: one optical path for measurement and one invariant reference path. If set up properly, the PDB440x and PDB450x detectors can reduce common mode noise for more than 35 dB over the specified frequency range. Below are given some recommendations to achieve an optimal common mode suppression:

- To obtain the maximum possible common mode rejection (common mode noise suppression), 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 as well 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 very important 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 on next page 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.
- Another critical point can be electrostatic coupling of electrical noise associated with ground loops. 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 PDB440x and PDB450x detectors Balanced Detector. Different common ground points can also be tested.

4 Maintenance and Service

Protect the PDB440x and PDB450x detectors from adverse weather conditions. The PDB440x and PDB450x detectors is not water resistant.

Attention

Be very careful when connecting the fibers to the optical inputs! 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 not to tighten the fiber connector too much in order to avoid damages 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 need a 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 contact Thorlabs 26 for return instructions.

Do not remove covers!

To clean the PDB440x and PDB450x detectors 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 debris using compressed air and wipe gently with an optic tissue wetted with isopropanol or alcohol.

5 Appendix

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:

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

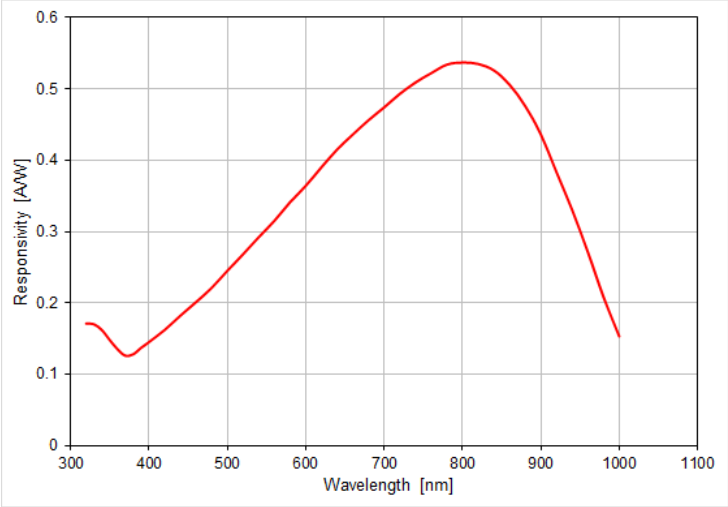
  This formula shows, that the conversion gain is dependent on the actual wavelength, as well. In the specifications, the conversion gain is given only for the peak responsivity wavelength of the photo diode. The conversion gain values are always given for a high impedance load at the RF Output; for 50 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 PDB440x and PDB450x detectors balanced detectors from DC to the RF Output cut frequency.
- **Max. 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" 10

5.1 Technical Data

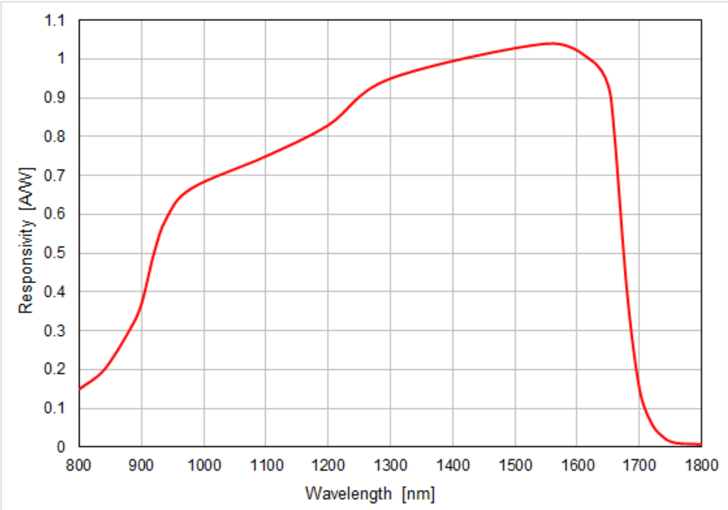
Common	
Optical Inputs	FC, removable
Max. Input Power (Damage Threshold)	20 mW
Electrical Outputs	SMA
RF OUTPUT	
Impedance	50 Ω
Voltage Swing, max. (PDB440x)	± 3.6 V [1])
Voltage Swing, max. PDB450, gain - 10^3 to 10^6 PDB450, gain - 10^7	 ± 4.6V [1]) ± 10V [1])
MONITOR Outputs	
Impedance	220 Ω
Voltage Swing, max.	10 V (high impedance load) 1.55 V (50 Ω load)
Bandwidth	DC to 1 MHz
Conversion Gain	10 V/mW @ peak responsivity
Voltage Noise	<180 μV_{RMS}
DC Offset	< ± 2 mV
General	
Power Supply	±12 V, 250mA
Dimensions	85 x 80x 30 mm^3
Operating Temperature Range [2])	0 - 40 °C
Storage Temperature Range	-40 to 70 °C
Weight	0.35 kg (w/o power supply)

[1]) Values are given for high impedance load. For a 50 Ω load, values are to be divided by 2.
[2]) non-condensing

Typical Detector responsivity curves

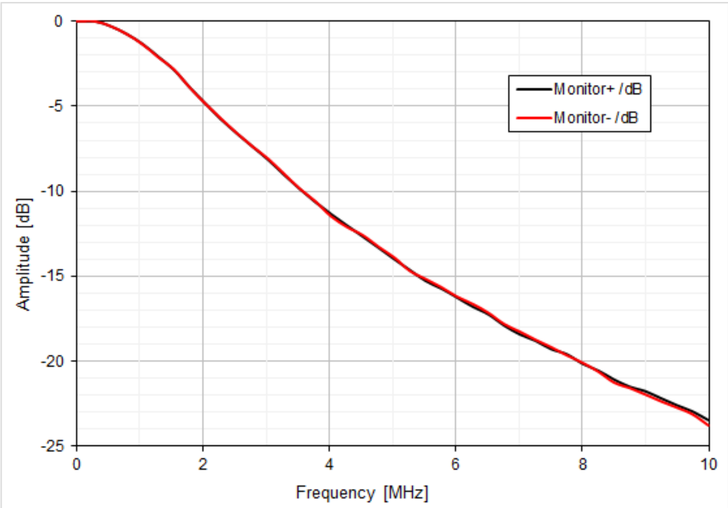


Typical Si Detector responsivity (PDB440A, PDB450A)



Typical InGaAs Detector responsivity (PDA440C, PDB450C)

Typical Monitor Output Frequency Response



PDB440 and PDB450 Series Monitor Output Frequency Response

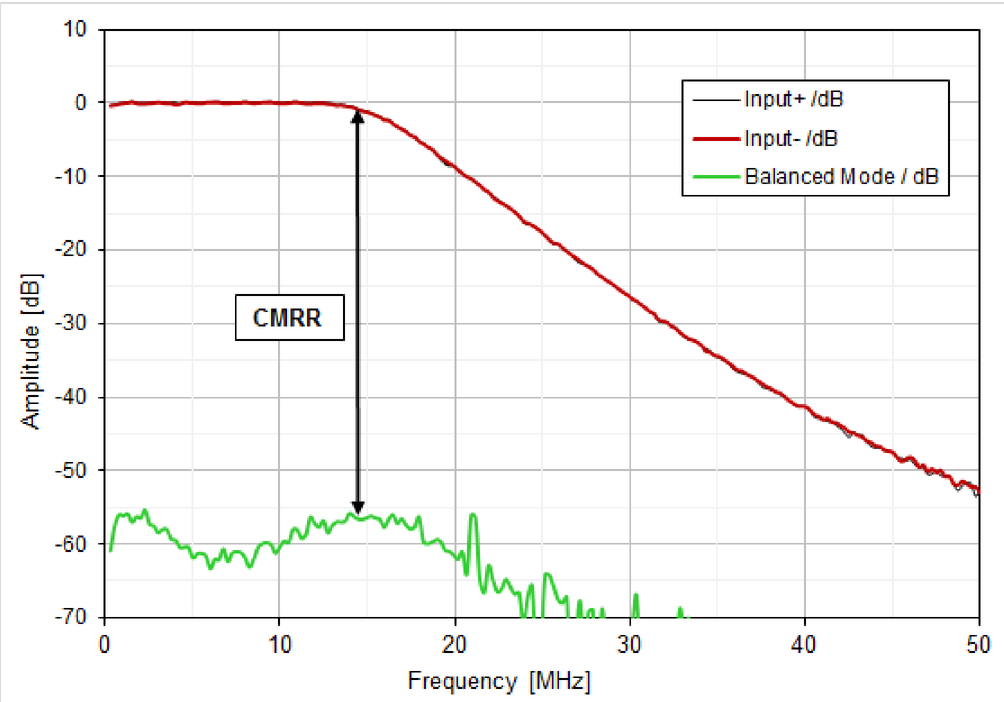
5.1.1 PDB440x Individual Technical Data

	PDB440A	PDB440C
Detector Material / Type	Si / PIN	InGaAs / PIN
Operating Wavelength Range	320 - 1000 nm	800 - 1700 nm
Max. Responsivity, typ.	0.53 A/W	1.0 A/W
Detector Active Area Ø	0.8 mm	0.3 mm
RF OUTPUT Bandwidth (-3 dB)	DC - 15 MHz	
CMRR	>35 dB	
RF OUTPUT Transimpedance Gain [1])	51×10^3 V/A	
RF OUTPUT Conversion Gain [2])	27×10^3 V/W	51×10^3 V/W
RF OUTPUT DC Offset	< ± 3 mV	
CW Saturation Power	130 µW @ 820 nm	70 µW @ 1550 nm
Minimum NEP (DC to 15 MHz)	6.9 pW/√Hz	3.9 pW/√Hz

[1]) Values are given for high impedance load. For a 50 Ω load, values are to be divided by 2.

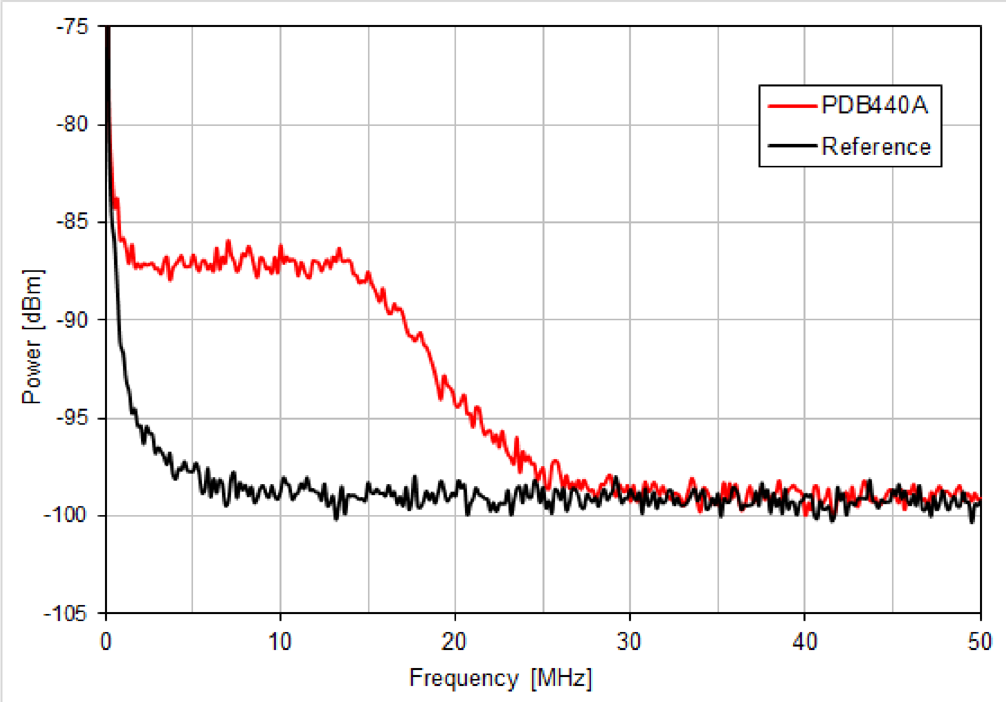
[2]) Values are given at peak responsivity of the detector, for high impedance load. For a 50 Ω load, values are to be divided by 2.

PDB440A: Typical RF OUTPUT Frequency Response



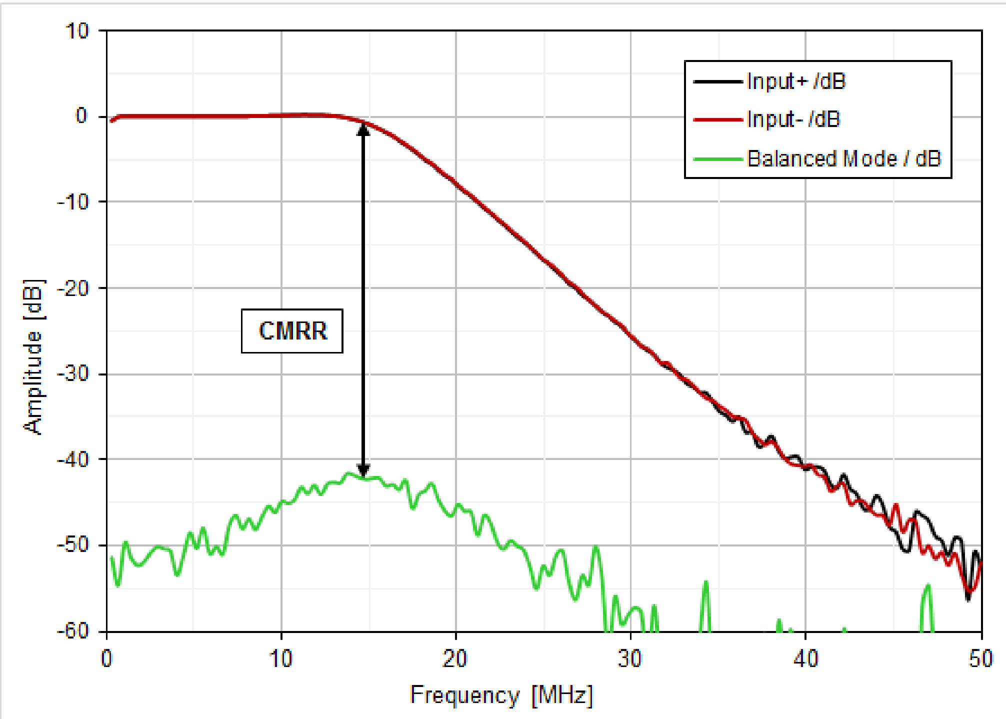
PDB440A: Typical RF OUTPUT Frequency Response

PDB440A: RF OUTPUT Spectral Noise



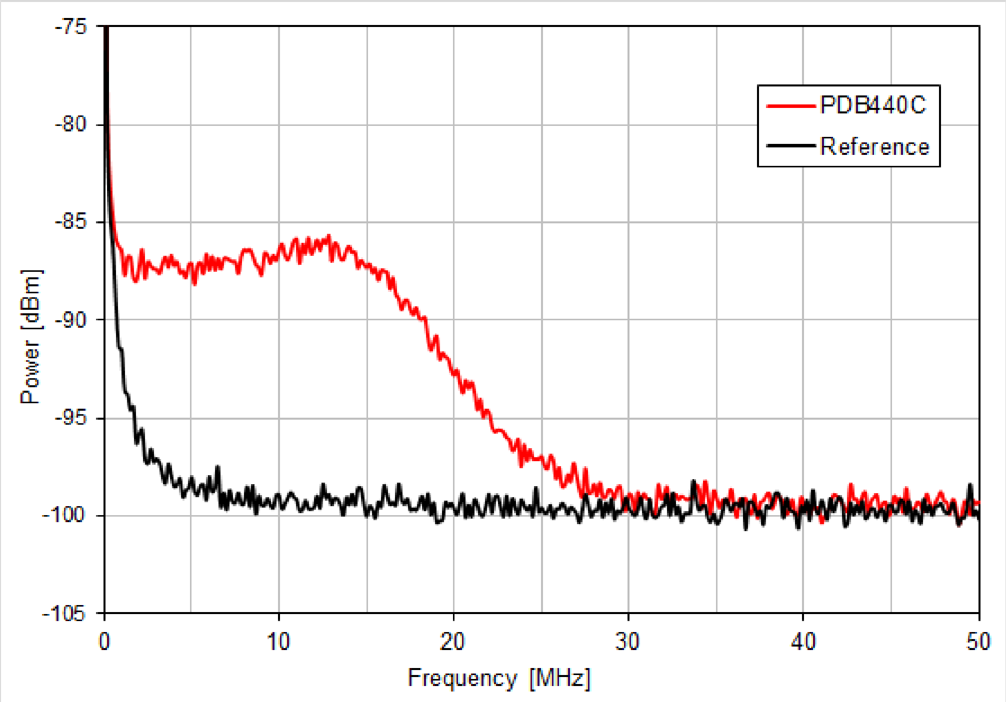
PDB440A: RF OUTPUT Spectral Noise

PDB440C: Typical RF OUTPUT Frequency Response



PDB440C: Typical RF OUTPUT Frequency Response

PDB440C: RF OUTPUT Spectral Noise



PDB440C: RF OUTPUT Spectral Noise

5.1.2 PDB450x Individual Technical Data

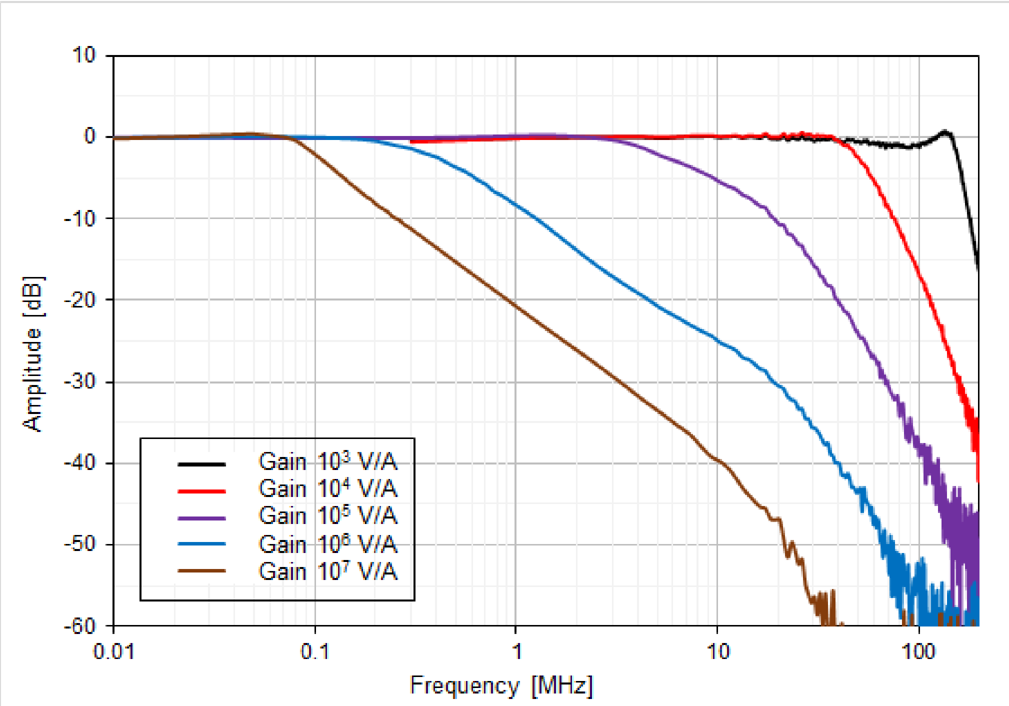
	PDB450A	PDB450C
Detector Material / Type	Si / PIN	InGaAs / PIN
Operating Wavelength Range	320 - 1000 nm	800 - 1700 nm
Max. Responsivity, typ.	0.53 A/W	1.0 A/W
Detector Active Area Ø	0.8 mm	0.3 mm
RF OUTPUT Bandwidth (-3 dB)	DC - 150 / 45 / 4 / 0.3 / 0.1 MHz	
CMRR	>25 dB (typ. >30 dB)	
RF OUTPUT Transimpedance Gain [1]	10^3 / 10^4 / 10^5 / 10^6 / 10^7 V/A	
RF OUTPUT Conversion Gain [2]	0.53 × 10^3 V/W 0.53 × 10^4 V/W 0.53 × 10^5 V/W 0.53 × 10^6 V/W 0.53 × 10^7 V/W	1 × 10^3 V/W 1 × 10^4 V/W 1 × 10^5 V/W 1 × 10^6 V/W 1 × 10^7 V/W
RF OUTPUT DC Offset	< ± 15 mV	
CW Saturation Power	9 mW @ 820 nm	4.5 mW @ 1550 nm
Minimum NEP DC to 0.1 MHz (Gain 10^7 V/A) DC to 0.3 MHz (Gain 10^6 V/A) DC to 4 MHz (Gain 10^5 V/A) DC to 45 MHz (Gain 10^4 V/A) DC to 150 MHz (Gain 10^3 V/A)	1.4 pW/√Hz 1.1 pW/√Hz 3.3 pW/√Hz 28.9 pW/√Hz 123 pW/√Hz	0.7 pW/√Hz 0.5 pW/√Hz 1.55 pW/√Hz 14.9 pW/√Hz 68.6 pW/√Hz

Note Make sure hat the transimpedance gain is set in such way, that RF OUTPUT is below saturation threshold!

[1]) Values are given for high impedance load. For a 50 Ω load, values are to be divided by 2.

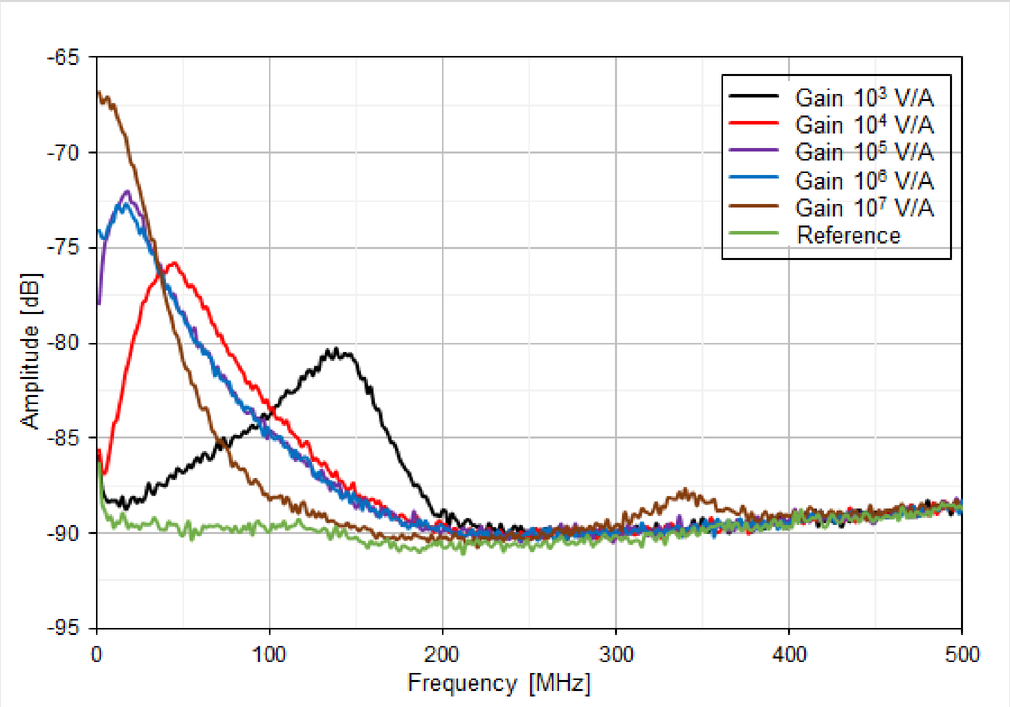
[2]) Values are given at peak responsivity of the detector, for high impedance load. For a 50 Ω load, values are to be divided by 2.

PDB450A: Typical RF OUTPUT Frequency Response



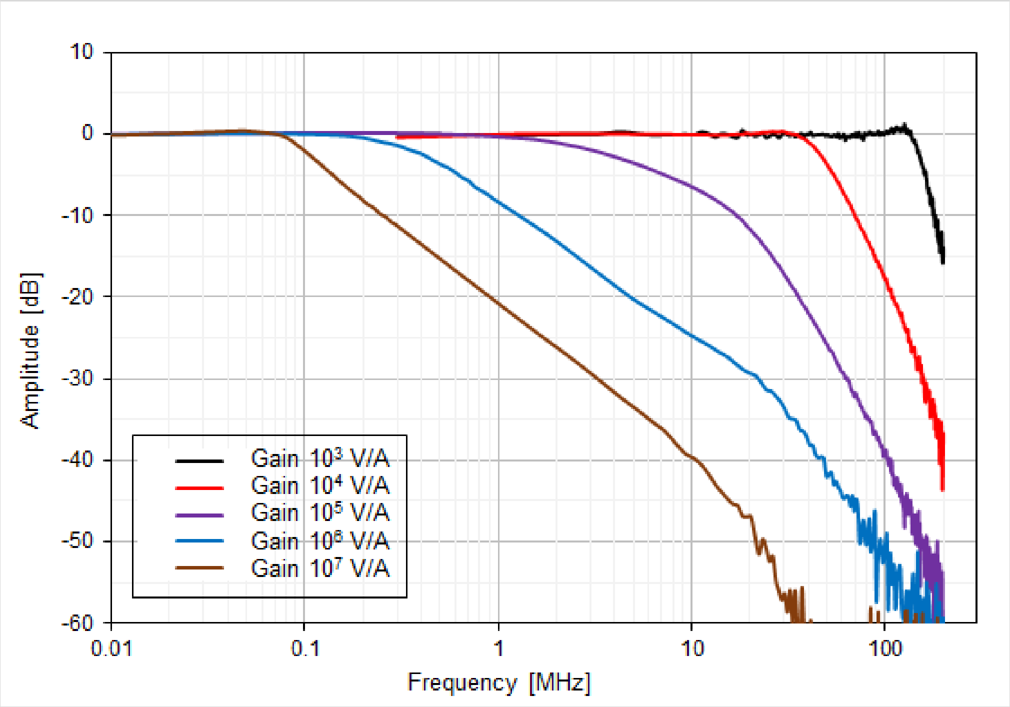
PDB450A: Typical RF OUTPUT Frequency Response at different gain settings

PDB450A: RF OUTPUT Spectral Noise



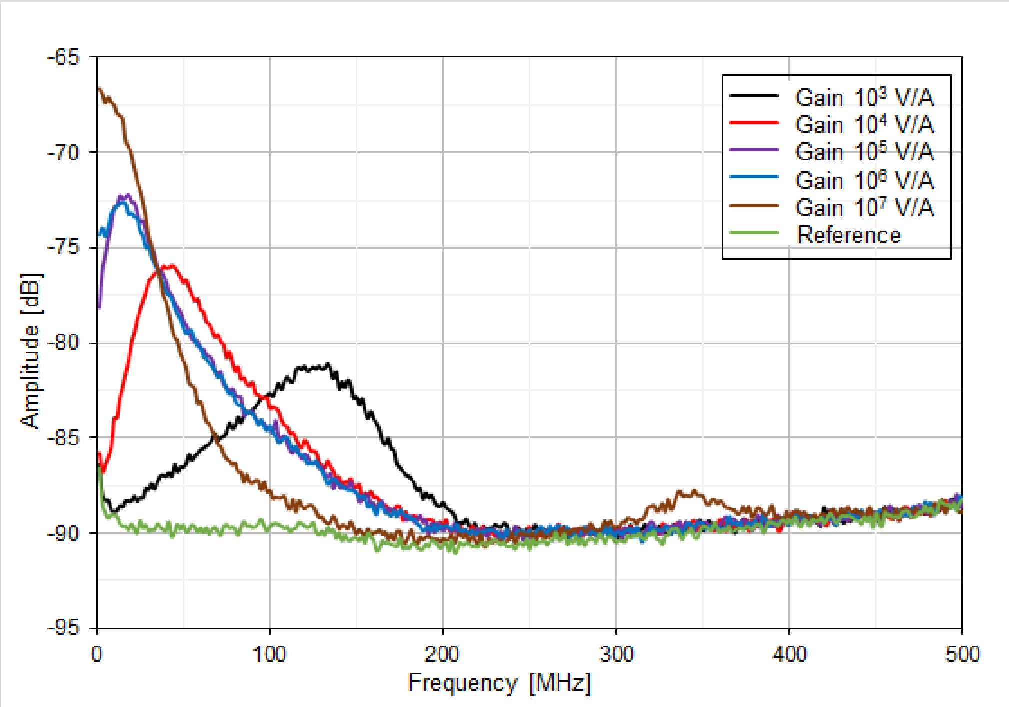
PDB450A: RF OUTPUT Spectral Noise at different gain settings

PDB450C: Typical RF OUTPUT Frequency Response



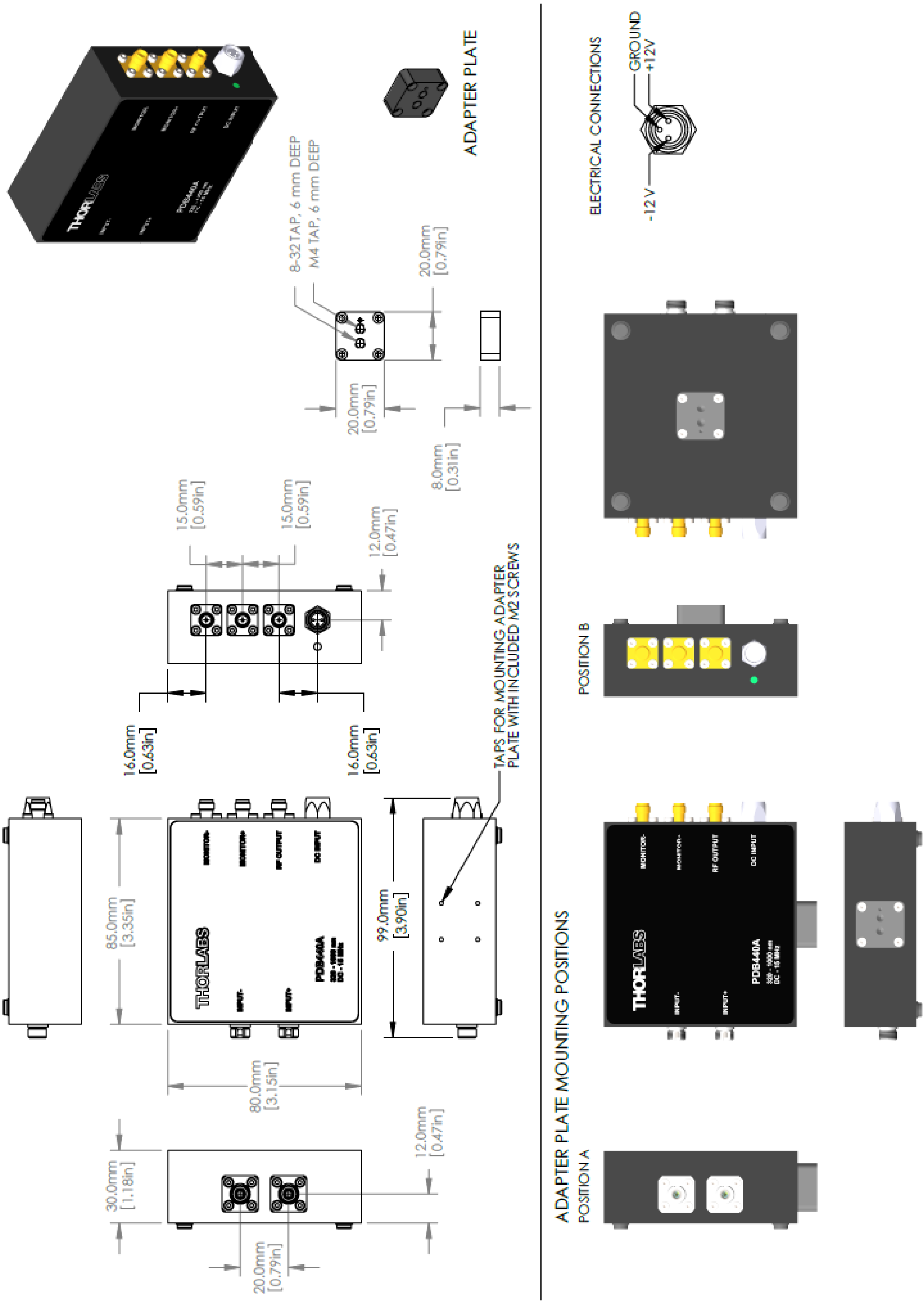
PDB450C: Typical RF OUTPUT Frequency Response at different gain settings

PDB450C: RF OUTPUT Spectral Noise

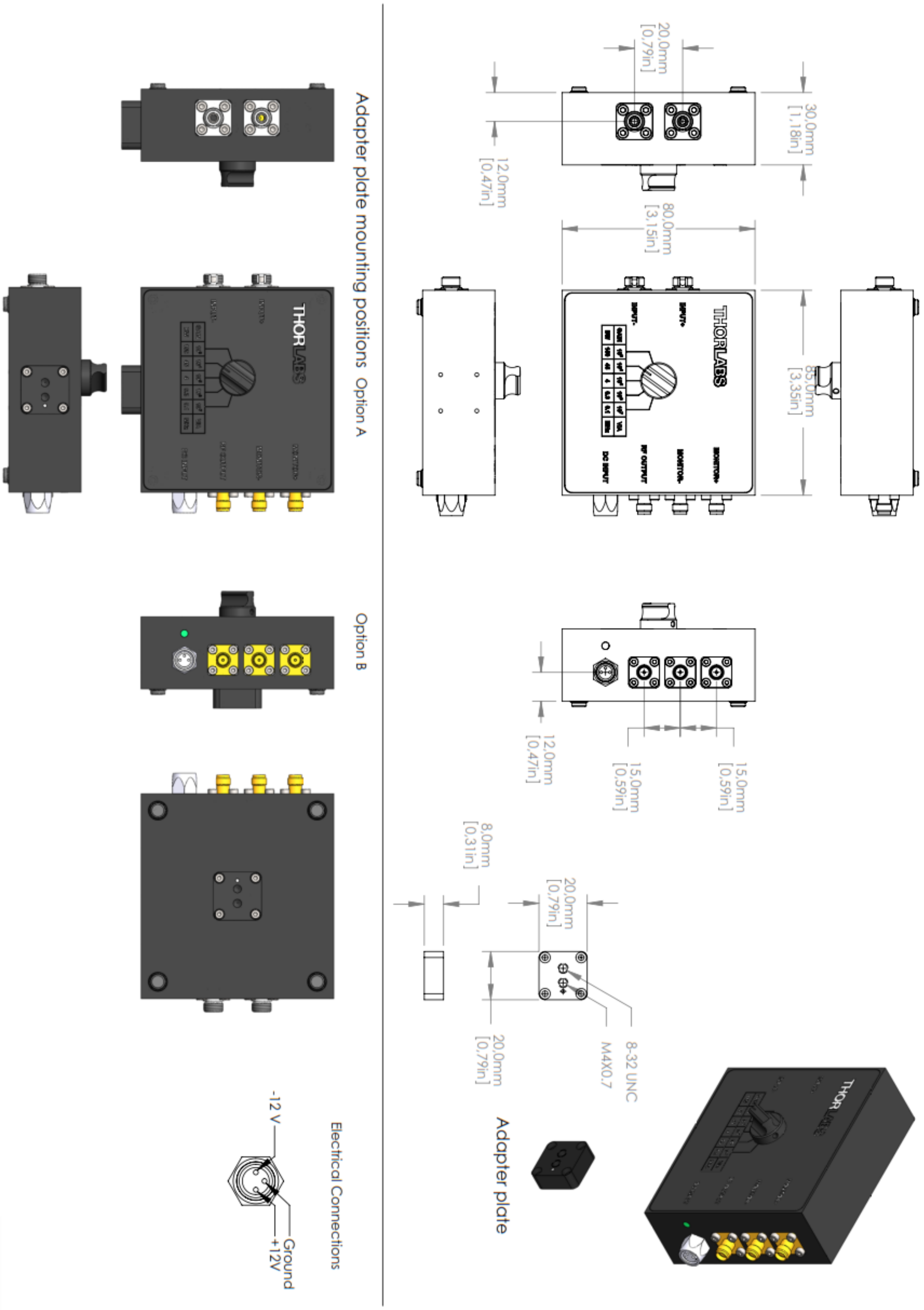


PDB450C: RF OUTPUT Spectral Noise at different gain settings

5.2 Dimensions



Mechanical Drawing PDB440



Mechanical Drawing PDB450

5.3 Certifications and Compliances

EU Declaration of Conformity

in accordance with EN ISO 17050-1:2010

We: Thorlabs GmbH

Of: Hans-Boeckler-Str. 6, 85221 Dachau/München, 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: ***PDB4 Series***

Equipment: ***Balanced Receiver***

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: D. Jennrich *On:* 19 September 2014

CE 14

Name: Dorothee Jennrich

Position: General Manager *EDC - PDB4 Series -2014-09-19*

5.4 Warranty

Thorlabs warrants material and production of the PDB440x and PDB450x detectors for a period of 24 months starting with the date of shipment. During this warranty period Thorlabs will see to defaults by repair or by exchange if these are entitled to warranty.

For warranty repairs or service the unit must be sent back to Thorlabs. The customer will carry the shipping costs to Thorlabs, in case of warranty repairs Thorlabs will carry the shipping costs back to the customer.

If no warranty repair is applicable the customer also has to carry the costs for back shipment.

In case of shipment from outside EU duties, taxes etc. which should arise have to be carried by the customer.

Thorlabs warrants the hard- and/or software determined by Thorlabs for this unit to operate fault-free provided that they are handled according to our requirements. However, Thorlabs does not warrant a fault free and uninterrupted operation of the unit, of the software or firmware for special applications nor this instruction manual to be error free. Thorlabs is not liable for consequential damages.

Restriction of Warranty

The warranty mentioned before does not cover errors and defects being the result of improper treatment, software or interface not supplied by us, modification, misuse or operation outside the defined ambient stated by us or unauthorized maintenance.

Further claims will not be consented to and will not be acknowledged. Thorlabs does explicitly not warrant the usability or the economical use for certain cases of application.

Thorlabs reserves the right to change this instruction manual or the technical data of the described unit at any time.

5.5 Copyright and Exclusion of Reliability

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 hardware and/or software. We furthermore do not guarantee that this product will function without errors, even if the stated specifications are adhered to.

Under no circumstances can we guarantee that a particular objective can be achieved with the purchase of this product.

Insofar as permitted under statutory regulations, we assume no liability for direct damage, indirect damage or damages suffered by third parties resulting from the purchase of this product. In no event shall any liability exceed the purchase price of the product.

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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.

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