THORLABS

Balanced Amplified Photodetectors

PDB570C
Operation Manual

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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 PDB570C Balanced Amplified Photodetectors consist of two well-matched, fiber coupled avalanche photodiodes with length matched fibers and an ultra-low noise, ultra-low distortion high-speed transimpedance amplifier that generates an output voltage (RF OUTPUT) proportional to the difference between the photo current in the two photodiodes, i.e. the two optical input signals.

Distinguished properties of the PDB570C are it's exceptionally low NEP, optical gain control and auto-balancing function with a variable closed loop control velocity.

Additionally, the unit has a CONTROL OUTPUT that allows to monitor the auto-balancing control loop signal.

An adapter for post mounting 10 can be attached to the bottom or side surface of the PDB570C housing. This adapter supports #8-32 as well as M4 post mounts.

The PDB570C is supplied with an external linear power supply.

The "Getting Started" 4 section gives an overview of how to set up the PDB570C Balanced Amplified Photodetectors. Subsequent sections contain detailed information about principle of operation, operating suggestions and technical specifications.

1.1 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.

Warning

Do not remove covers! The PDB570C operates with high voltages.

1.2 Ordering Codes and Accessories

PDB570C	400 MHz ultra-low noise, variable optical gain auto-balanced amplified photodetector with fiber length matched pigtailed InGaAs avalanche photo diodes, fiber SMF28

2 Installation

This section is intended to provide information how to set up quickly the PDB570C 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 PDB570C mechanically and electrically.

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

1. PDB570C 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 Getting Started

Attention

Please check prior to operation, if the indicated line voltage range on the power supply matches with your local mains voltage to avoid damages to the AC power supply.

If you want use your own power supply, Thorlabs offers an appropriate DC power cable.

- 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.
- If required, mount the unit on your optical table or application. Therefore, mount the adapter plate on bottom or side wall using the four M2x8 screws first. The adapter plate has two mounting holes, M4 and #8-32. The M4 thread is marked. These threads can be used for mounting onto Thorlabs posts.
- Set the power supply to 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.
- Connect the power supply to the AC outlet, turn power supply on
- Connect RF OUTPUT with coaxial cable to the data acquisition device. Please note, that a 50 Ω impedance device should be used for best RF performance.

- For operation in AUTO BAL mode, it is helpful to connect the CONTROL OUTPUT to an oscilloscope to monitor the control loop feedback signal. The CONTROL OUTPUT is designed for high impedance loads, but works also on 50 Ω load.
- Turn the power switch of the power supply to "**I**". The green LED next to the DC input connector indicates correct power supply.
- Connect the optical source(s) to the optical input(s). Please note that the PDB570C is designed for FC/APC connectors!
- Select the desired operation mode using the mode selector switch "RF OUTPUT". For a detailed description, please see section Operating Modes 7.
- After the measurements are finished, turn power off.

Attention

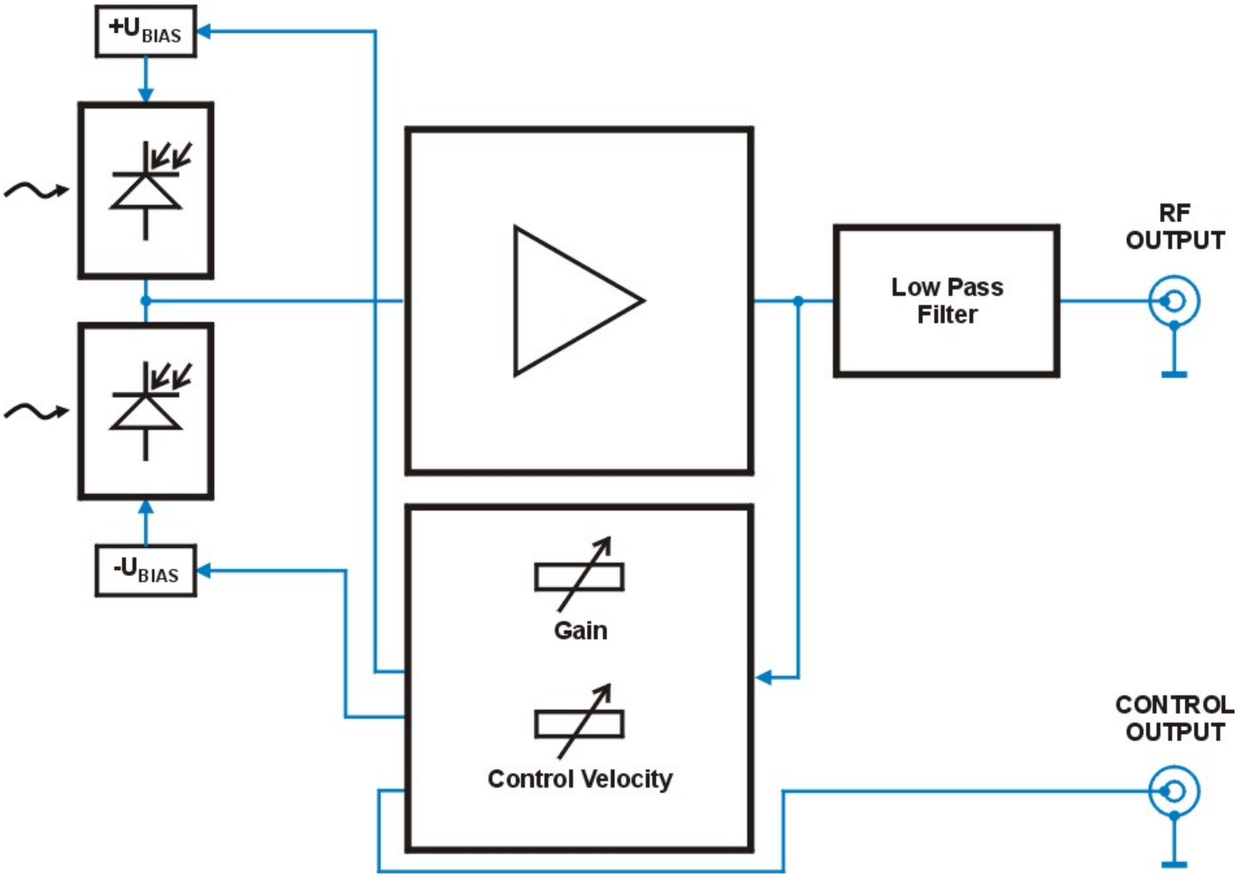
The damage threshold of the photo diodes is 200 µW! Exceeding this value will permanently destroy the detector!

3 Operating Instruction

3.1 Operating Principle

Thorlabs PDB570C Balanced Amplified Photodetectors consist of two well-matched, pigtailed avalanche photodiodes (APD) and an ultra-low noise, ultra-low distortion 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 between the two optical input signals. The fiber lengths of the photo diodes are matched to minimize optical path length differences between the input connectors and the APD's active area.

Additionally, the optical gain of the photo diodes can be manually controlled by changing the bias voltage of the APD. This optical gain control is used as well for the auto-balancing function. In auto-balanced mode, a control output allows to monitor the control loop signal. The velocity of the control loop is adjustable.



The PDB570C is powered by an external linear power supply (±12 V, 250 mA - included) via a PICO M8 power connector.

3.2 Operating Elements

INPUT + / INPUT -	FC/APC inputs; inside SMF28 fiber
CONTROL OUTPUT	SMA Output of the loop control signal
RF OUTPUT	SMA, Main signal output with respect to the selected mode
DC INPUT	Power supply
OPTICAL GAIN	Control the optical gain of the photo detectors
CONTROL VELOCITY	Adjust control loop velocity
Switch RF OUTPUT	Operating mode selector

3.3 Operating Modes

The PDB570C offers three different operating modes:

3.3.1 Single Detector Mode

In single detector mode, both inputs can be connected to a signal source. Set the mode switch to **INPUT+** or **INPUT-** depending on what input should be monitored at RF OUTPUT.

Use **OPTICAL GAIN** control to adjust the **RF OUTPUT** signal level. Monitoring of the input signals is helpful to adjust the experimental setup for equal input power levels prior to continue measurements in BAL or AUTO-BAL mode.

Notes

- In single detector mode, CONTROL VELOCITY and CONTROL OUTPUT are disabled.
- In single detector mode, the bandwidth is limited to 300 MHz with a slight gain peak (see typical diagrams 18)

- When adjusting optical gain, make sure not to saturate the amplifier. The RF OUTPUT voltage swing must not exceed ±2.1 V (50 Ω load) resp. ±4.2 V (high Z load)!
- The other input, that is not in use, will be muted. However, due to the operating principle of the optical gain control, the not selected input will not be completely switched off, it remains active with a very weak sensitivity.

Attention

Make sure not to exceed the maximum input power of 200 µW! Higher power level may destroy the photo detector!

3.3.2 Balanced Mode

Set the mode switch to **BAL.** This mode is equivalent to a standard balanced detector, with the difference that the optical gain can be adjusted for both inputs simultaneously by a factor 4 (M = 2.5 to 10). The balance needs to be achieved by adjusting the input power levels and observing the difference signal at the **RF OUTPUT**.

Note

In balanced mode, CONTROL VELOCITY and CONTROL OUTPUT are disabled.

Attention

Make sure not to exceed the maximum input power of 200 µW! Higher power level may destroy the photo detector!

3.3.3 Auto-Balanced Mode

Set the mode switch to **AUTO-BAL**.

In auto balanced mode, CONTROL VELOCITY and CONTROL OUTPUT are active. The **OPTICAL GAIN** control affects only **INPUT-**, while **INPUT+** is controlled by the control loop signal for power balance. An outstanding feature of the PDB570C is the gain control to lower as well as to higher values. That means, that it's not significant which of the two input signals has the higher level. However, the gain control is limited to the optical gain adjustment range and is affected by the actual **Optical Gain** setting. If the input signal power imbalance is greater than the optical gain adjustment range, AUTO-BAL cannot operate properly.

A good starting point to achieve an optimal auto-balancing performance is if the input power levels are close each to the other and the **Optical Gain** of **INPUT-** is set to a medium value.

In order to achieve optimal measurement results, set **OPTICAL GAIN** to medium value (or in accordance with power ratio between the inputs). Set the **CONTROL VELOCITY** to minimum for a maximum control loop stability. Depending on the input conditions higher **CONTROL VELOCITY** settings may lead to better noise suppression and should be figured out experimentally.

Note

If the input power difference is too large and/or the loop velocity is set too high, oscillations of the control loop may appear.

Attention

Make sure not to exceed the maximum input power of 200 µW! Higher power level may destroy the photo detector!

3.4 Optical Inputs

The PDB570C comes with fiber-coupled optical inputs. Both photo detectors are SMF28 pigtailed and FC/APC connectorized. For this reason, a free space beam coupling directly to the PDB570C is not possible. However, if the PDB570C shall be used with open beam, we recommend Thorlabs' pigtailed aspheric collimators CFS18-1310-APC or similar.

For details about operating wavelength range, spectral responsivity etc. please see the explanations in section Appendix 16 and the subsequent specifications and diagrams.

The PDB570C can be used in balanced mode (both inputs are illuminated) as well as in single detector mode.

In order to avoid saturation, the output signal level should not exceed the max. RF OUTPUT voltage swing! This can be achieved by reducing the optical input power or the optical gain setting.

Attention

The damage threshold of the photo diodes is 200 µW! Exceeding this value will permanently destroy the photo diode!

Note

Take care for clean fiber connectors prior to attach them to the PDB570C's optical inputs! Clean and dust free connections are essential to minimize coupling loss and back reflections.

Using other than SMF28 fibers at the input may lead to increase of coupling loss.

3.5 Electrical Outputs

The Thorlabs PDB570C has two SMA output connectors:

- **CONTROL OUTPUT**
- **RF OUTPUT**

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

$$U_{RF,\,OUT} = (P_{INPUT+} - P_{INPUT-})\ x\ \Re(\lambda)\ x\ G_{TRANS}\ x\ M$$

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

P_{INPUT+} and P_{INPUT-} - optical input power

G_{TRANS} - transimpedance gain of the RF output

M - APD multiplication (optical gain) factor; adjustable between 2.5 and 10.

The responsivity $\Re(\lambda)$ for a given wavelength can be read from the individual curve in section Individual Diagrams 18 to estimate the **RF OUTPUT** voltage. Please note that the given responsivity curve represents typical values - individual responsivity may vary.

The maximum output voltage swing of the **RF OUTPUT** is ± 4.2 V for high impedance loads and ±2.1 V into 50 Ω.

Note

It is recommended to use the RF OUTPUT with 50 Ω load, as the performance is optimized for this termination. A high impedance load can be connected, but in this case distortions will appear in case of broadband signals.

CONTROL OUTPUT

The **CONTROL OUTPUT** is active in auto-balanced mode only and delivers an output voltage proportional to the feedback loop control signal. It is a measure for the power imbalance of the optical input signals. In the case, that the input signal spectrum contains low frequency components, the control output will reproduce these components while they are suppressed at the RF-OUTPUT in auto-balanced condition. The CONTROL VELOCITY setting determines the cutoff frequency for the low frequency components.

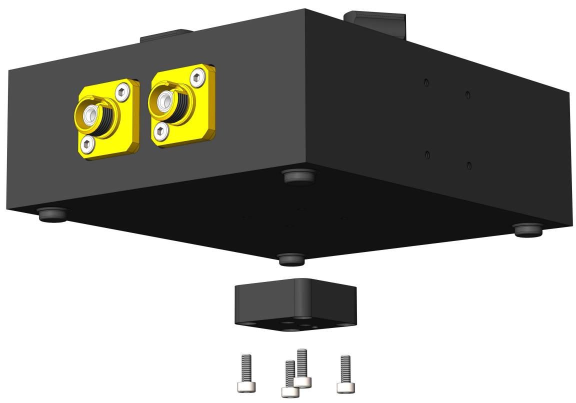
The maximum output swing of the CONTROL OUTPUT of ± 4.7V is reached with high Z loads only. 50 Ω loads are possible, but in this case the output voltage drops to 5% due to the internal source impedance. The monitoring of the **CONTROL OUTPUT** signal is also recommended to ensure that the control loop does not oscillate due to critical conditions 8.

Further, as the the auto balance loop is able to "filter out" low frequency components of the balanced signal, the CONTROL OUTPUT signal may contain relevant measurement information, for example in swept source absorption measurements.

3.6 Mounting

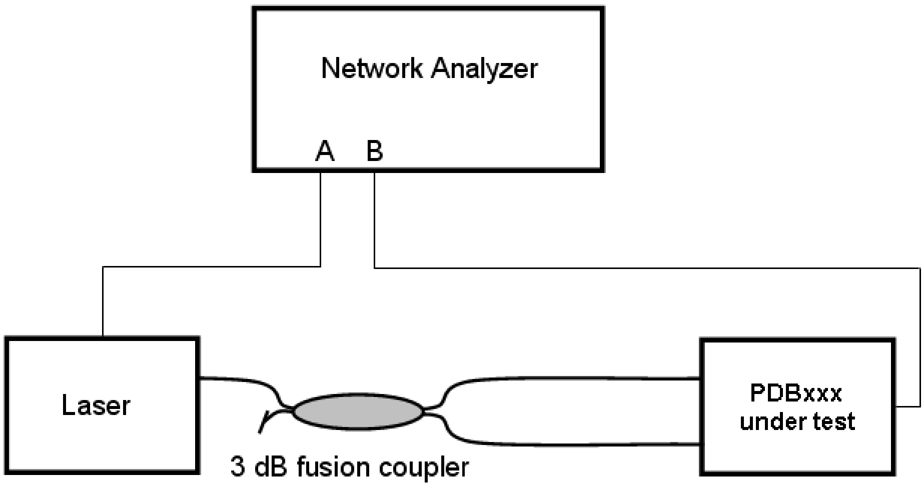
The PDB570C is housed in a rugged shielded aluminum enclosure.

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.



3.7 CMRR and Frequency Response

An important specification for balanced amplifiers is it's ability to suppress common mode noise, which is reflected in the Common Mode Rejection Ratio (CMRR). In the setup as described below, the Device under Test (DuT) - here a PDB570C - is tested for CMRR. A common mode signal is generated, which is canceled out when the amplifier is in balanced or auto-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. The RF OUTPUT of the DuT is connected to the network analyzers Port B.

Frequency response measurements

Depending on the setting of the operation mode selector 7, the frequency responses of each signal path can be measured:

INPUT+ and INPUT- : both coupler outputs can be connected and the signal path, that should be measured, is selected by the operation mode selector.

BAL mode: the frequency response is measured by connecting only one coupler output to the appropriate input.

AUTO-BAL-mode: The frequency response curve in AUTO-BAL mode is identical to BAL-mode. Frequency response measurements should be made in BAL-mode only.

The frequency response curves of the RF OUTPUT from INPUT + and INPUT- and in BAL mode are shown in the individual diagrams 19.

CMRR measurement

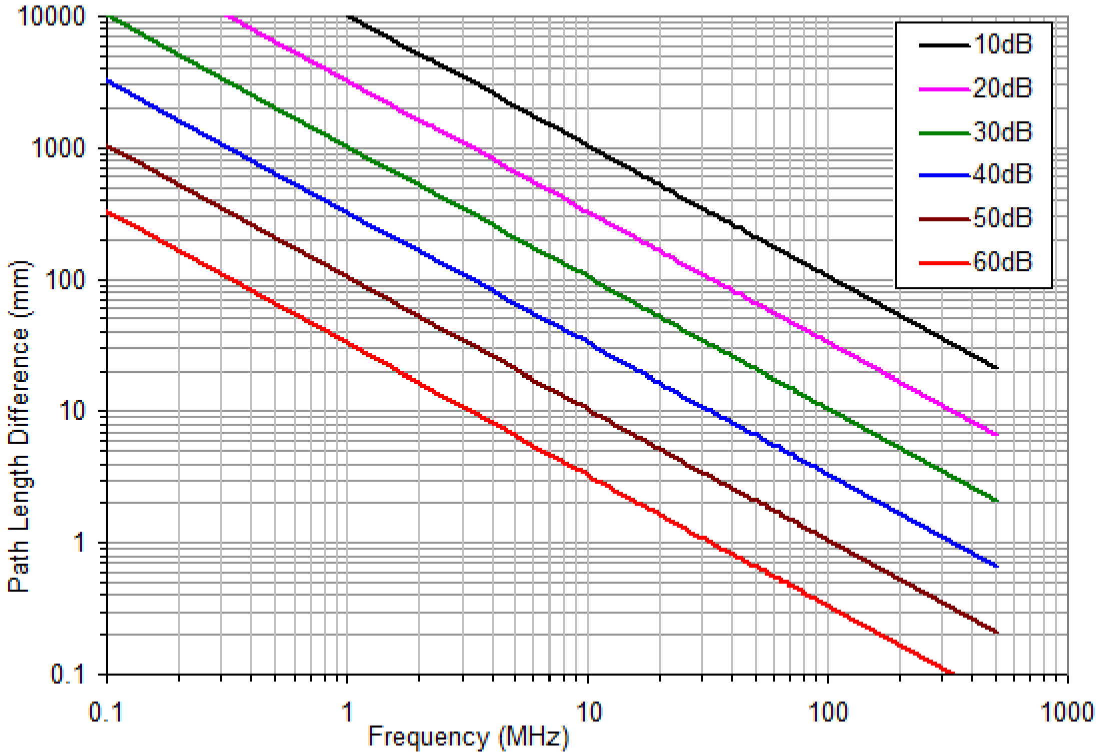
For Common Mode Rejection measurement, both outputs of the fusion coupler are connected to both inputs of the DuT. The optical power level at both inputs must be well matched ("balanced") in order to achieve the optimal common mode suppression in BAL mode. In the AUTO-BAL mode, the optical power levels at both inputs can be slightly different. 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 diagrams 19.

3.8 Recommendations

Thorlabs PDB570C Balanced Amplified Photodetectors can eliminate noise sources to allow precise measurements. The PDB570C is designed to be used in a fiber based setup: one optical path for measurement and one invariant reference path. If set up properly, the PDB570C can reduce common mode noise for more than 30 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. In BAL mode, a manual adjustment is necessary while in AUTO-BAL mode the power imbalance should not exceed the adjustment range of the **OPTICAL GAIN** to allow automatic power balance.

- 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 below shows the maximum allowed path length difference in fiber to obtain a desired CMRR.

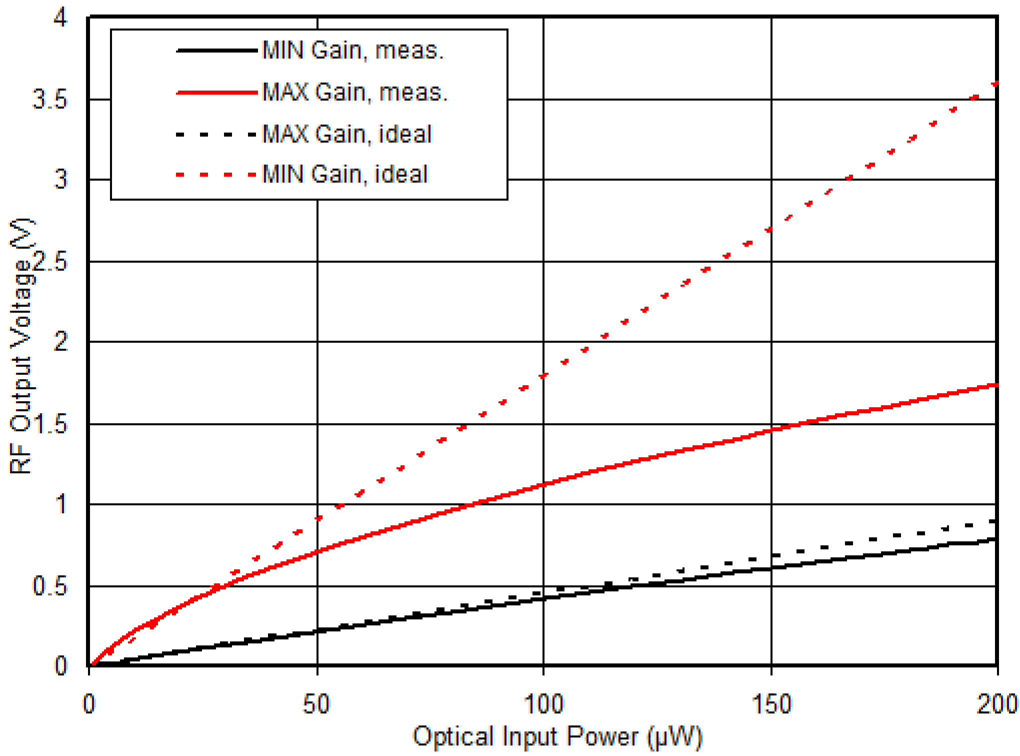


- Avoid etalon effects (interference fringes caused between two optical surfaces) in optical paths. Using angle polished optical connectors will greatly reduce etalon effects in a fiber based setup. Effects like residual frequency modulation, polarization noise, polarization wiggle or spatial modulation 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.

- 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 PDB570C Balanced Detector. Different common ground points can also be tested.

- APD are particularly suitable for measurement of very low power. But the higher the optical gain and the higher the input power, the higher is the noise generated in the APD, this way impacting the NEP. This increment is known as "excess noise" and characterized by the Excess Noise Factor (ENF). It describes the statistical noise that is inherent with the stochastic APD multiplication process.

- The non-linearity of the used APD leads to a decrease of the PDB570C conversion gain, particularly at high optical gain and high input power levels:



Above diagram shows the dependency of the RF OUTPUT voltage of optical input power. The dotted lines show the theoretical curves that are calculated (see the formula 9), while the solid lines represent the measured values. The reason for this behavior is that the APD multiplication factor (optical gain) depends not only on the applied reverse voltage, but also on the incident optical power. As a consequence, it is recommended to keep the optical power level as low as possible, particularly when operating with high optical gain.

Control Velocity Setting

The output signal of the transimpedance amplifier represents the current imbalance between the two optical inputs. In auto-balanced mode, this imbalance signal is used as the input signal of the control loop. Depending on the polarity of the imbalance, the output signal of the loop amplifier decreases ($P_{INPUT+} > P_{INPUT-}$) or increases ($P_{INPUT+} < P_{INPUT-}$) the optical gain of INPUT+. The control loop velocity defines how fast the loop reacts - the higher the velocity, the faster the loop. By other words, the auto balance control loop can suppress low frequency components of the balanced signal at the RF OUTPUT, while the CONTROL VELOCITY setting defines the "upper cut frequency". However, the loop velocity depends also on the following confounding factors:

- optical gain, set for INPUT-
- ratio of input power levels
- absolute input power level
- modulation depth of of the disturbance signal

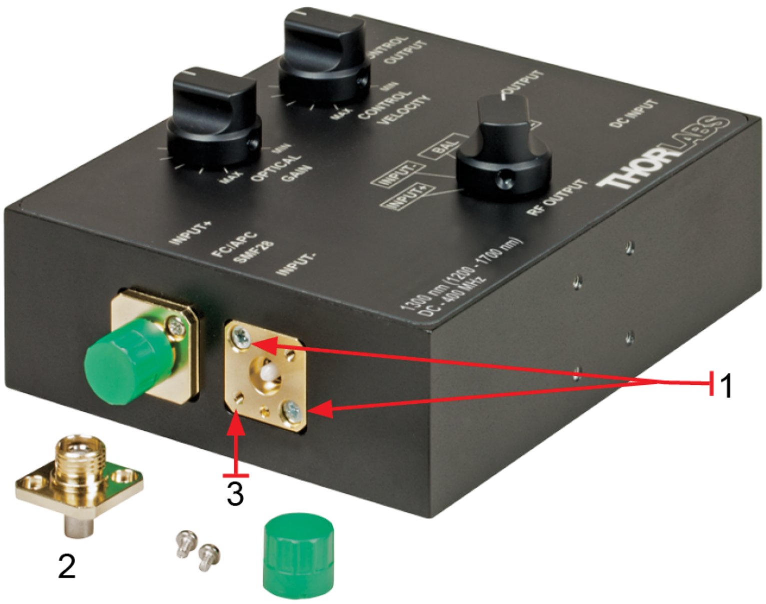
This means, that the loop velocity varies depending on above stated factors. For this reason, the **CONTROL VELOCITY** is not graduated in bandwidth values.

4 Maintenance and Service

Note

The detector performance may suffer from dirty or dusty fiber connectors. This might be the cause for reduced overall performance or loss of balance between the detectors. Therefore, when fiber connectors are frequently un- and replugged, please clean the fiber connectors as described below.

Cleaning of the fiber connectors



The photodiodes of the PDB570C are pigtailed with a single mode fiber and connect to fibers with FC/APC connectors. Clean and dust-free surfaces of the ferrule tips are essential to minimize coupling losses and to keep the two detectors balanced. If the connectors are suspected to be dirty, please follow these instructions:

Remove the two screws (1), which hold the front part (2) of the switchable adapter. Detach the front part (2) and remember the correct orientation. Clean the ferrule tip using a lint-free tissue damped with alcohol or iso-propanol. Clean the ferrule receptacle of the front part from dust using compressed air.

When remounting the front adapter, ensure its correct orientation: The cylindrical key of the front part must match with its counterpart in the PDB570C housing.

Warning

Never remove the screws (3), fixing the base of the switchable adapter to the housing!

Note

Aside from this, 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. If other malfunctions occur, please contact Thorlabs.

Warning

Do not remove housing covers! The PDB570C operates with high voltages!

Protect the PDB570C from adverse weather conditions. The PDB570C is not water resistant.

Attention

To avoid damage to the instrument, do not expose it to spray, liquids or solvents! To clean the PDB570C housing, use a damp cloth. Do not soak the unit in water or use solvent based cleaners.

5 Appendix

Comments and explanations to the individual specifications

- **Operating Wavelength** The operating wavelength range is 1200 to 1700 nm. The optimal performance is reached between 1260 and 1625 nm due to the SMF28 fiber properties. However, the photo detectors operate within the 900 to 1700 nm range. Away from the optimum wavelength range 1260 to 1625nm, the fiber pigtails may introduce a higher insertion loss (particularly, between the two optical windows of the used SMF28 fiber and beyond 1625 nm) or the light will propagate multi-modal (below the SMF28 cut-off wavelength of 1240 nm).
- **Typical responsivity** is the responsivity $\Re(\lambda)$ of the photo diode at the stated wavelength.
- **Transimpedance gain [V/A]** is the ratio of output voltage to photo current, it is wavelength independent and independent from optical gain. The value is given into a high impedance load. For 50 Ω load at RF output, the value is divided by 2.
- **Optical Gain M** is the adjustable (optical) gain of the photo detector.
- **Conversion gain [V/W]** is the ratio of output voltage to input optical power, by other words

  $$G_{CONV} = G_{TRANS} \times \Re(\lambda) \times M$$

  This formula shows, that the conversion gain is dependent on the actual wavelength. In specifications, it is given only for the indicated operating wavelength. The value is given into a high impedance load. For 50 Ω load at RF output, the value is divided by 2.
- **NEP** (Noise Equivalent Power) is stated for DC to 100 MHz frequency range.
- **Overall output voltage noise** [V_{RMS}] is the value which can be measured across a 50 Ω load at large bandwidth and maximum optical gain, e.g., if connect the RF output to a 50 Ω terminated scope input.
- **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). 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. The electrical noise is independent of the optical gain setting!
- **Typical frequency response curves** are measured using the setup described in section "CMRR and Frequency Response" 11

5.1 Technical Data

Item #	**PDB570C**
Detector	
Detector Type	InGaAs / APD
Optical Inputs	FC/APC **(SMF28e+ inside)**
Coupling Loss	< 0.5 dB (typ. < 0.3 dB)
Operating Wavelength	**1300 nm** (1200 - 1700 nm)
Max. Responsivity, typ. [1])	0.9 A/W @ 1300 nm
Optical Back Reflection	< -40 dB
Max. Input Power [2])	200 µW
RF OUTPUT	
Bandwidth (3dB; Balanced / Auto-Balanced)	DC to 400 MHz
Bandwidth (3dB; INPUT + / INPUT -)	DC to 300 MHz
Common Mode Rejection Ratio	>25 dB (typ. >35 dB)
Transimpedance Gain, High Z	2 x 10^3 V/A
Optical Gain Factor	2.5 to 10, adjustable
Conversion Gain at 1300 nm	4.5 x 10^3 to 18.0 x 10^3 V/W
CW Saturation Power [2])	200 µW @ 1300 nm
RF Output Coupling	DC coupling only
RF Output Impedance	50 Ω
RF Output Voltage Swing, max.	± 4.2 V (High Z load) ± 2.1 V (50 Ω load)
Minimum NEP (DC to 100 MHz) [2])	1.0 pW/√Hz
Overall Output Voltage Noise	< 0.4 mV_{RMS}
DC Offset, typ.	±3 mV
CONTROL Output	
CONTROL Output Impedance	1 kΩ
CONTROL Output Voltage Swing, High Z load	max. ±4.7 V
General	
Electrical Outputs	SMA
DC Power Supply	± 12V @ 250mA
Operating Temperature Range [3])	0 - 40 °C
Storage Temperature Range	-40 to 70 °C
Dimensions without connectors (W x H x D)	95 mm x 80 mm x 44.3 mm
Weight	0.37 kg

[1]) at M=1

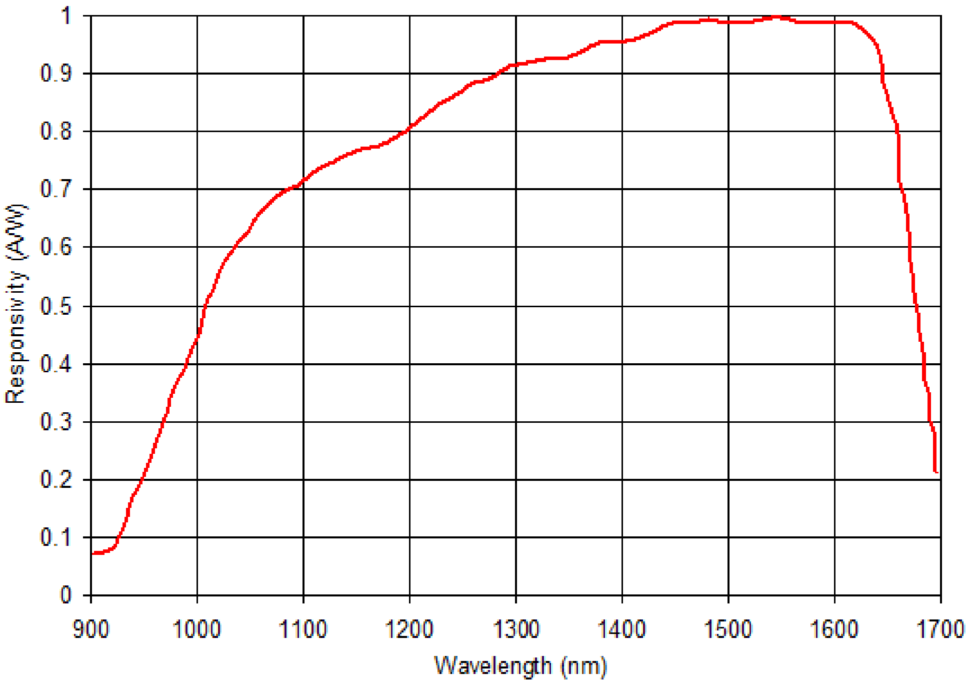
[2]) at maximum optical gain (M=10)

[3]) non-condensing

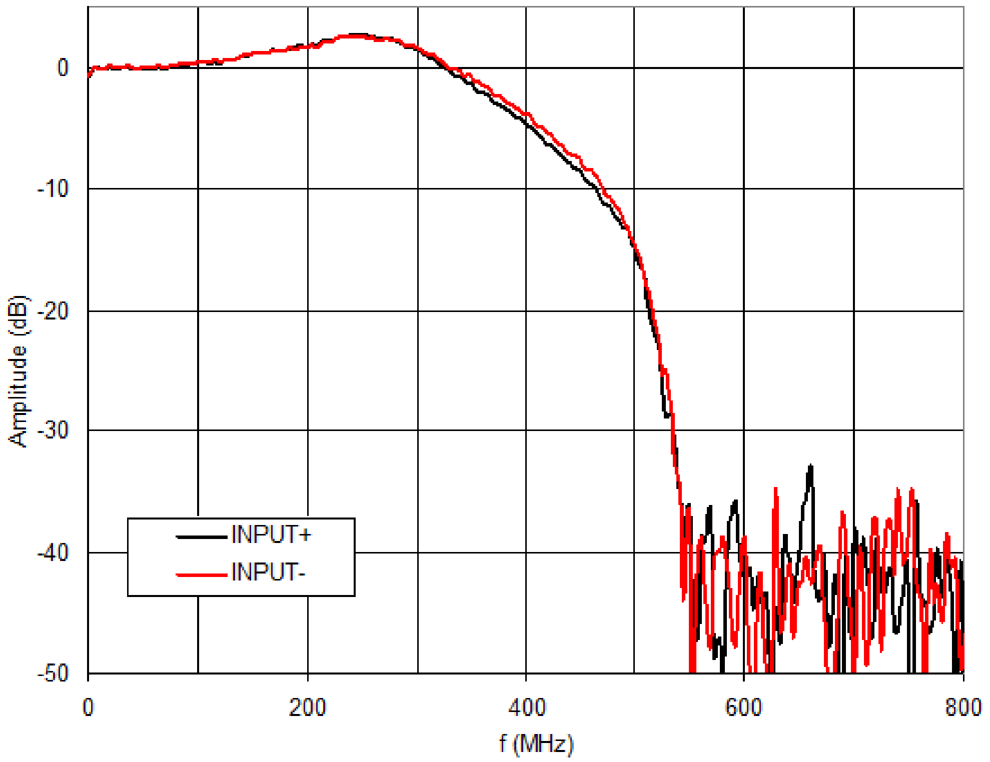
Values for transimpedance and conversion gain are lossless gain values, i.e., losses introduced by FC/APC connectors (typically 0.15 to 0.35 dB) are not considered.

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

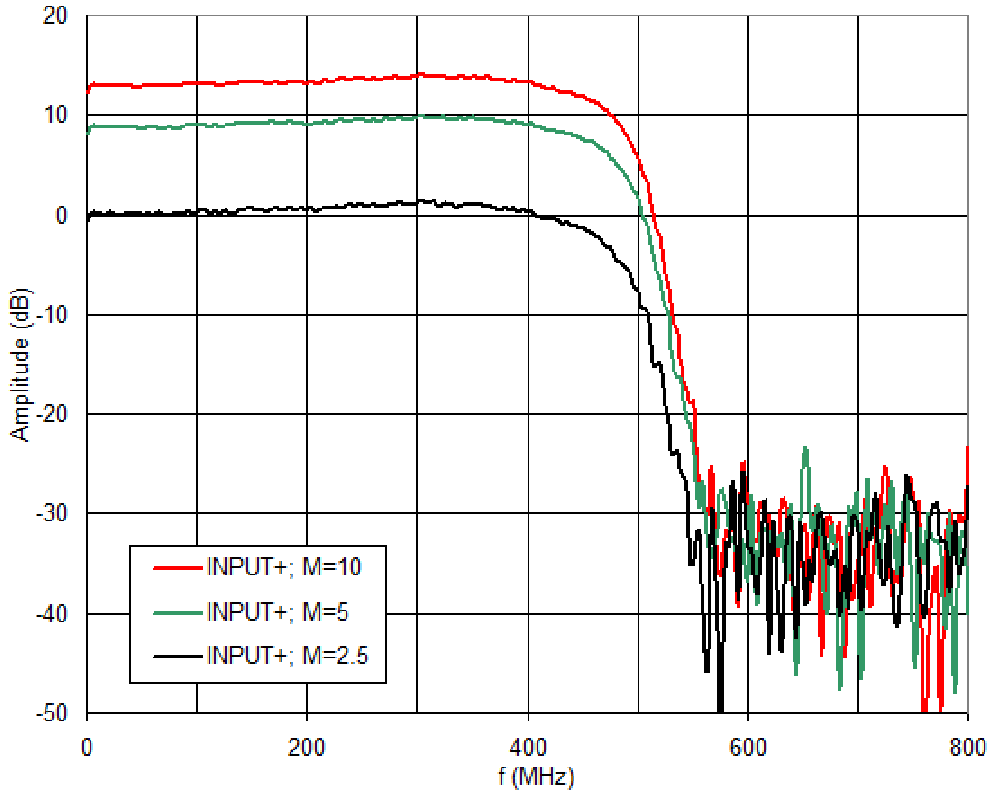
5.2 Individual Diagrams PDB570C



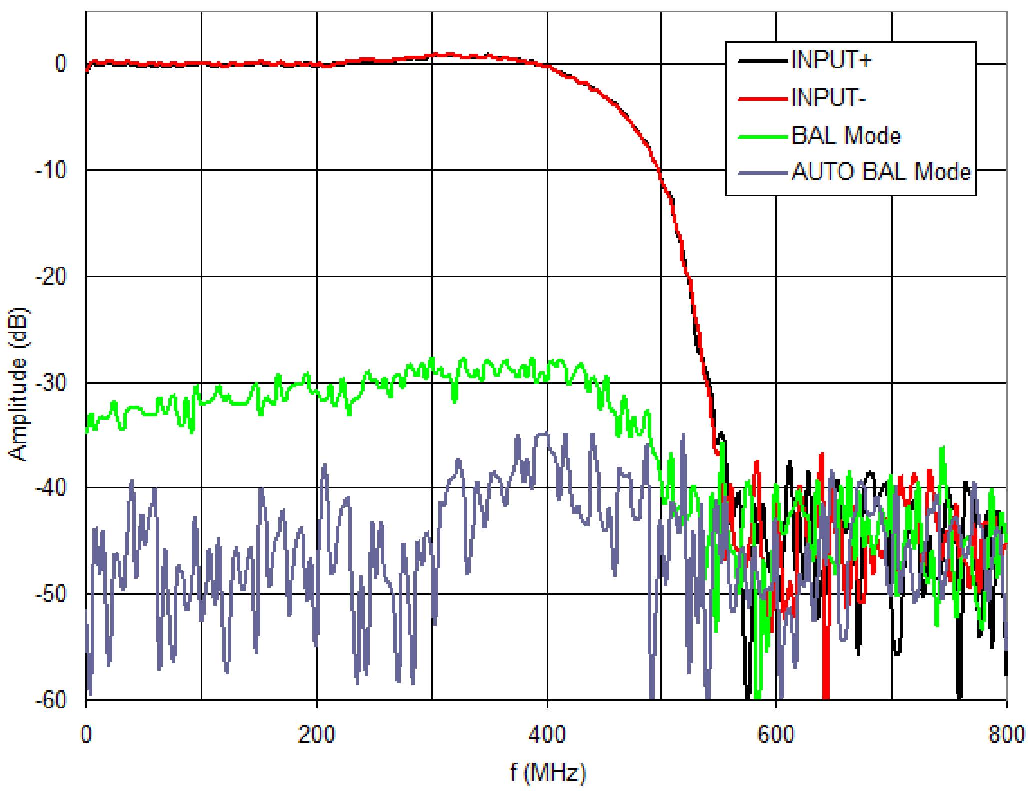
PDB570C - Typical Detector Responsivity



PDB570C Typical RF Output Frequency Response
(Single Detector Mode, Gain M=5)

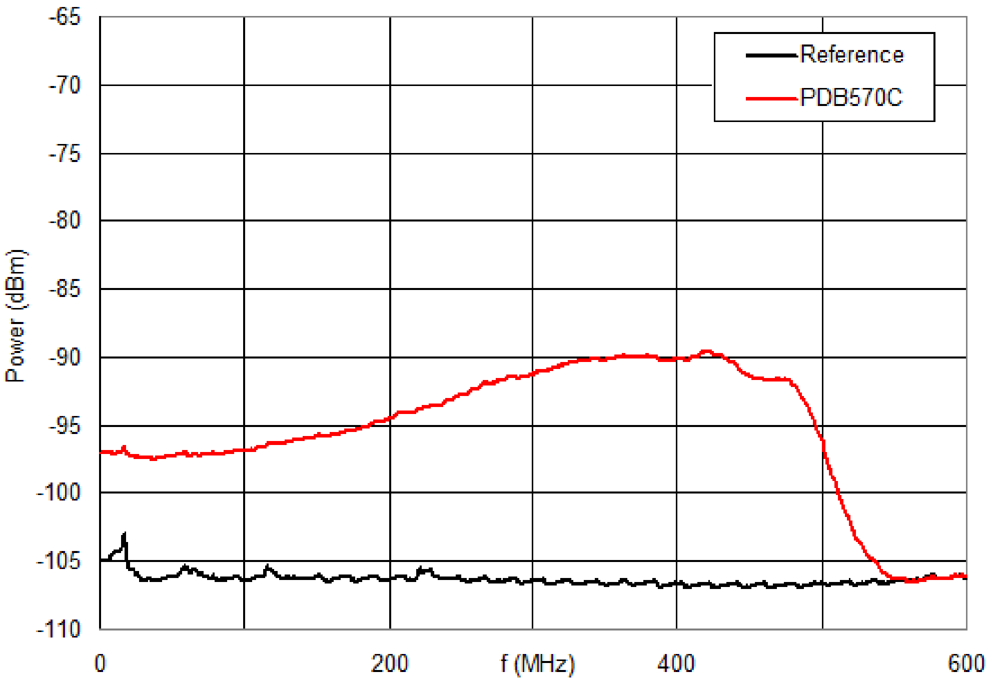


PDB570C - Optical Gain Variation in Single Detector mode



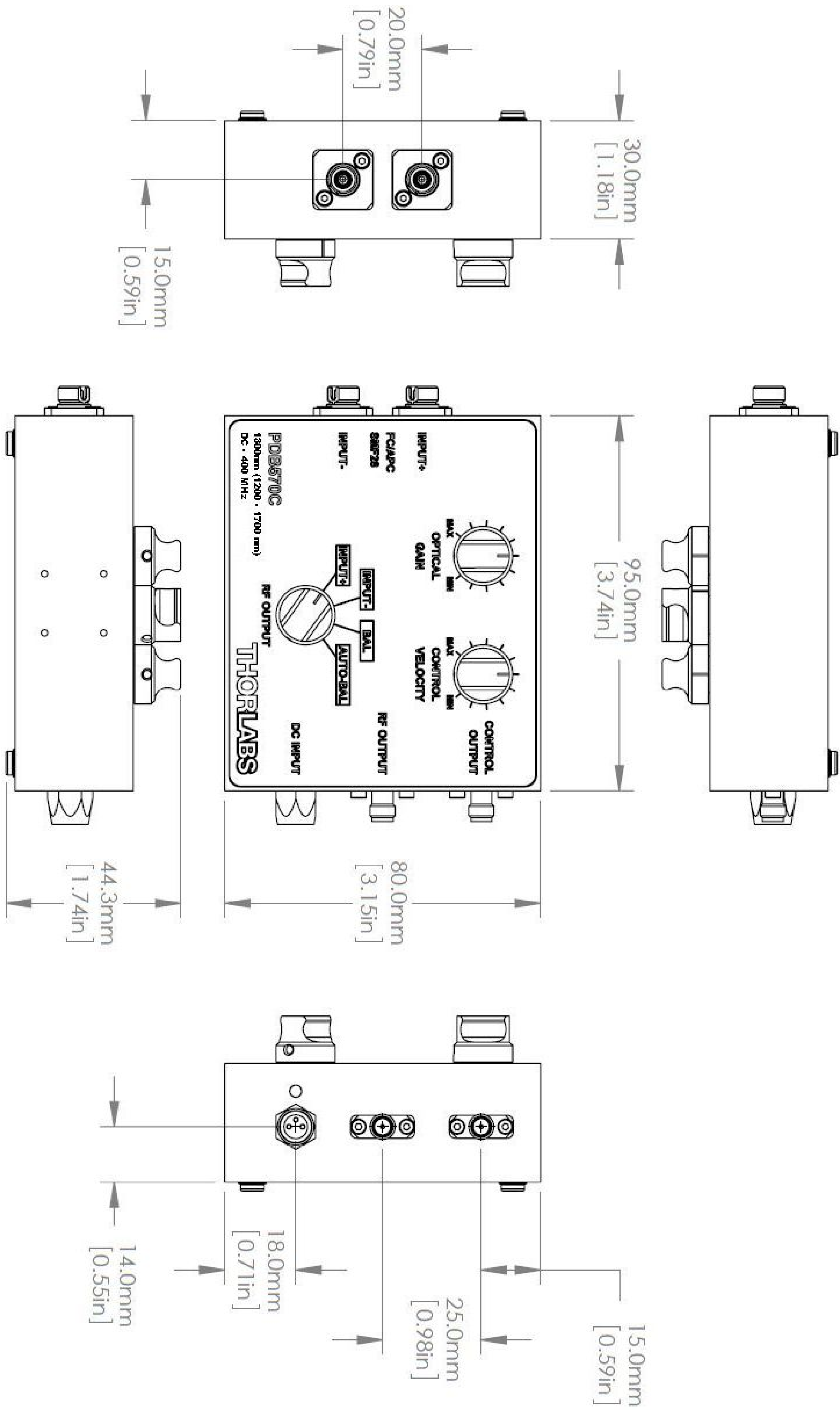
PDB570C Frequency Response in BAL and AUTO BAL modes

Above diagram shows the PDB570C frequency response in balanced and auto-balanced modes. For these measurements, the two input signals were not exactly balanced to show the improvement of CMRR when switching over to AUTO BAL mode. The curves for INPUT+ and INPUT- were taken in BAL mode with only one input connected.



PDB570C Spectral Noise

5.3 Dimensions



PDB570C Mechanical Drawing

5.4 Certifications and Compliances

Category	Standards or description	
EC Declaration of Conformity - EMC	Meets intent of Directive 2004/108/EC for Electromagnetic Compatibility. Complies with the following specifications as listed in the Official Journal of the European Communities:	
	EN 61326-1:2006	Electrical equipment for measurement, control and laboratory use – EMC requirements: Immunity: complies with basic immunity test requirements [1]. Emission: complies with EN 55011 Class A Limits [1,2]
FCC EMC Compliance	Emissions comply with the Class A Limits of FCC Code of Federal Regulations 47, Part 15, Subpart B [1,2].	
EC Declaration of Conformity - Low Voltage	Complies with the following specification as listed in the Official Journal of the European Communities: Low Voltage Directive 2006/95/EC	
	EN 61010-1:2010	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use - Part 1: General Requirements
Additional Compliance	IEC 61010-1:2010	
Equipment Type	Test and Measuring	
Safety Class	Class III equipment according to IEC 60950-1:2005	

[1] Compliance demonstrated using high-quality shielded interface cables shorter than or equal to 3 meters.

[2] Emissions, which exceed the levels required by these standards, may occur when this equipment is connected to a test object.

5.5 Warranty

Thorlabs warrants material and production of the PDB570C 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.

5.6 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.

Please note that the content of this document is neither part of any previous or existing agreement, promise, representation or legal relationship, nor an alteration or amendment thereof. All obligations of *Thorlabs* result from the respective contract of sale, which also includes the complete and exclusively applicable warranty regulations. These contractual warranty regulations are neither extended nor limited by the information contained in this document. Should you require further information on this product, or encounter specific problems that are not discussed in sufficient detail in the document, please contact your local *Thorlabs* dealer or system installer.

5.7 Thorlabs 'End of Life' Policy (WEEE)

As required by the WEEE (Waste Electrical and Electronic Equipment Directive) of the European Community and the corresponding national laws, Thorlabs offers all end users in the EC the possibility to return “end of life” units without incurring disposal charges.

This offer is valid for Thorlabs electrical and electronic equipment

- sold after August 13th 2005
- marked correspondingly with the crossed out “wheelie bin” logo (see figure below)
- sold to a company or institute within the EC
- currently owned by a company or institute within the EC
- still complete, not disassembled and not contaminated

As the WEEE directive applies to self contained operational electrical and electronic products, this “end of life” take back service does not refer to other Thorlabs products, such as

- pure OEM products, that means assemblies to be built into a unit by the user (e. g. OEM laser driver cards)
- components
- mechanics and optics
- left over parts of units disassembled by the user (PCB’s, housings etc.).

Waste treatment on your own responsibility

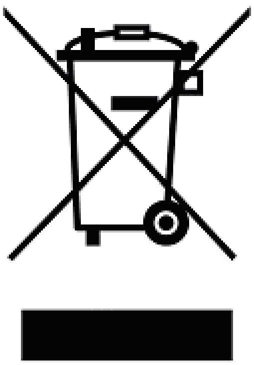
If you do not return an “end of life” unit to Thorlabs, you must hand it to a company specialized in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.

WEEE Number (Germany) : DE97581288

Ecological background

It is well known that waste treatment pollutes the environment by releasing toxic products during decomposition. The aim of the European RoHS Directive is to reduce the content of toxic substances in electronic products in the future.

The intent of the WEEE Directive is to enforce the recycling of WEEE. A controlled recycling of end-of-life products will thereby avoid negative impacts on the environment.



Crossed out "Wheelie Bin" symbol

5.8 Thorlabs Worldwide Contacts

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