

## Features

- Quantum efficiency > 90% from 1000 - 1530 nm
- Noise figure < 3 dB over the entire bandwidth
- High frequency: 200 MHz
- Max CMRR > 60 dB

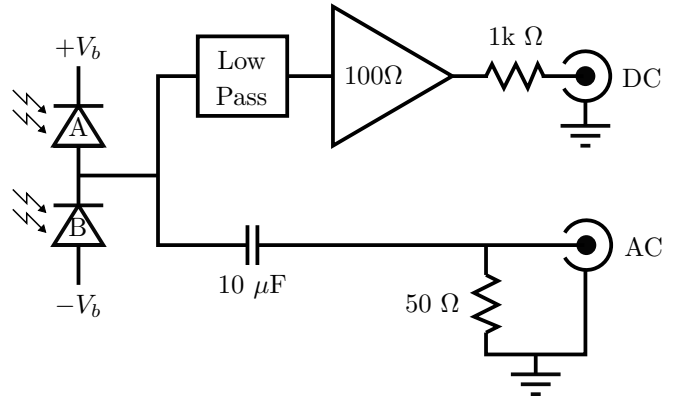
## General Description

The PD-B series are balanced photodetectors which use high quantum efficiency anti-reflection coated PIN photodiodes. There are two differential ports: one AC coupled, one DC coupled. Figure 1 shows a block diagram of the internal signal chain. The detector is powered by  $\pm 15$  V via a 3-pin female M8 connector which is compatible with a New Focus 0901. The signal outputs are female BNC connectors. Two 8-32 mounting holes which line up with a standard optics table one inch grid are provided on the bottom of the photodetector.

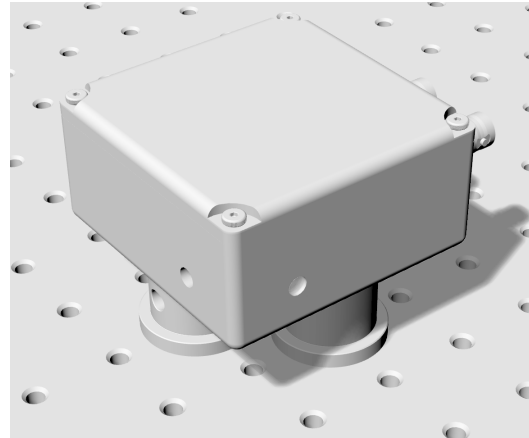
## Precautions

Photodiodes typically come in a package which is sealed with a protective transparent window. To achieve the highest quantum efficiency, we use photodiodes which do not have a protective window. Care should be taken to prevent anything (dust, cleaning supplies,...) from coming in direct contact with the photodiode.

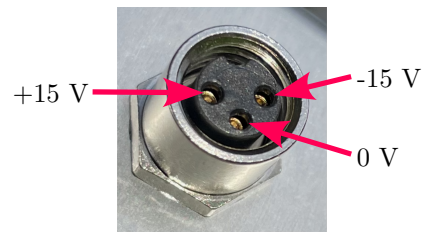
While the photodetector's power connector is physically compatible with several power supplies, care should be taken to ensure the voltages are correct. For example, a ThorLabs LDS12B should not be used because the voltages are incorrect, even though it is physically compatible. The power supply must also be able to provide a minimum of 300 mA to both positive and negative supplies.



**Figure 1:** Block diagram of photodetector circuit. Values inside amplifiers indicate gain.



**Figure 2:** Photograph of the detector. Physical dimensions: 3.5 x 3 x 1.5 inches. The centers of the photodiodes are 0.5 inches above the bottom of the detector.



**Figure 3:** Pinout diagram for the female M8 power connector.

## Absolute Maximum Ratings

**Table 1:** Absolute Maximum Ratings

Parameter	Rating
Power supply voltage	$\pm 22$ V
Current consumption	< 100 mA
Optical power per photodiode	20 mW

**Note:** Stresses above those listed under Absolute Maximum Ratings can cause permanent damage to the device. This is a stress rating only. Functional operation of the device is not implied in any conditions above those indicated in the Electrical Specifications section.

## Electrical Specifications

All specifications are for  $20^{\circ}\text{C}$  unless otherwise noted.

**Table 2:** Photodiode Specifications

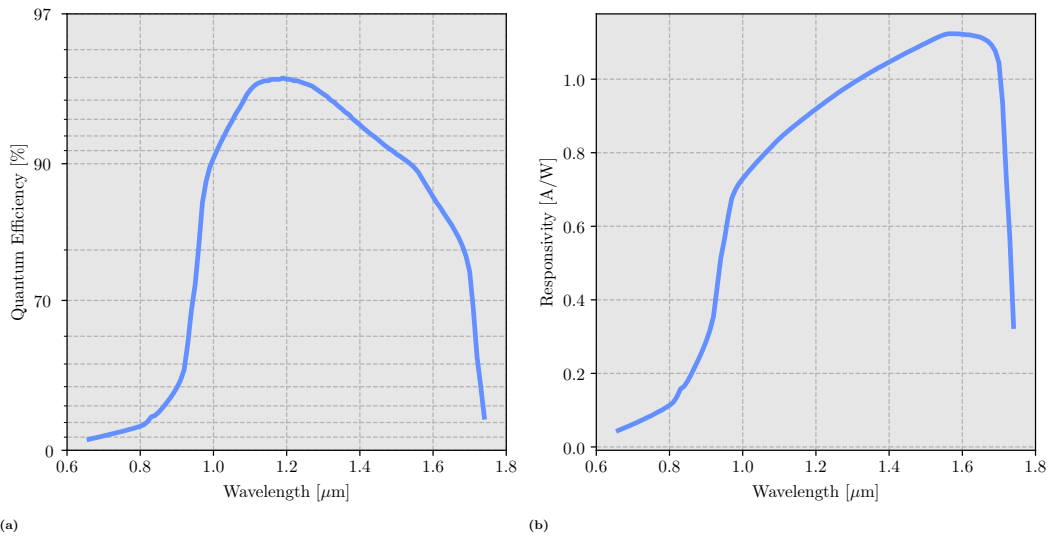
Parameter	Value	Unit	Notes / Conditions
Quantum efficiency	89.7	%	at 1550 nm
Photodiode active area diameter	350	$\mu\text{m}$	
Maximum deviation from linearity	3.5	%	
Saturation intensity	$1069 \pm 4$	$\text{mW}/\text{mm}^2$	at 1550 nm

**Table 3:** DC and AC Port Specifications

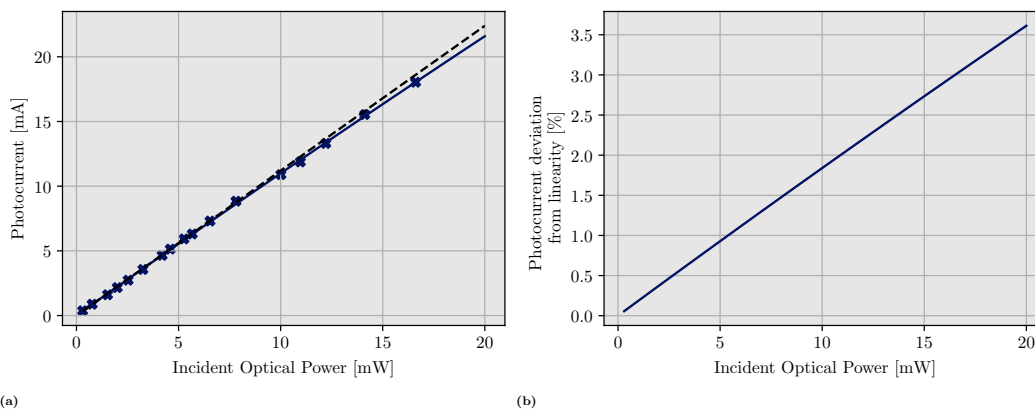
Parameter	Value	Value	Unit	Conditions
	DC Port	AC Port		
Minimum noise equivalent power	70/ R	25.7 / R	$\text{pW}/\sqrt{\text{Hz}}$	
-3 dB power bandwidth	0 - 800	350k - 200M	Hz	small signal
Transimpedance gain	-100	25	$\Omega$	external load = 1 M $\Omega$ for DC, 50 $\Omega$ for AC
Output impedance	1k	50	$\Omega$	
Maximum difference optical power before amplifier saturation	$20/R$	N.A.	mW	
Output voltage range	-2 to +2	N.A.	V	external load = 1 M $\Omega$ for DC
DC output voltage offset	< 500	0	$\mu\text{V}$	after 30 second warmup

<sup>1</sup> R = responsivity [A/W]. See Fig. 5b

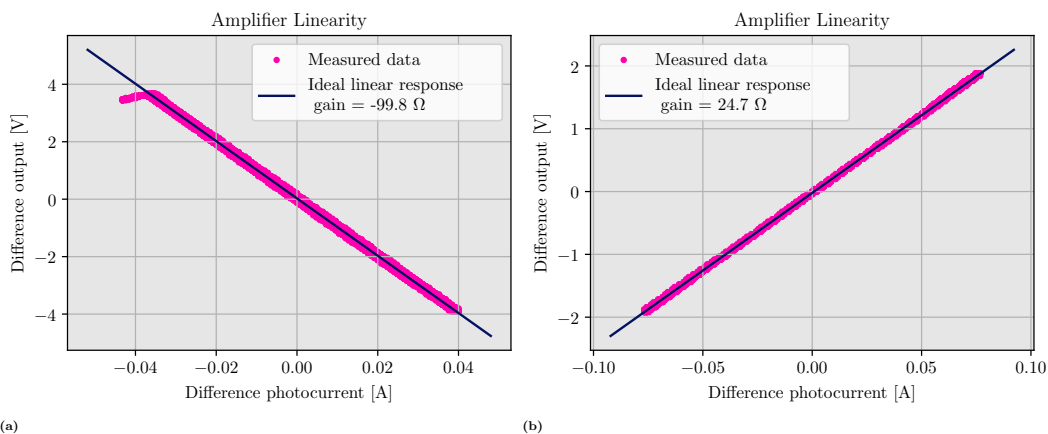
## Plots of Electrical Characteristics



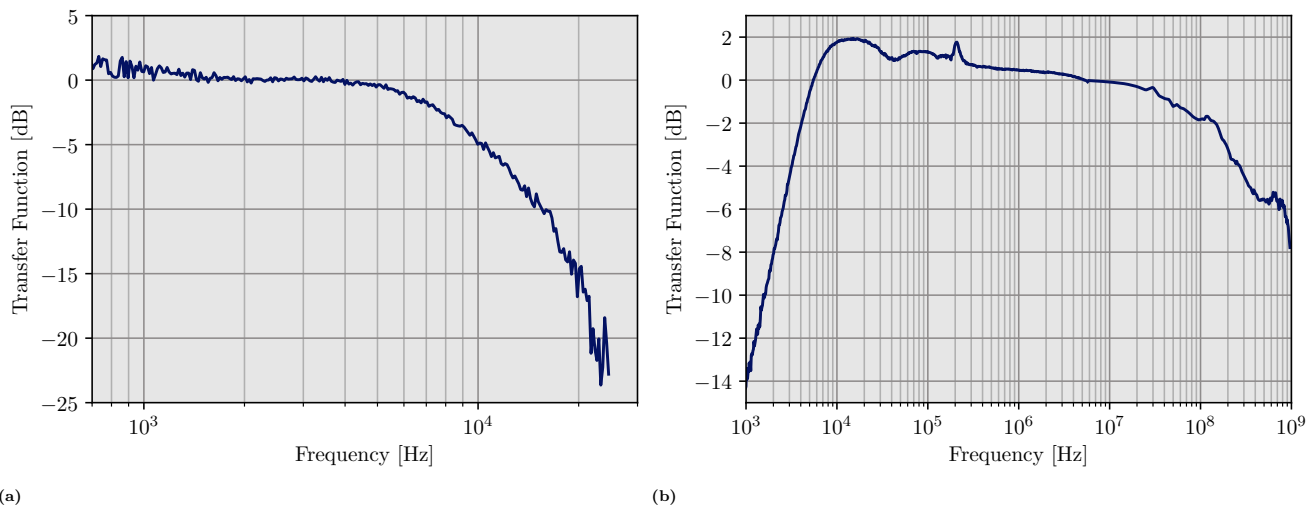
**Figure 4:** (a) Photodiode quantum efficiency vs wavelength. (b) Photodiode responsivity vs wavelength. These figures display the same data set in different units. This information is provided by the photodiode manufacturer and has not been verified by Quantum Components.



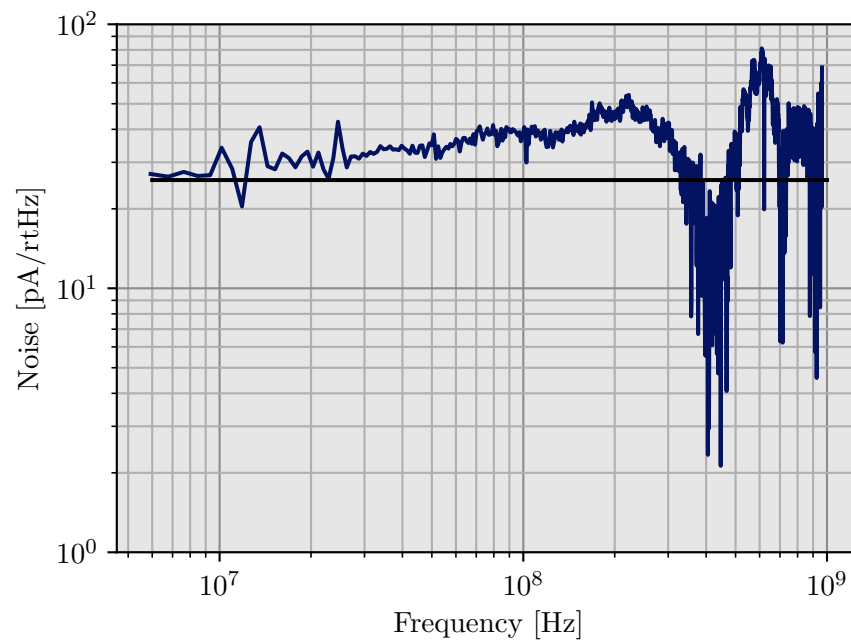
**Figure 5:** (a) Photocurrent as a function of optical power on the photodiode active surface for uniform illumination. This measurement is independent of the amplifiers. The solid blue curve is a fit of the function  $(RP_{sat}P)/(P_{sat} + P)$  to the data, where R is the responsivity,  $P_{sat}$  is the saturation power, and P is the optical power. For  $\lambda = 1550$  nm,  $P_{sat} = 102.9 \pm 0.3$  mW. The black dashed curve is give by  $I = R \cdot P$ , which is the ideal, perfectly linear response. (b) The ratio between the true response and the ideal response in percent.



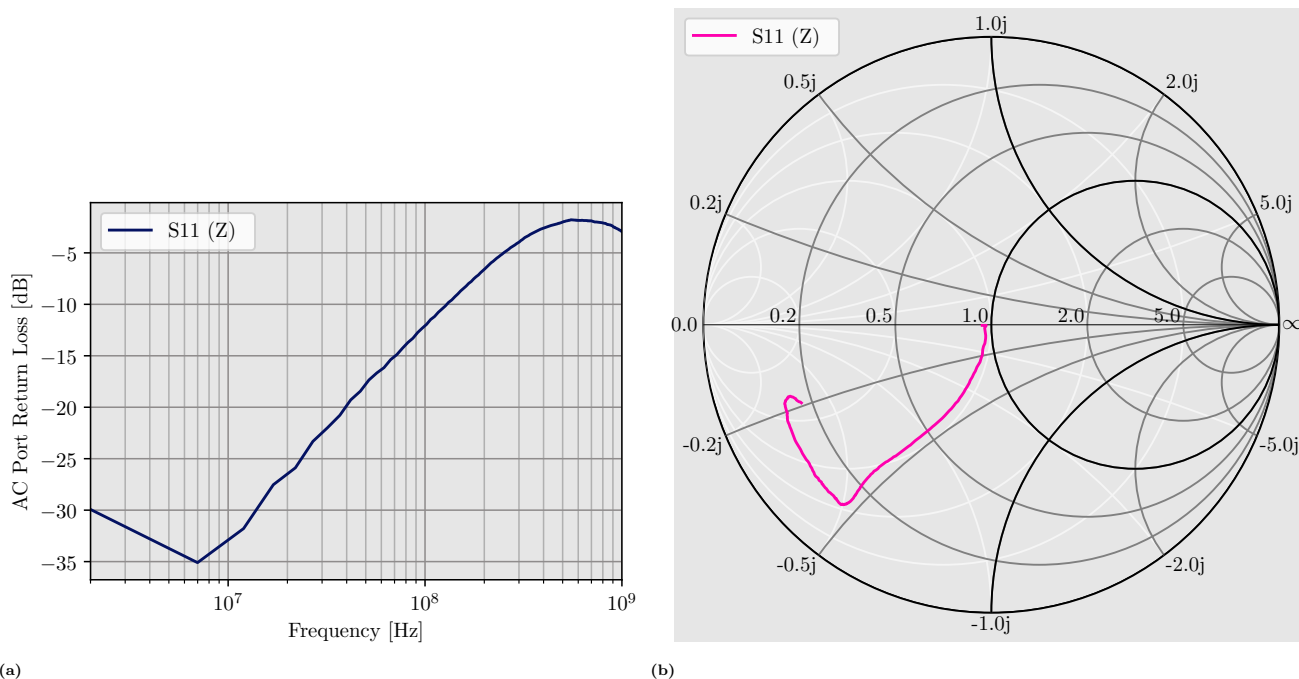
**Figure 6:** Output voltage as a function of difference input current for the (a) DC port and (b) AC port. Both signal chains are exceptionally linear within their specified operating range.



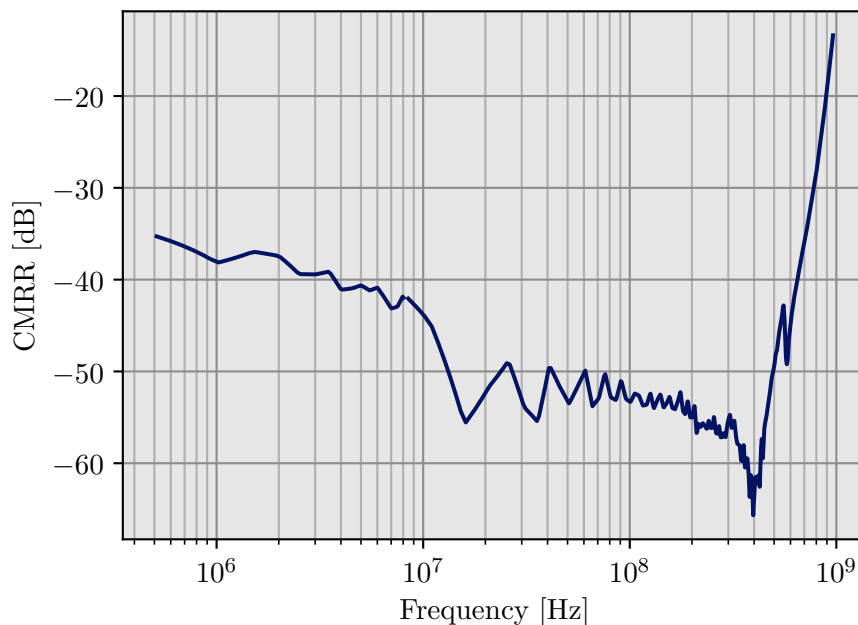
**Figure 7:** (a) Transfer function of the DC port (a) and AC port (b).



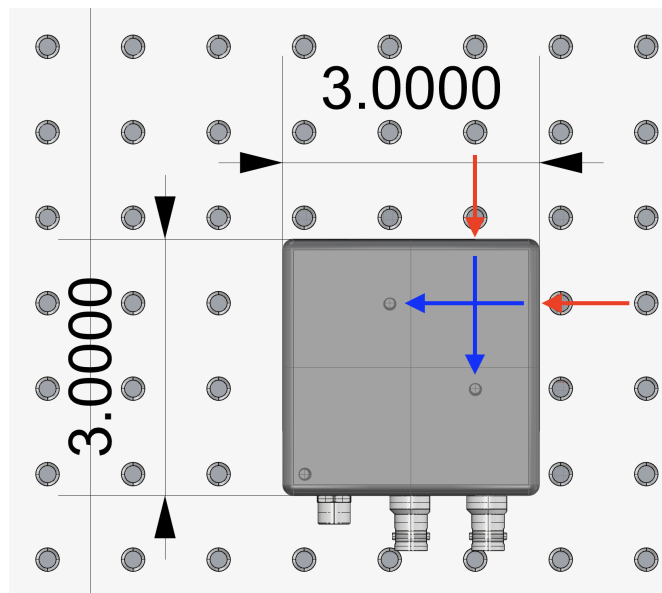
**Figure 8:** Noise equivalent current (NEC) at the input of the AC port vs frequency. To turn this into noise equivalent power, simply divide by the responsivity at the desired wavelength which can be found in figure 5b. The black line indicates the theoretical Johnson Noise of a 25  $\Omega$  resistor. Note that unlike most photodetectors, the NEC actually decreases above the -3 dB frequency. This is because the RC time constant formed by the junction capacitance of the photodiodes in parallel with the 25  $\Omega$  load they see is about 200 MHz (which is the -3 dB frequency), and so above 200 MHz, the Johnson Noise of the load is shorted out by the combined photodiode junction capacitance.



**Figure 9:** (a) S11 measurement for the AC port and (b) the associated Smith Chart. The smith chart is almost exactly what would be expected based on the figure 1: At low frequencies (above the high-pass cutoff) the AC port looks like a 50Ω load (the center of the Smith chart). As frequency increases, the shunt junction capacitance of the photodiodes causes the trace to follow the constant conductance  $g=1$  circle clockwise. At the highest frequencies the parasitic lead inductance of the photodiodes dominates.



**Figure 10:** Common mode rejection ratio (CMRR) measured for the AC port. We suspect this is limited by the measurement setup rather than the photodetector.



**Figure 11:** Bottom view of the photodetector on an optics table with a one inch grid of holes. Dimensions are in inches. Red arrows indicate the location of photodiodes. Blue arrows indicate the location of the 8-32 mounting holes.