COHERENT

Non-Amplified Photodetectors

User Guide

Thank you for purchasing your Non-Amplified Photodetector from Coherent. This user guide will help answer any questions you may have regarding the safe use and optimal operation of your Non-amplified Photodetector.

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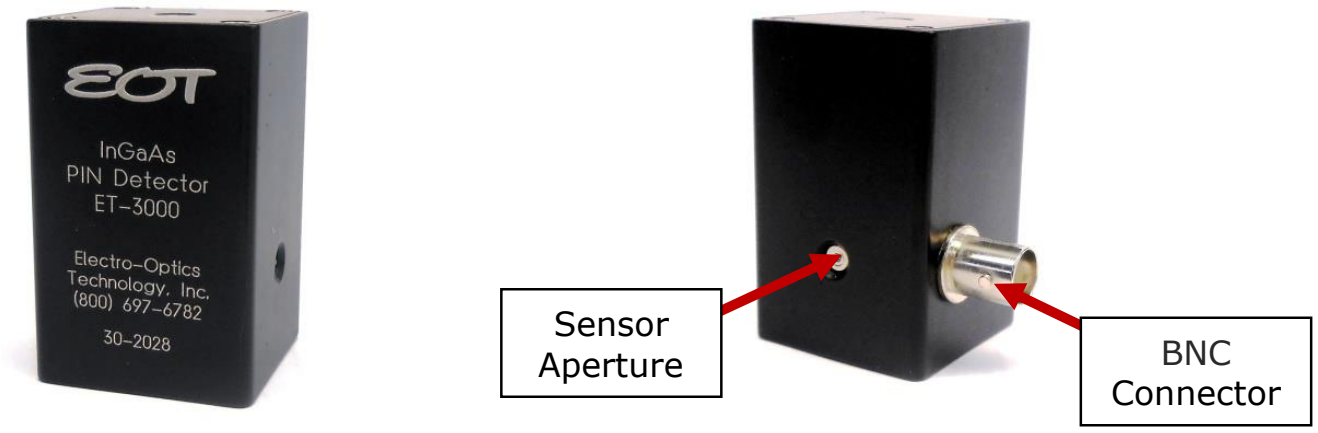
I. Non-amplified Photodetector Overview

Coherent Non-Amplified Photodetectors contain PIN photodiodes that utilize the photovoltaic effect to convert optical power into an electrical current. Figure 1 below identifies the main elements of your Non-amplified Photodetector.

Figure 1: Coherent Non-amplified Photodetec



When terminated into 50 Ω into an oscilloscope, the pulsewidth of a laser can be measured. When terminated into a spectrum analyzer, the frequency response of a laser can be measured.

II. Operation of your Coherent Non-Amplified Photodetector

A. Caution: Eye safety precautions must be followed when utilizing any equipment used in the vicinity of laser beams. Laser beams may reflect from the surface of the detector or the optical mount and caution must be exercised.

B. Mount the detector to an optical stand by the mounting holes on the bottom of the detector housing.

C. Adjust the voltage of the oscilloscope to 100 mV/division before connecting the detector. On models with >3 V bias supply, the signal may be large enough to damage the oscilloscope if this is not done.

D. Connect the detector to the oscilloscope using a 50 Ω coaxial cable that one meter or less.

E. Use the 50 Ω termination input of the oscilloscope. If the oscilloscope does not have a 50 Ω input, connect the coaxial cable to a 50 Ω terminator and connect this to the oscilloscope's 1 MΩ input.

F. After being certain that the damage threshold of the detector is not exceeded, place the detector in the center of the laser beam.

III. Troubleshooting

A. No signal is seen the first time the detector is used:

1. Be certain that the signal is not high off scale on the oscilloscope.
2. Is the wavelength of the laser within the spectral range of the detector?
3. Has a 50 Ω termination input been used?
4. Try moving the detector within the laser beam.
5. Is there enough light (see sensitivity spec on the data sheet) incident on the detector to generate a signal?

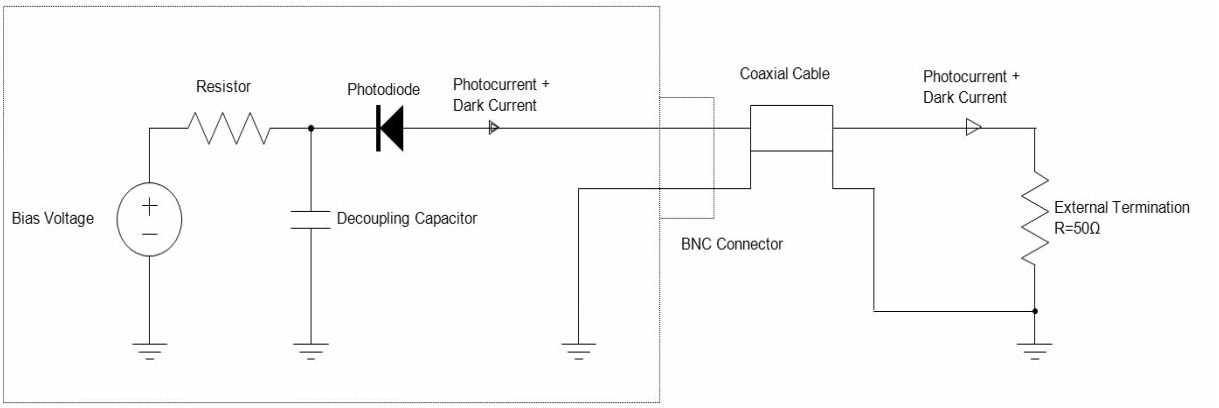
B. A signal has been previously obtained, but not currently:

1. Try steps listed under A.
2. Inspect the active area of the photodiode for any signs of damage.
3. Try a higher input termination on the oscilloscope, but remember to return to 50 Ω if this does not work.
4. Test the power supply:
    a. Units with internal batteries will typically operate for several years, but operation with CW or high rep rate lasers can drain the batteries much faster. **If a load is present at the output, current will be drawn from the batteries, turn off the power switch when not in use.** Remove top cover to replace the 3 V lithium cells with Duracell Model DL2430, positive side down.
    b. Units with an external power supply should at least receive the voltage that is printed on the plug.
5. You can terminate the detector in 1 MΩ input of an oscilloscope to obtain a higher output voltage signal but this will decrease the detector's bandwidth by a factor of $5x10^{-5}$.

C. Increasing the power incident on the detector does not result in a higher voltage signal on the oscilloscope:

1. The detector is probably saturated. You should lower the power incident on the detector to a level below the saturation point.

IV. Schematics: Non-Amplified Photodetectors



V. Photodetector Warranty and Service

Limited Warranty: Coherent, Inc. warrants to the original purchaser that its Photodetectors are free from defects in materials and workmanship and comply with published specifications, active at the time of purchase, for a period of twelve (12) months. Coherent, Inc., will at its option, repair or replace any product or component found to be defective during the warranty period. This warranty applies only to the original purchaser and is not transferrable.

Return Instructions for Warranty or Service Repair

Obtaining Warranty Service: For warranty service, please contact your closest Coherent service center (see below) to obtain a Return Material Authorization (RMA) number.

Instructions for Returning your Coherent Photodetector: To prepare your Photodetector for return to Coherent, attach a tag to the unit that includes the name and address of the owner, the contact individual, the serial number, and the RMA number you received from Customer Service.

Email address for warranty and repair are:

China: service.china@coherent.com
Europe: service.dieburg@coherent.com
Japan: svc.jpn@coherent.com
Korea: service.korea@coherent.com
North America: customer.support@coherent.com
PIR (Southeast Asia): service.asean@coherent.com
Taiwan: twn.customer.support@coherent.com

VI. Glossary of Terms

Bandwidth:
The range of frequencies from 0 Hz (DC) to the frequency at which the amplitude decreases by 3 dB. Bandwidth and rise time can be approximately related by the equation:

Bandwidth ≈ 0.35/rise time for a Gaussian pulse input.

Bias Voltage:
The photodiode's junction capacitance can be modified by applying a reverse voltage. The bias voltage reduces the junction capacitance, which causes the photodiode to have a faster response.

BNC Connector:
Used to connect the customer's coaxial cable.

Dark Current:
When a termination is present, a dark current (nA range) will flow if the photodiode is biased. Disconnecting the coaxial cable will prevent this current from flowing.

Decoupling Capacitor:
Maintains bias voltage when fast pulses cause the battery voltage to reduce (this would slow the response time of the photodiode); the capacitor allows the battery to recover to its initial voltage. It also acts as a low-pass filter for external power supplies.

Noise Equivalent Power (NEP):
A function of responsivity and dark current and is the minimum optical power needed for an output signal to noise ratio of 1. Dark current is the current that flows through a reverse biased photodiode even when light is not present, and is typically on the order of nA. Shot noise (Ishot) is a source of noise generated in part by dark current; in the case of reversed biased diodes it is the dominant contributor. NEP is calculated from shot noise and responsivity. For example, for an ET-2040: dark current <20 nA, responsivity @ 830 nm = 0.5 A/W:

$$Shot\_Noise = \sqrt{2qI_d} = \sqrt{2(1.6\text{x}10^{-19}As)(20x10^{-9}A)} = 0.08\text{pA}\sqrt{\text{s}} = 0.08\text{pA}/\sqrt{\text{Hz}}$$

$$NEP = I_{shot}/\text{R}_{830\text{nm}} = \frac{0.08pA}{\sqrt{Hz}} * \frac{\text{W}}{0.5\text{A}} = 0.16\text{pW}/\sqrt{\text{Hz}}$$

q = charge on an electron

Photodiode:
Converts photons into a photocurrent.

Resistor:
Part of the low-pass filter at the photodiode cathode.

Responsivity:
In amps per watt (A/W), responsivity is the current output of the photodiode for a given input power, and is determined by the diode structure. Responsivity varies with wavelength and diode material.

Rise Time/Fall Time:
Rise Time is the time taken by a signal to change from a specified low value to a specified high value. Fall Time is the time taken for the amplitude of a pulse to decrease from a specified value to another specified value. A larger junction capacitance will slow the detector's response time.

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