

# AMPLIFIED PHOTODETECTOR USER'S GUIDE

Thank you for purchasing your Amplified Photodetector. This user's guide will help answer any questions you may have regarding the safe use and optimal operation of your Amplified Photodetector.

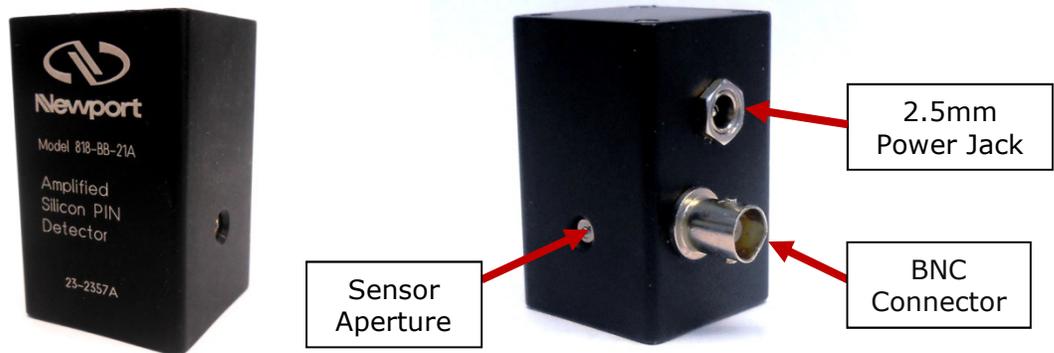
## TABLE OF CONTENTS

I. Amplified Photodetector Overview.....	1
II. Operation of your Amplified Photodetector.....	1
III. Troubleshooting.....	2
IV. Drawings: Amplified Photodetectors.....	2
V. Specifications: Amplified Photodetectors.....	3
VI. Schematics: Amplified Photodetectors.....	3
VII. Glossary of Terms.....	4

## I. Amplified Photodetector Overview

The 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 Amplified Photodetector.

**Figure 1: Amplified Photodetector**



When terminated into  $50\Omega$  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 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. An 8/32 nylon standoff is included to isolate the detector from the optical stand if noise is generated due to grounding through the stand.

- C. Adjust the voltage of the oscilloscope to 100mV/division before connecting the detector.
- D. Connect the detector to the oscilloscope using a 50Ω coaxial cable that one meter or less.
- E. Use the 50Ω termination input of the oscilloscope. If the oscilloscope does not have a 50Ω input, connect the coaxial cable to a 50Ω terminator and connect this to the oscilloscope's 1MΩ input.
- F. When possible, use a scatterplate (white paper works) to integrate the laser beam. Focus on the active area only if you need increased sensitivity.
- G. If the full bandwidth of the detector is not needed, use lowpass, bandpass, or highpass filters to remove excess noise.

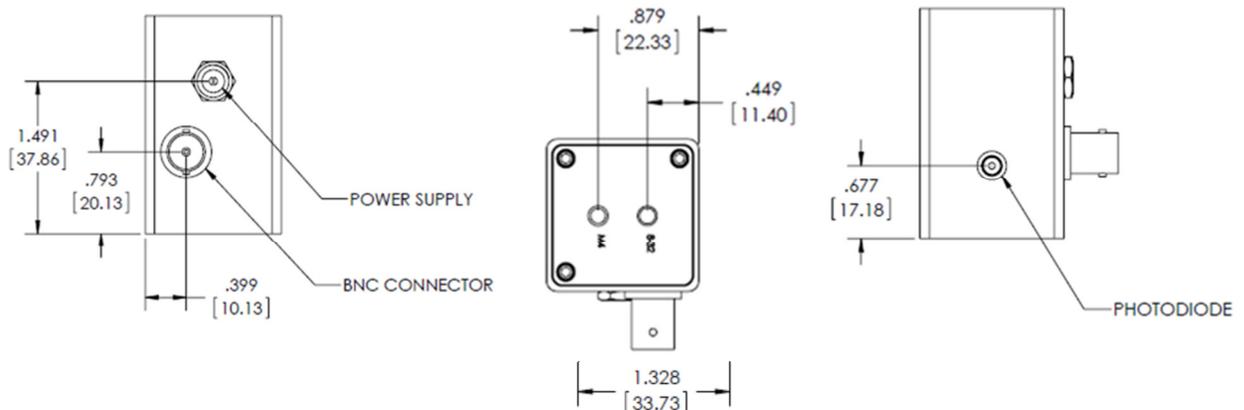
### III. Troubleshooting

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

1. Is the AC power supply plugged in?
2. Is the detector terminated into 50Ω at the oscilloscope?
3. Is the wavelength of the laser within the spectral range of the detector?
4. Is the signal high off the scale on the oscilloscope?
5. Inspect the diode for possible damage.
6. If increasing the incident power does not result in a higher voltage output, the detector is probably saturated. Check the photodetector's data sheet for the Maximum Linear Rating specification.
7. Are all the connectors securely in place?
8. Is the bandwidth you are trying to measure below the low frequency cutoff of 75kHz?

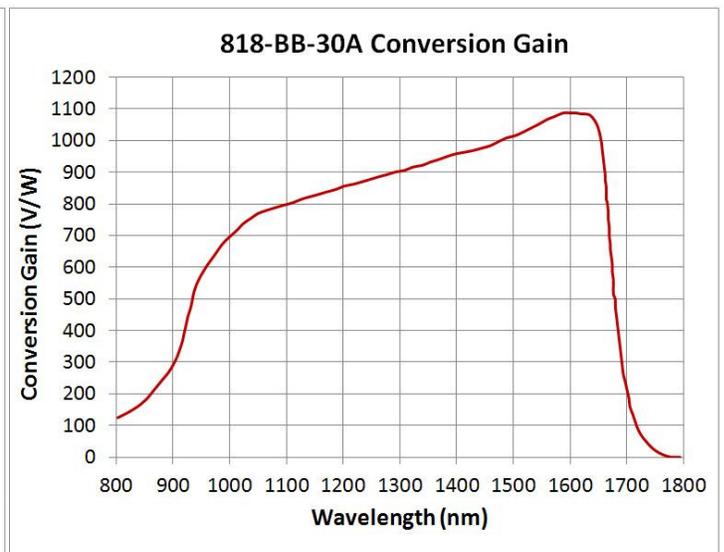
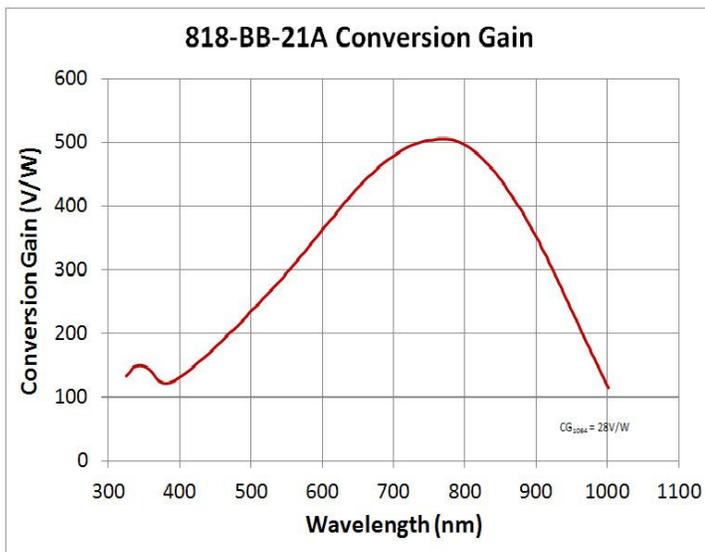
### IV. Drawings: Amplified Photodetectors

#### A. 818-BB-21A, 818-BB-30A Dimensions:

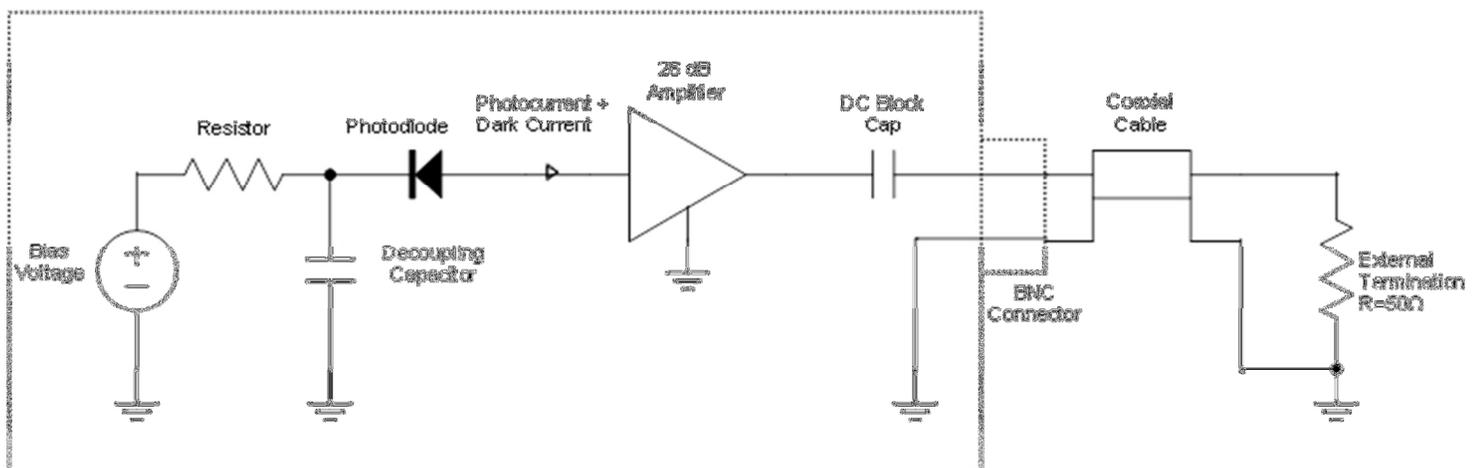


## V. Specifications: Amplified Photodetectors

Part No. (Model)	818-BB-21A	818-BB-30A
Detector Material	Silicon	InGaAs
Rise Time/Fall Time (ps)	<500/<500	<400/<400
Conversion Gain	450 V/W at 830nm	900 V/W at 1300nm
Power Supply (VDC)	24	24
Spectral Range (nm)	350-1100	800-1750
Bandwidth	30kHz—1.2GHz	30kHz—1.5GHz
Active Area Diameter	400 $\mu$ m	100 $\mu$ m
Acceptance Angle (1/2 angle)	10 $^{\circ}$	20 $^{\circ}$
Noise Equivalent Power (pW/ $\sqrt$ Hz)	<60	<30
Maximum Linear Rating	1.3V peak	1.3V peak
Mounting (Tapped Holes)	8-32 or M4	8-32 or M4
Output Connector	BNC	BNC



## VI. Schematics: Amplified Photodetectors



## VII. Glossary of Terms

**Amplifier:** Provides a power gain of 26dB throughout the photodiode's bandwidth. The photodiode current is converted to an output voltage.

**Bandwidth:** Unlike non-amplified photodetector bandwidth, which is defined as the range of frequencies from 0Hz (DC) to the frequency at which the amplitude decreases by 3dB, the amplified photodetectors have a low frequency cutoff of -3dB, which is greater than 0Hz due to the DC Block Capacitor. Bandwidth and rise time can be approximately related by the equation:  
Bandwidth  $\approx$  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.

**Conversion Gain:** The relative level of the optical input power that is amplified and converted into a voltage output.

**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.

**DC Block Capacitor:** Prevents the DC voltage that is supplied through the amplifier output from exiting the detector which would cause a large DC offset voltage. Therefore, the amplified detector is an AC coupled device and will have a low cut-off frequency as well as a high cut-off frequency.

**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 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 (I<sub>shot</sub>) is a source of noise generated in part by dark current; in the case of reversed biased diodes it is the dominant contributor.

**Photodiode:** Converts photons into a photocurrent.

**Resistor:** Protects the photodiode from excessive current. This could occur if an external power supply was too high in voltage, or if its polarity were reversed; this happens when a customer uses their own power supply.

**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.

