Temporal Sensors

Fast Photodiode Detectors

FPD-IG-25

Temporal Sensors

User Manual

Ophir Optronics Solutions Ltd.
www.ophiropt.com/photonics

Ophir Fast Photodiode Detector User's Manual

Thank you for purchasing your Fast Photodiode Detector from Ophir. This user's manual will help answer any questions you may have regarding the safe use and optimal operation of your Fast Photodiode Detector.

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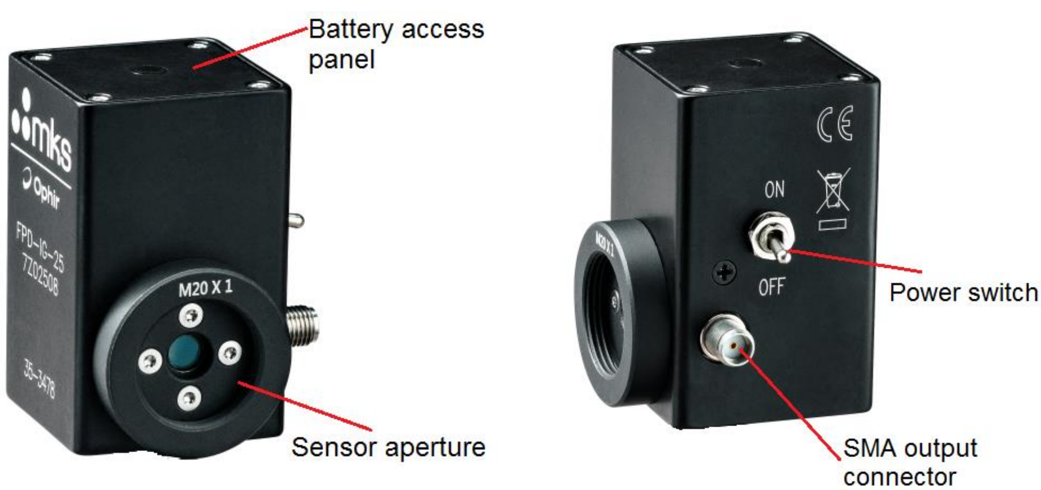
I. Fast Photodiode Detector Overview

Ophir's Fast Photodiode Detectors contain PIN photodiodes that utilize the photovoltaic effect to convert optical power into an electrical current for measurement. Internal circuitry provides a reverse bias voltage to improve the photodiode's response time. For optimal performance, the output should be connected to a 50Ω load resistance. Figure 1 below identifies the main elements of your Fast Photodiode Detector.

Figure 1: Ophir Fast Photodiode Detector



When terminated into the 50Ω input of an oscilloscope, the pulse width 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 Ophir Fast Photodiode Detector

A. Caution: Eye safety precautions must be followed with 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. Each detector is provided with an 8-32 threaded nylon standoff. If the detector is mounted to a metal post, it is recommended to insert the standoff between the detector and the post in order to minimize the potential for electrical noise pickup.

C. Adjust the voltage scale of the oscilloscope to 20mV/division before connecting the detector.

D. Connect the detector to the oscilloscope using a coaxial cable designed for at least 15 GHz operation.

E. Use the 50Ω termination input of the oscilloscope.

F. After being certain that the damage threshold of the detector is not exceeded, place the detector in the laser beam and turn the detector power switch to "On".

G. There is an internal 50Ω resistor in the output stage of the detector circuit. This will reduce the output current from the detector to 50% of the photodiode output current. For example, the output to your equipment will be 450µA for a 1mW optical input at a wavelength at which the responsivity is 0.9A/W.

   Note: This 50Ω resistor presents a constant load to the photodiode so anytime the detector power switch is turned on, current will be drawn from the batteries to flow through the photodiode. To prevent premature battery drainage, turn off the power switch whenever the detector is not in use.

III. Batteries

Batteries will typically operate for several years, but operation with CW or high rep rate lasers can drain the batteries much faster. Leaving the detector output connected to a load for long periods of time can also drain the batteries. It is recommended to disconnect the output whenever the detector will not be in use for long periods of time.

As the batteries become depleted, the bias voltage on the photodiode will decrease. This will increase the rise and falls times of the detector and also reduce its saturation level. The ability of the battery to supply current quickly will also be reduced which is manifested as saturation effects in the output signal.

The batteries can be accessed for checking their voltage and replacement by removing the top plate of the housing. If necessary, replace with type two (2) CR2430 lithium cells. Install batteries with positive side down.

IV. Accessories

The following types of accessories are available for use with Ophir Fast Photodiode Detectors:

1. Fiber optic cable connectors
2. Adapters for attachment to IS6 integrating spheres
3. ND filters for attenuating the laser signal level

Fiber Adapters	SC type	7Z08227
	ST type	7Z08226
	FC type	7Z08229
	SMA type	1G01236A
ND Attenuators	ND1 nom. X10 attenuator	7Z08200
	ND2 nom. X50 attenuator	7Z08201
IS6 Integrating Sphere Adapter	For FPD detectors	7Z08350

SC fiber adapter

ST fiber adapter

FC fiber adapter

SMA fiber adapter

ND Attenuators

IS6 Integrating Sphere Adapter

V. Troubleshooting

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

1. Is the power switch on?
2. Be certain that the signal is not too high for the scale set on the oscilloscope.
3. Is the wavelength of the laser within the spectral range of the detector?
4. Has a 50Ω termination input been used?
5. Try moving the detector within the laser beam. The detector's small active area may make alignment somewhat difficult.
6. Is the light level (see sensitivity spec on the data sheet) incident on the detector sufficient to generate a measurable signal?

B. **A signal has been detected previously obtained, but is currently lost.**

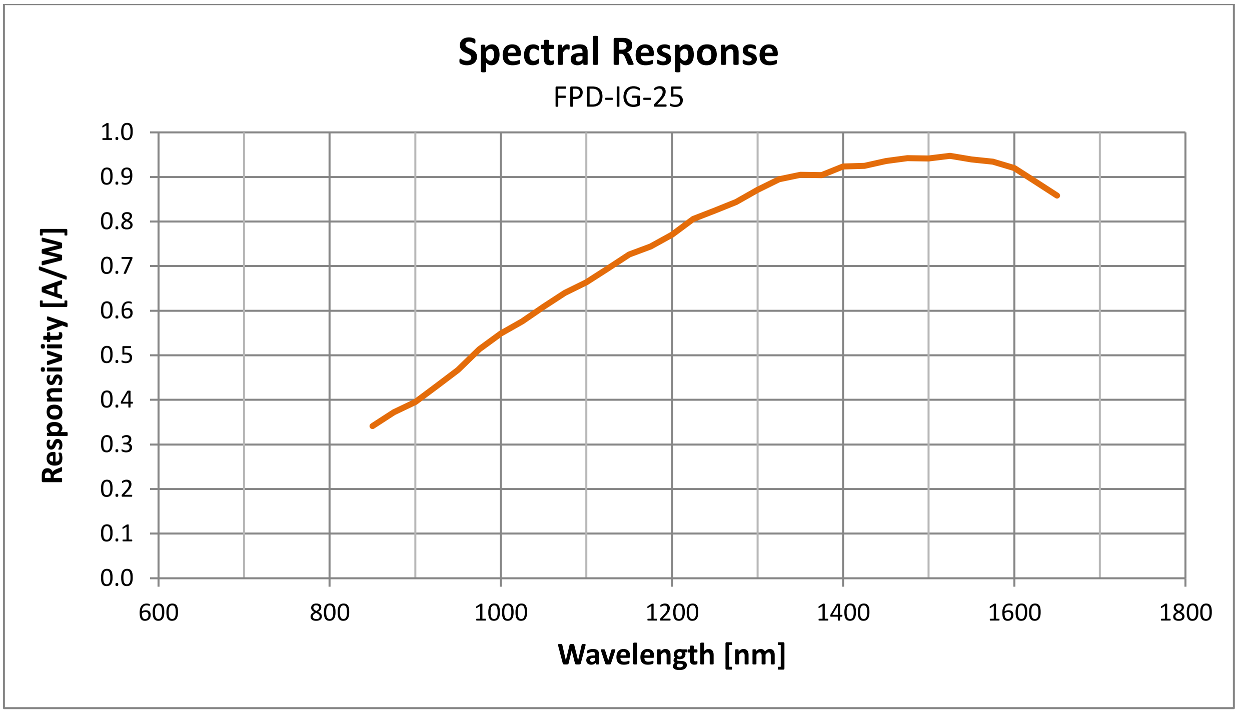
1. Try steps listed under A.
2. Inspect the active area of the photodiode for any signs of damage.
3. Test the batteries :
   a. Units with internal batteries will typically operate for several years, but operation with CW or high rep rate lasers can drain the batteries much faster.
   The 50Ω output resistor presents a constant load to the photodiode so anytime the detector power switch is turned on, current will be drawn from the batteries to flow through the photodiode. **To prevent premature battery drainage, turn off the power switch whenever the detector is not in use.**
   Remove top cover to replace the 3V 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.

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

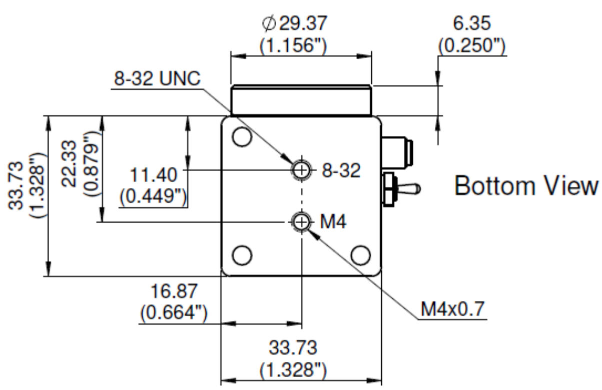
1. The detector is probably saturated. You should lower the power incident on the detector to a level below the saturation point.

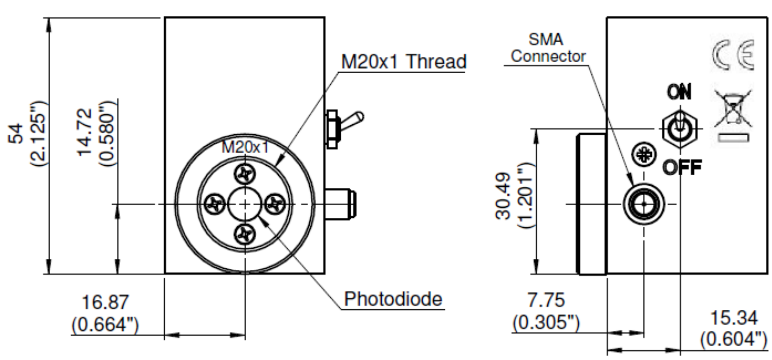
VI. Specifications: Fast Photodiode Detectors

Model [a]	**FPD-IG-25**
Detector Type	InGaAs
Rise Time/Fall Time nsec	<0.025
Spectral Range nm (see graph below)	900-1700
Active Area Diameter mm	0.032
Detector Area mm^2	0.00080
Wavelength of Peak Sensitivity nm	1500
Responsivity at Peak Wavelength A/W	0.95
Responsivity (Irradiance) at Peak Wavelength $V/(W/cm^2)$	0.19×10^{-3}
Bias Voltage VDC	6
Bias Voltage Source	Batteries
Battery Type	CR2430 x2
Bandwidth	>15 GHz
Dark Current nA	<3
Noise Equivalent Power[b] pW/√Hz	20
Maximum Average Power Input [b], [c] mW	10
Mounting (Tapped Holes)	8-32 & M4
Output Connector	SMA
Accessory Threads	M20x1
Version	
Part Number	7Z02508
Notes: (a) All specs are with 50 Ω load Notes: (b) At wavelength of peak sensitivity Notes: (c) Maximum peak power is twice the average power for 10 nsec pulses	

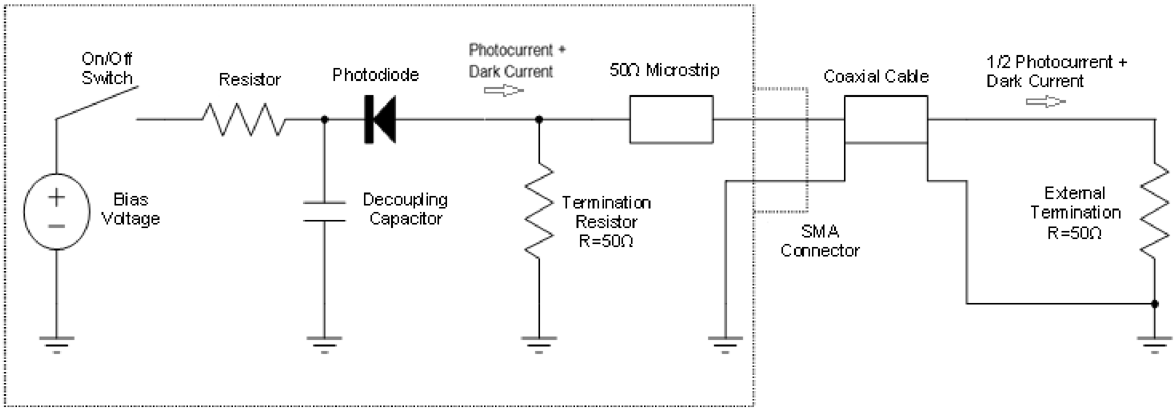


VII. Drawings: Fast Photodiode Detectors





VIII. Schematic: Fast Photodiode Detectors



IX. Glossary of Terms

Bandwidth: The range of frequencies from 0Hz (DC) to the frequency at which the responsivity decreases by 3dB. 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 improves the photodiode's temporal response. The bias voltage also induces a dark current. When a photodiode is used with reverse bias, the shot noise of the dark current is usually the dominant contributor to the NEP.

Dark Current: When a photodiode is connected in a circuit and operated in reverse bias mode, a small DC current (typically nanoamps) will flow, even without the presence of an optical signal. Turning off the power switch will prevent this current from flowing. If operated without a reverse bias (photovoltaic mode) the dark current will be comprised of thermally generated noise without any DC component. This thermal noise will typically be orders of magnitude lower than the shot noise of the dark current in the same device when it is reverse biased.

Decoupling Capacitor: A capacitor is connected in parallel with the bias voltage source. Its purpose is twofold: 1) It maintains the bias voltage when fast signal pulses would otherwise cause the battery voltage to droop (this would slow the response time of the photodiode) and 2) It also acts as a low-pass filter for external power supplies.

Noise Equivalent Power (NEP): NEP refers to the amount of optical input power that would generate an electric signal that is equal in magnitude to the electrical noise (in the dark). 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.

Photodiode: A semiconductor device that **c**onverts photons into an electrical current.

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.

Responsivity (Irradiance): In V per W/cm^2 is the voltage output as a function of the light input irradiance. This is equal to the responsivity in units of A/W multiplied by the photodiode sensitive area and the effective impedance load seen by the photodiode.

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.

SMA Connector: Used to connect the customer's coaxial cable for high frequencies.

Termination Resistor (50Ω): Reduces signal reflections and balances the 50Ω microstrip/coaxial cable lines. As a result, half the photodiode current is lost to the internal resistor.

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For the latest version, please visit our website: www.ophiropt.com/photonics.