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THORLABS

DET25K2 - APR 27, 2022

Item # DET25K2 was discontinued on APR 27, 2022. For informational purposes, this is a copy of the website content at that time and is valid only for the stated product.

FREE-SPACE BIASED DETECTORS

- ▶ Monitor CW or Fast Pulsed Lasers
- ▶ Detectors for Wavelengths from 150 to 2600 nm
- ▶ Integrate with Cage or Lens Tube Systems

DET36A2
Biased Si Detector

DET10D2
Biased InGaAs Detector

Application Idea

DET Series Detector Attached to a 30 mm Cage System Using the Included SM1 Coupler and an SM1T2 Adapter (See the *Housing* Tab for Details)

Hide Overview

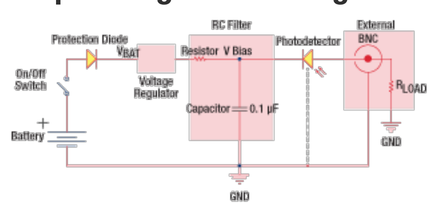
OVERVIEW

Features

- 11 Models Cover the 150 nm to 2.6 µm Wavelength Range
- Rise Times as Fast as 1 ns
- Compact Housing for Measurements in Tight Spaces
- SM05 Lens Tube, SM1 Lens Tube, Cage System, and Ø1/2" Post Compatible
- Internal A23 12 V Bias Battery Included
- Optional Power Adapter and Power Supply Available Below
- Can be Fiber Coupled Using Our Internally and Externally SM1-Threaded Fiber Adapters

Click to Enlarge
Each detector has an internal SM05 and external SM1 thread and comes with an attached SM1T1 Internal SM1 Adapter and SM1RR Retaining Ring.

Operating Circuit Diagram



Click to Enlarge
The detectors are reverse biased to produce a linear response with applied input light.

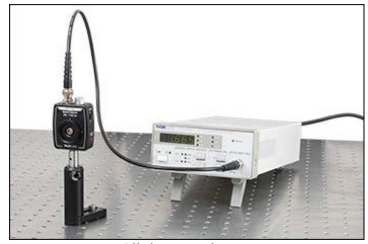
Thorlabs' Biased Photodetectors are available in eleven models that cover the wavelength range from the UV to the mid-IR (150 nm to 2.6 µm). The slim housing allows the optical detector to slip into tight setups. Our DET30B2 and DET50B2 Ge detectors are based on N-on-P type photodiodes, whereas our GaP, Si, and InGaAs detectors are based on fast PIN photodiodes. Every detector comes complete with an internal bias battery packaged in a rugged aluminum housing. Our biased photodetectors are compatible with our benchtop photodiode amplifier and PMT transimpedance amplifier.

With a wide bandwidth DC-coupled output, these detectors are ideal for monitoring fast pulsed lasers as well as DC optical sources. The direct photodiode anode current is provided on a side panel BNC. This output is easily converted to a positive voltage using a terminating resistor. When looking at high-speed signals, Thorlabs recommends using a 50 Ω load resistor. For lower bandwidth applications, our variable terminator or fixed stub-style terminators quickly adjusts the measured voltage. The detectors below do not have amplifiers or built-in gain, which generally allows them to operate at higher speeds than our PDA series of amplified photodetectors; for applications that require gain or switchable filters, a PDA amplified photodetector may be more suitable.

All connections and controls are located away from the light path, which simplifies integration of our detectors in enclosed spaces. Every detector has

Click to Enlarge
The Red Battery Test Button on the DET10D2

internal SM05 (0.535"-40) threading and external SM1 (1.035"-40) threading. Each DET housing includes a detachable Ø1" Optic Mount (SM1T1) that allows for Ø1" optical components, such as optical filters and lenses, to be mounted along the optical axis. Each DET detector can also be mounted in a cage system, lens tube system, or on a Ø1/2" optical post. Every unit's housing features two universal mounting holes that accept both 8-32 and M4 threads. For more information about the location of these mounting points and mounting these units, please see the *Housing Features* and *Mounting Options* tabs.



Click to Enlarge
PDA200C Benchtop Photodiode Amplifier Connected to a DET10A2 Photodetector Using a BNC Cable

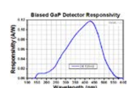
Each detector is reverse-biased by an A23 12 VDC battery incorporated into the housing. The housing also includes a red button (pictured to the left) which, when held down, applies the battery's voltage across the external load. For a high-Z load, this will output the battery's voltage over BNC, providing an easy way to determine if the battery should be replaced without removing it from the housing. An in-line current-limiting resistor prevents fast battery drainage if the battery is tested while connected to a 50 Ω load. Please note that due to slight physical variations of the positive terminal from manufacturer to manufacturer, Thorlabs only recommends using an Energizer® battery in our DET series of photodetectors. A battery was chosen for the reverse bias because it provides an extremely low noise source of power. If the finite lifetime of a battery is not acceptable, the battery can be replaced by a DET2B power adapter bundle. Extra batteries and the DET2B are available for purchase below.

Please note that inhomogeneities at the edges of the active area of the detector can generate unwanted capacitance and resistance effects that distort the time-domain response of the photodiode output. Thorlabs therefore recommends that the incident light on the photodiode is well centered on the active area. The SM1 (1.035"-40) threading on the housing is ideally suited for mounting a Ø1" focusing lens or pinhole in front of the detector element.

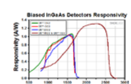
Thorlabs also offers high-speed free-space detectors and high-speed fiber-coupled detectors for wavelengths between 400 - 1700 nm.

Hide Graphs

GRAPHS



Click to Enlarge
Click Here for Raw Data



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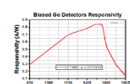
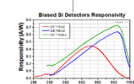


Click to Enlarge
Click Here for Raw Data



Click to Enlarge
Click Here for Raw Data

Hide Housing

HOUSING

DET Series Housing Features

Thorlabs' high-speed detectors feature a slim design. Each housing features internal SM05 (0.535"-40) threading and external SM1 (1.035"-40) threading. Each detector includes an SM1T1 internally SM1-threaded adapter and an SM1RR retaining ring, as shown to the right. The SM1T1 can hold up to 0.1" (2.8 mm) thick optics. The detectors can be mounted using a 1/2" Post, as shown in the images below. Every detector has a housing design that features the active area flush with the front of the housing, simplifying alignments within optomechanical systems. This design also has two universal mounting holes that accept both 8-32 and M4 threads. As a convenience, the back panel is engraved with the responsivity curve of the photodiode.

Click to Enlarge
Each detector has an internal SM05 and external SM1 thread and comes with an attached SM1T1 Internal SM1 Adapter and SM1RR Retaining Ring.

Click to Enlarge
All detector housings have a red battery check button. The DET10D2 is shown here.

Lens Tube Compatibility
These detectors can be integrated into various optomechanical systems using the internal SM05 and external SM1 threads. A lens tube can be directly attached to the SM1 threads, making the detectors compatible with lens tube systems. The SM1T1 adapter can be used to mount Ø1" (Ø25.4 mm) optical components, such as optical filters and lenses.

Cage System Compatibility
The detectors are also cage system compatible, as shown in the two images below right. A CP33(/M) cage plate can be attached directly to the SM1 threads. This attachment method does not require an adapter piece and allows the diode to be as close as possible to the cage plate, which can be important in setups where the light is divergent. Another method for integrating a detector into a cage system is using the included SM1T1 with an SM1T2 adapter. This allows more freedom in choosing the orientation of the detector. Additionally, these detectors can be used with SM1-threaded fiber adapters (sold below).

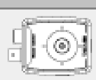
Post Mounting
Threaded holes on the housings of the detectors allow the units to be mounted in a horizontal or vertical orientation using a 1/2" Post. This gives the user the option to route the BNC cable from above or alongside the beam path, as shown below left.

Click to Enlarge
DET Photodetector Mounted Horizontally

Click to Enlarge
[APPLIST]
[APPLIST]
DET Photodetector Connected to an SM1 Lens Tube in a 30 mm Cage System

Click to Enlarge
[APPLIST]
[APPLIST]
DET Photodetector Integrated into a 30 mm Cage System Using the External SM1 Threads

Click to Enlarge
[APPLIST]
[APPLIST]
DET Photodetector Integrated into a 30 mm Cage System Using the SM1T1 (included) and SM1T2 Adapter

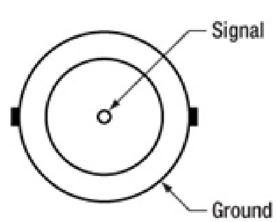
Housing Drawing (Click Icon for Details)	Mounting Taps	SM Thread Compatibility	Dimensions	Output Connector
	Two Universal Taps for 8-32 and M4	Internal SM05 (0.535"-40)[a] External SM1 (1.035"-40)	1.96" x 0.89" x 2.79" (49.8 mm x 22.5 mm x 70.9 mm)	BNC

Hide Pin Diagrams

PIN DIAGRAMS

Output Signal (Photocurrent)

BNC Female



We recommend installing a 50 Ω terminating resistor (e.g., Item # T4119) to the BNC output of each detector. For max photocurrent output, please see the Housing Features column in the tables below.

Note: Our previous generation of free-space biased detectors specified an output voltage, which provided information about the max voltage output under the saturation limit, but the output signal was a photocurrent. To avoid confusion, our current generation of detectors now specify the output current. We apologize for any inconvenience this may have caused.

Hide Battery Lifetime

BATTERY LIFETIME

Battery Lifetime

When using a battery-operated photodetector, it is important to understand the battery's lifetime and how this affects the operation of the detector. As a current output device, the output current of the photodetector is directly proportional to the amount of incident light on the detector. Most users will convert this current to a voltage by using a terminating load resistor. The resistance value is approximately equal to the circuit gain. For very high speed detectors, such as the DET08 series, it is very important to use a 50 Ω terminating resistor to match the impedance of standard coaxial cables to reduce cable reflections and improve overall signal performance and integrity. Most high-bandwidth scopes come equipped with this termination.

The battery usage lifetime directly correlates to the current used by the detector. Most battery manufacturers provide a battery lifetime in terms of mAh (milliamp hours). For example, if a battery is rated for 190 mA hrs, it will reliably operate for 190 hr at a current draw of 1.0 mA. This battery will be used in the following example on how to determine battery lifetime based on usage.

For this example we have a 780 nm light source with an average 1 mW power is applied to a detector. The responsivity of a biased photodetector based on the response curve at this wavelength is 0.5 A/W. The photocurrent can be calculated as:

$$\begin{aligned} I_{current} &= 0.5\,\text{A/W} \times 1\,\text{mW} \\ &= 0.5\,\text{mA} \end{aligned}$$

Given the battery has a rated lifetime of 190 mA hr, the battery will last:

$$\begin{aligned} T &= \frac{190\,\text{mA hr}}{0.5\,\text{mA}} \\ &= 380\,\text{hr} \end{aligned}$$

or 16 days of continuous use. By reducing the average incident power of the light to 10 µW, the same battery would last for about 4 years when used continuously. When using the recommended 50 Ω terminating load, the 0.5 mA photocurrent will be converted into a voltage of:

$$\begin{aligned} V &= I \times R \\ &= 0.5\,\text{mA} \times 50\Omega \\ &= 25\,\text{mV} \end{aligned}$$

If the incident power level is reduced to 40 µW, the output voltage becomes 1 mV. For some measurement devices this signal level may be too low and a compromise between battery life and measurement accuracy will need to be made.

When using a battery-powered, biased photodetector, it is desirable to use as low a light intensity as is possible, keeping in mind the minimum voltage levels required. It is also important to remember that a battery will not immediately cease producing a current as it nears the end of its lifetime. Instead, the voltage of the battery will drop, and the electric potential being applied to the photodiode will decrease. This in turn will increase the response time of the detector and lower its bandwidth. As a result, it is important to make sure the battery has sufficient voltage (as given in the *Troubleshooting* chapter of the detector's manual) for the detector to operate within its specified parameters. The voltage can be checked with a multimeter.

Another suggestion to increase the battery lifetime is to remove, or power down the light source illuminating the sensor. Without the light source, the photodetector will continue to draw current proportional to the photodetector's dark current, but this current will be significantly smaller.

For applications where a DET series photodetector is continuously illuminated with a relatively high-power light source, or if having to change the battery is not acceptable, we offer the DET2B power adapter bundle, which includes the power adapter and power supply (sold below). The drawback to this option is the noise in the line voltage will add to the noise in the output signal and could cause more measurement uncertainty.

Hide Photodiode Tutorial

PHOTODIODE TUTORIAL

Photodiode Tutorial

Theory of Operation

A junction photodiode is an intrinsic device that behaves similarly to an ordinary signal diode, but it generates a photocurrent when light is absorbed in the depleted region of the junction semiconductor. A photodiode is a fast, highly linear device that exhibits high quantum efficiency based upon the application and may be used in a variety of different applications.

It is necessary to be able to correctly determine the level of the output current to expect and the responsivity based upon the incident light. Depicted in Figure 1 is a junction photodiode model with basic discrete components to help visualize the main characteristics and gain a better understanding of the operation of Thorlabs' photodiodes.

$$I_{OUT} = I_{DARK} + I_{PD}$$

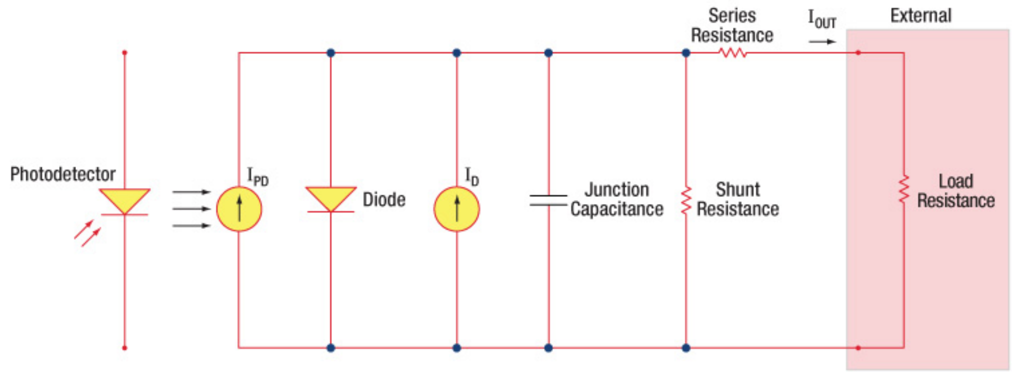


Figure 1: Photodiode Model

Photodiode Terminology

Responsivity

The responsivity of a photodiode can be defined as a ratio of generated photocurrent (I_{PD}) to the incident light power (P) at a given wavelength:

$$R(\lambda) = \frac{I_{PD}}{P}$$

Modes of Operation (Photoconductive vs. Photovoltaic)

A photodiode can be operated in one of two modes: photoconductive (reverse bias) or photovoltaic (zero-bias). Mode selection depends upon the application's speed requirements and the amount of tolerable dark current (leakage current).

Photoconductive

In photoconductive mode, an external reverse bias is applied, which is the basis for our DET series detectors. The current measured through the circuit indicates illumination of the device; the measured output current is linearly proportional to the input optical power. Applying a reverse bias increases the width of the depletion junction producing an increased responsivity with a decrease in junction capacitance and produces a very linear response. Operating under these conditions does tend to produce a larger dark current, but this can be limited based upon the photodiode material. (Note: Our DET detectors are reverse biased and cannot be operated under a forward bias.)

Photovoltaic

In photovoltaic mode the photodiode is zero biased. The flow of current out of the device is restricted and a voltage builds up. This mode of operation exploits the photovoltaic effect, which is the basis for solar cells. The amount of dark current is kept at a minimum when operating in photovoltaic mode.

Dark Current

Dark current is leakage current that flows when a bias voltage is applied to a photodiode. When operating in a photoconductive mode, there tends to be a higher dark current that varies directly with temperature. Dark current approximately doubles for every 10 °C increase in temperature, and shunt resistance tends to double for every 6 °C rise. Of course, applying a higher bias will decrease the junction capacitance but will increase the amount of dark current present.

The dark current present is also affected by the photodiode material and the size of the active area. Silicon devices generally produce low dark current compared to germanium devices which have high dark currents. The table below lists several photodiode materials and their relative dark currents, speeds, sensitivity, and costs.

Material	Dark Current	Speed	Spectral Range	Cost
Silicon (Si)	Low	High Speed	Visible to NIR	Low
Germanium (Ge)	High	Low Speed	NIR	Low
Gallium Phosphide (GaP)	Low	High Speed	UV to Visible	Moderate
Indium Gallium Arsenide (InGaAs)	Low	High Speed	NIR	Moderate
Indium Arsenide Antimonide (InAsSb)	High	Low Speed	NIR to MIR	High
Extended Range Indium Gallium Arsenide (InGaAs)	High	High Speed	NIR	High
Mercury Cadmium Telluride (MCT, HgCdTe)	High	Low Speed	NIR to MIR	High

Junction Capacitance

Junction capacitance (C_j) is an important property of a photodiode as this can have a profound impact on the photodiode's bandwidth and response. It should be noted that larger diode areas encompass a greater junction volume with increased charge capacity. In a reverse bias application, the depletion width of the junction is increased, thus effectively reducing the junction capacitance and increasing the response speed.

Bandwidth and Response

A load resistor will react with the photodetector junction capacitance to limit the bandwidth. For best frequency response, a 50 Ω terminator should be used in conjunction with a 50 Ω coaxial cable. The bandwidth (f_{BW}) and the rise time response (t_r) can be approximated using the junction capacitance (C_j) and the load resistance (R_{LOAD}):

$$f_{BW} = 1 / (2 * \pi * R_{LOAD} * C_j)$$
$$t_r = 0.35 / f_{BW}$$

Noise Equivalent Power

The noise equivalent power (NEP) is the generated RMS signal voltage generated when the signal to noise ratio is equal to one. This is useful, as the NEP determines the ability of the detector to detect low level light. In general, the NEP increases with the active area of the detector and is given by the following equation:

$$NEP = \frac{Incident\ Energy * Area}{\frac{S}{N} * \sqrt{\Delta f}}$$

Here, S/N is the Signal to Noise Ratio, Δf is the Noise Bandwidth, and Incident Energy has units of W/cm^2. For more information on NEP, please see Thorlabs' Noise Equivalent Power White Paper.

Terminating Resistance

A load resistance is used to convert the generated photocurrent into a voltage (V_{OUT}) for viewing on an oscilloscope:

$$V_{OUT} = I_{OUT} * R_{LOAD}$$

Depending on the type of the photodiode, load resistance can affect the response speed. For maximum bandwidth, we recommend using a 50 Ω coaxial cable with a 50 Ω terminating resistor at the opposite end of the cable. This will minimize ringing by matching the cable with its characteristic impedance. If bandwidth is not important, you may increase the amount of voltage for a given light level by increasing R_{LOAD}. In an unmatched termination, the length of the coaxial cable can have a profound impact on the response, so it is recommended to keep the cable as short as possible.

Shunt Resistance

Shunt resistance represents the resistance of the zero-biased photodiode junction. An ideal photodiode will have an infinite shunt resistance, but actual values may range from the order of ten Ω to thousands of MΩ and is dependent on the photodiode material. For example, and InGaAs detector has a shunt resistance on the order of 10 MΩ while a Ge detector is in the kΩ range. This can significantly impact the noise current on the photodiode. For most applications, however, the high resistance produces little effect and can be ignored.

Series Resistance
Series resistance is the resistance of the semiconductor material, and this low resistance can generally be ignored. The series resistance arises from the contacts and the wire bonds of the photodiode and is used to mainly determine the linearity of the photodiode under zero bias conditions.

Common Operating Circuits

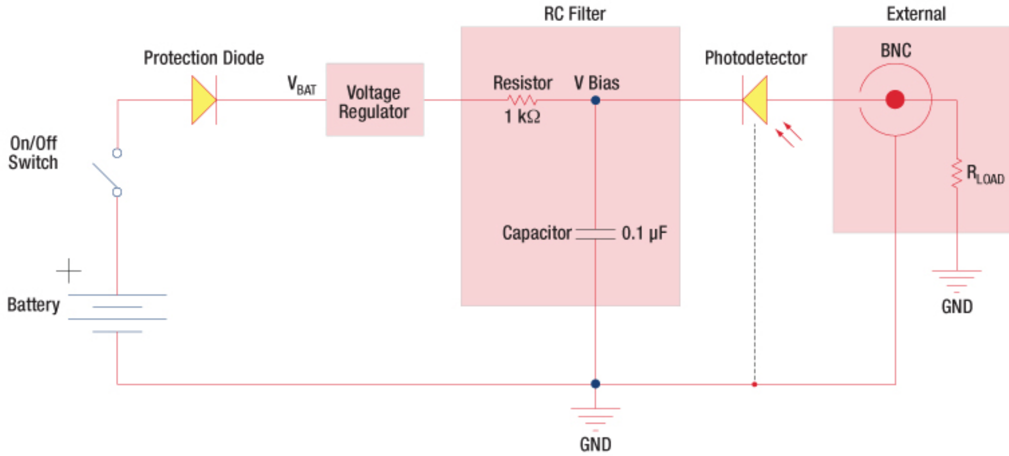


Figure 2: Reverse-Biased Circuit (DET Series Detectors)

The DET series detectors are modeled with the circuit depicted above. The detector is reverse biased to produce a linear response to the applied input light. The amount of photocurrent generated is based upon the incident light and wavelength and can be viewed on an oscilloscope by attaching a load resistance on the output. The function of the RC filter is to filter any high-frequency noise from the input supply that may contribute to a noisy output.

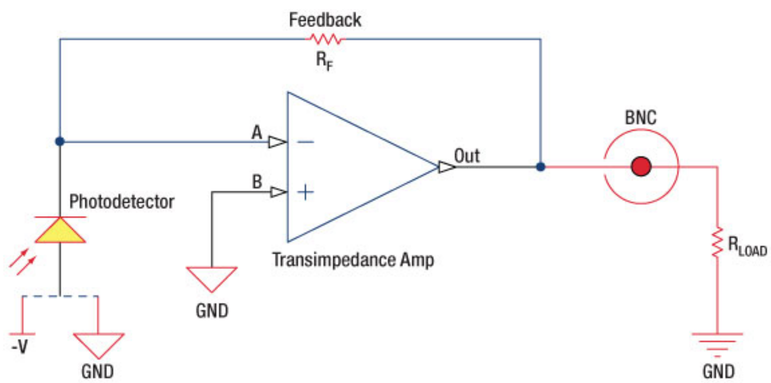


Figure 3: Amplified Detector Circuit

One can also use a photodetector with an amplifier for the purpose of achieving high gain. The user can choose whether to operate in Photovoltaic of Photoconductive modes. There are a few benefits of choosing this active circuit:

- Photovoltaic mode: The circuit is held at zero volts across the photodiode, since point A is held at the same potential as point B by the operational amplifier. This eliminates the possibility of dark current.
- Photoconductive mode: The photodiode is reversed biased, thus improving the bandwidth while lowering the junction capacitance. The gain of the detector is dependent on the feedback element (R_f). The bandwidth of the detector can be calculated using the following:

$$f(-3dB) = \sqrt{\frac{GBP}{4\pi * R_f * C_D}}$$

where GBP is the amplifier gain bandwidth product and C_D is the sum of the junction capacitance and amplifier capacitance.

Effects of Chopping Frequency

The photoconductor signal will remain constant up to the time constant response limit. Many detectors, including PbS, PbSe, HgCdTe (MCT), and InAsSb, have a typical 1/f noise spectrum (i.e., the noise decreases as chopping frequency increases), which has a profound impact on the time constant at lower frequencies.

The detector will exhibit lower responsivity at lower chopping frequencies. Frequency response and detectivity are maximized for

$$f_c = \frac{1}{2\pi\tau_r}$$

Hide Lab Facts

LAB FACTS

Dark Current as a Function of Temperature or Reverse-Bias Voltage

Measurements of dark current as a function of temperature and dark current as a function of reverse-bias voltage were acquired for several packaged detectors. As is described in the following section, dark current is a relatively small electrical current that flows in p-n junction photodetectors when no light is incident on the detector. For certain applications, it may be necessary to account for the change in dark current as temperature fluctuates and/or as the reverse-bias voltage changes. As a consequence of a battery's supplied voltage decreasing as it drains, the relationship between the reverse-bias voltage and the dark current level may be of particular interest if a battery is used to reverse-bias voltage the photodiode.

One set of measurements were taken for silicon (Si), germanium (Ge), and indium gallium arsenide (InGaAs) reverse-biased photodiodes over temperatures from 10 °C to 50 °C, and another set of measurements were taken for the same detectors while they were held at 24 °C and the reverse-bias voltage varied from 0 to 10 V. Please click the "More [+]" labels in the following expandable tables to read about the experiments and our measurements.

Current-Voltage Characteristics of p-n Junction Photodiodes

The characteristic current-voltage relationship of p-n junction photodiodes includes a forward-biased and a reverse-biased voltage regime. Operation of p-n junction photodiodes occurs in the reverse-biased voltage regime, in which a potential difference is applied across the diode to resist the flow of current. A convenient feature of some packaged photodiodes is that a battery inserted into the package can supply the reverse-bias voltage. Ideally, if no light is incident on a reverse-biased photodiode, no current flows.

Under real-world conditions, random processes in the semiconductor material of the photodiode always generate current carriers (electrons and holes) that produce current. These current generation processes are not driven by the photogeneration of electrons and holes. Instead, they are largely driven by the thermal energy contained in the semiconductor material [1]. This dark current is generally small, but it is present when the photodiode is reverse biased and not illuminated. Dark current magnitudes vary for photodiodes of different material compositions; the efficiencies of the thermal generation processes depend on the type and crystal quality of the semiconductor used in the detector's sensing head. The magnitude of the dark current can be expected to increase as the temperature of the photodiode increases and as the reverse-bias voltage applied to the photodiode increases.

It is important to note that if the reverse bias voltage is increased beyond a certain threshold, the photodiode will suffer reverse breakdown, in which the magnitude of the current increases exponentially and permanent damage to the diode is likely. For this reason, many of the Thorlabs DET packages include a voltage regulator to prevent the bias voltage from reaching breakdown.

When a photodiode is illuminated, the current generated by the incident light adds to the dark current. The carriers in the photocurrent are generated by the energy contained in the photons of the incident light. Above a certain illumination threshold intensity, the magnitude of the photocurrent exceeds the magnitude of the dark current. When the photocurrent is larger than the dark current, the magnitude of the photocurrent can be calculated by measuring the total current and then subtracting the contribution of the dark current. When the photocurrent is smaller than the noise on the dark current, the photocurrent is undetectable. Because of this, it is desirable to minimize the levels of dark current in photodiodes.

[1] J. Liu, Photonic Devices. Cambridge University Press, Cambridge, UK, 2005

Dark Current as a Function of Temperature More [+]

Dark Current as a Function of Reverse-Bias Voltage More [+]

About Our Lab Facts

Our application engineers live the experience of our customers by conducting experiments in Alex's personal lab. Here, they gain a greater understanding of our products' performance across a range of application spaces. Their results can be found throughout our website on associated product pages in *Lab Facts* tabs. Experiments are used to compare performance with theory and look at the benefits and drawbacks of using similar products in unique setups, in an attempt to understand the intricacies and practical limitations of our products. In all cases, the theory, procedure, and results are provided to assist with your buying decisions.

Hide Previous Generation

PREVIOUS GENERATION

The following table lists Thorlab's selection of previous and current generation PDA, PDF, and DET detectors.

Previous Generation Cross Reference of PDA and DET Detectors

Wavelength	Material	Biased Detector		Amplified Detector	
		Current Generation	Previous Generation	Current Generation	Previous Generation
150 - 550 nm	GaP	DET25K2	DET25K(/M)	PDA25K2	PDA25K(-EC)
200 - 1100 nm	Si	DET10A2	DET10A(/M)	PDA10A2	PDA10A(-EC)
320 - 1000 nm	Si	-	-	PDA8A2	PDA8A
320 - 1100 nm	Si	DET100A2	DET100A(/M)[a]	PDA100A2	PDA100A(-EC)[b]
	Si	-	-	PDF10A2	PDF10A(/M)
350 - 1100 nm	Si	DET36A2	DET36A(/M)	PDA36A2	PDA36A(-EC)
500 - 1700 nm	InGaAs	DET10N2	DET10N(/M)	-	-
800 - 1700 nm	InGaAs	DET20C2	DET20C(/M)	PDA20CS2	PDA20CS(-EC)
		-	-	PDA05CF2	PDA10CF(-EC)
		-	-	PDF10C2	PDF10C(/M)
		-	-	PDA20C2	PDA20C(/M)
800 - 1800 nm	Ge	DET30B2	DET30B(/M)	PDA30B2	PDA30B(-EC)
		DET50B2	DET50B(/M)	PDA50B2	PDA50B(-EC)
900 - 1700 nm	InGaAs	DET10C2	DET10C(/M)	PDA10CS2	PDA10CS(-EC)
900 - 2600 nm	InGaAs	DET05D2	DET05D(/M)[c]	PDA10D2	PDA10D(-EC)[c]
		DET10D2	DET10D(/M)[c]	-	-

a. The DET100A(/M) wavelength range is 350 - 1100 nm.
b. The PDA100A(-EC) wavelength range is 340 - 1100 nm.
c. The DET05D(/M), PDA10D(-EC), and DET10D(/M) wavelength range is 800 - 2600 nm.

Hide Pulse Calculations

PULSE CALCULATIONS

Pulsed Laser Emission: Power and Energy Calculations

Determining whether emission from a pulsed laser is compatible with a device or application can require referencing parameters that are not supplied by the laser's manufacturer. When this is the case, the necessary parameters can typically be calculated from the available information. Calculating peak pulse power, average power, pulse energy, and related parameters can be necessary to achieve desired outcomes including:

Click above to download the full report.

- Protecting biological samples from harm.
- Measuring the pulsed laser emission without damaging photodetectors and other sensors.
- Exciting fluorescence and non-linear effects in materials.

Pulsed laser radiation parameters are illustrated in Figure 1 and described in the table. For quick reference, a list of equations are provided below. The document available for download provides this information, as well as an introduction to pulsed laser emission, an overview of relationships among the different parameters, and guidance for applying the calculations.

Equations:

Period **and** ***repetition rate*** **are reciprocal:** $\Delta t = \frac{1}{f_{rep}}$ and $f_{rep} = \frac{1}{\Delta t}$

Pulse energy **calculated from** ***average power*****:** $E = \frac{P_{avg}}{f_{rep}} = P_{avg} \cdot \Delta t$

Average power **calculated from** ***pulse energy*****:** $P_{avg} = \frac{E}{\Delta t} = E \cdot f_{rep}$

Peak pulse power **estimated from** ***pulse energy*****:** $P_{peak} \approx \frac{E}{\tau}$

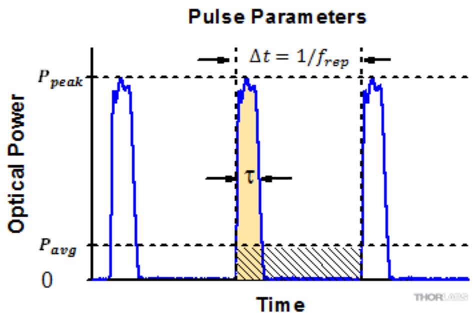
Peak power **and** ***average power*** **calculated from each other:**

$$P_{peak} = \frac{P_{avg}}{f_{rep} \cdot \tau} = \frac{P_{avg} \cdot \Delta t}{\tau}$$ and $$P_{avg} = P_{peak} \cdot f_{rep} \cdot \tau = \frac{P_{peak} \cdot \tau}{\Delta t}$$

Peak power **calculated from** ***average power*** **and** ***duty cycle******:**

$$P_{peak} = \frac{P_{avg}}{\tau/\Delta t} = \frac{P_{avg}}{duty\ cycle}$$

*Duty cycle ($\tau/\ \Delta t$) is the fraction of time during which there is laser pulse emission.



Click to Enlarge

Figure 1: Parameters used to describe pulsed laser emission are indicated in the plot (above) and described in the table (below). **Pulse energy** (**E**) is the shaded area under the pulse curve. Pulse energy is, equivalently, the area of the diagonally hashed region.

Parameter	Symbol	Units	Description
Pulse Energy	**E**	Joules [J]	A measure of one pulse's total emission, which is the only light emitted by the laser over the entire period. The pulse energy equals the shaded area, which is equivalent to the area covered by diagonal hash marks.
Period	**Δt**	Seconds [s]	The amount of time between the start of one pulse and the start of the next.
Average Power	P_{avg}	Watts [W]	The height on the optical power axis, if the energy emitted by the pulse were uniformly spread over the entire period.
Instantaneous Power	**P**	Watts [W]	The optical power at a single, specific point in time.
Peak Power	P_{peak}	Watts [W]	The maximum instantaneous optical power output by the laser.
Pulse Width	τ	Seconds [s]	A measure of the time between the beginning and end of the pulse, typically based on the full width half maximum (FWHM) of the pulse shape. Also called **pulse duration**.
Repetition Rate	f_{rep}	Hertz [Hz]	The frequency with which pulses are emitted. Equal to the reciprocal of the period.

Example Calculation:

Is it safe to use a detector with a specified maximum peak optical input power of **75 mW** to measure the following pulsed laser emission?

- Average Power: 1 mW
- Repetition Rate: 85 MHz
- Pulse Width: 10 fs

The energy per pulse:

$$E = \frac{P_{avg}}{f_{rep}} = \frac{1\ mW}{85\ MHz} = \frac{1\ x\ 10^{-3} W}{85\ x\ 10^{6} Hz} = 1.18\ x\ 10^{-11} J = 11.8\ pJ$$

seems low, but the peak pulse power is:

$$P_{peak} = \frac{P_{avg}}{f_{rep} \cdot \tau} = \frac{1\ mW}{85\ MHz\ \cdot 10\ fs} = 1.18\ x\ 10^{3}\ W = \mathbf{1.18\ kW}$$

It is ***not safe*** to use the detector to measure this pulsed laser emission, since the peak power of the pulses is >5 orders of magnitude higher than the detector's maximum peak optical input power.

Hide Cross Reference

CROSS REFERENCE

The following table lists Thorlabs' selection of photodiodes and photoconductive detectors. Item numbers in the same row contain the same detector element.

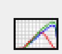
Photodetector Cross Reference						
Wavelength	Material	Unmounted Photodiode	Mounted Photodiode	Biased Detector	Amplified Detector	Amplified Detector, OEM Package
150 - 550 nm	GaP	-	SM05PD7A	DET25K2	PDA25K2	-
200 - 1100 nm	Si	FDS010	SM05PD2A SM05PD2B	DET10A2	PDA10A2	-
	Si	-	SM1PD2A	-	-	-
320 - 1000 nm	Si	-	-	-	PDA8A2	-
320 - 1100 nm	Si	FD11A	SM05PD3A		PDF10A2	-
	Si	- [a]	-	DET100A2 [a]	PDA100A2 [a]	PDAPC2 [a]
340 - 1100 nm	Si	FDS10X10	-	-	-	-
350 - 1100 nm	Si	FDS100 FDS100-CAL [b]	SM05PD1A SM05PD1B	DET36A2	PDA36A2	PDAPC1
	Si	FDS1010 FDS1010-CAL [b]	SM1PD1A SM1PD1B	-	-	-
400 - 1000 nm	Si	-	-	-	PDA015A(/M) FPD310-FS-VIS FPD310-FC-VIS FPD510-FC-VIS FPD510-FS-VIS FPD610-FC-VIS FPD610-FS-VIS	-
400 - 1100 nm	Si	FDS015 [c]	-	-	-	-
	Si	FDS025 [c] FDS02 [d]	-	DET02AFC(/M) DET025AFC(/M) DET025A(/M) DET025AL(/M)	-	-
400 - 1700 nm	Si & InGaAs	DSD2	-	-	-	-

500 - 1700 nm	InGaAs	-	-	DET10N2	-	-
750 - 1650 nm	InGaAs	-	-	-	PDA8GS	-
800 - 1700 nm	InGaAs	FGA015	-	-	PDA015C(/M)	-
	InGaAs	FGA21 FGA21-CAL [b]	SM05PD5A	DET20C2	PDA20C2 PDA20CS2	-
	InGaAs	FGA01 [c] FGA01FC [d]	-	DET01CFC(/M)	-	-
	InGaAs	FDGA05 [c]	-	-	PDA05CF2	-
	InGaAs	-	-	DET08CFC(/M) DET08C(/M) DET08CL(/M)	-	-
	InGaAs	-	-	-	PDF10C2	-
800 - 1800 nm	Ge	FDG03 FDG03-CAL [b]	SM05PD6A	DET30B2	PDA30B2	-
	Ge	FDG50	-	DET50B2	PDA50B2	-
	Ge	FDG05	-	-	-	-
900 - 1700 nm	InGaAs	FGA10	SM05PD4A	DET10C2	PDA10CS2	-
900 - 2600 nm	InGaAs	FD05D	-	DET05D2	-	-
		FD10D	-	DET10D2	PDA10D2	-
950 - 1650 nm	InGaAs	-	-	-	FPD310-FC-NIR FPD310-FS-NIR FPD510-FC-NIR FPD510-FS-NIR FPD610-FC-NIR FPD610-FS-NIR	-
1.0 - 5.8 µm	InAsSb	-	-	-	PDA10PT(-EC)	-
2.0 - 8.0 µm	HgCdTe (MCT)	VML8T0 VML8T4 [e]	-	-	PDAVJ8	-
2.0 - 10.6 µm	HgCdTe (MCT)	VML10T0 VML10T4 [e]	-	-	PDAVJ10	-
2.7 - 5.0 µm	HgCdTe (MCT)	VL5T0	-	-	PDAVJ5	-
2.7 - 5.3 µm	InAsSb	-	-	-	PDA07P2	-

a. If you are interested in purchasing the bare photodiode incorporated in these detectors without the printed circuit board, please contact Tech Support.
b. Calibrated Unmounted Photodiode
c. Unmounted TO-46 Can Photodiode
d. Unmounted TO-46 Can Photodiode with FC/PC Bulkhead
e. Photovoltaic Detector with Thermoelectric Cooler

Hide Biased Si Detectors: 200 - 1100 nm

Biased Si Detectors: 200 - 1100 nm

Item # [a]	Housing Features	Active Area	Wavelength Range	Rise Time [b,c,d]	Bandwidth	Noise-Equivalent Power (NEP) (Typ.)	Dark Current [e]	Junction Capacitance	Bias Voltage	Responsivity Data [f] (Click Here for Raw Data)
DET10A2		0.8 mm^2 (Ø1.0 mm) [g]	200 - 1100 nm [h]	1 ns (Typ.)	350 MHz [i]	5.0 x 10^{-14} W/Hz$^{1/2}$	0.3 nA (Typ.) 2.5 nA (Max)	6 pF (Typ.)	10 V	
DET100A2		75.4 mm^2 (Ø9.8 mm)	320 - 1100 nm	35 ns [j] (Typ.)	10 MHz [k]	2.4 x 10^{-14} W/Hz$^{1/2}$	0.9 nA (Typ.) 10 nA (Max)	150 pF (Typ.)	10 V	
DET36A2		13 mm^2 (3.6 x 3.6 mm) [g]	350 - 1100 nm	14 ns [j] (Typ.)	25 MHz [k]	1.6 x 10^{-14} W/Hz$^{1/2}$	0.35 nA (Typ.) 6.0 nA (Max)	40 pF (Typ.)	10 V	

a. Click on the link to view a photo of each item.
b. Measured with a specified bias voltage of 10.0 V.
c. Low battery voltage will result in slower rise times and decreased bandwidth.

d. For a 50 Ω Load
e. Measured with a 1 MΩ Load
f. If a flattened wavelength-dependent responsivity curve is desired, please see our response-flattening filters for Si photodiodes and detectors.
g. The detector active area surface is flush with the front of the housing.
h. When long-term UV light is applied, the product specifications may degrade. For example, the product's UV response may decrease and the dark current may increase. The degree to which the specifications may degrade is based upon factors such as the irradiation level, intensity, and usage time.
i. Calculated based on the typical rise time and with a 50 Ω load.
j. Specified at 632 nm. The photodiode will be slower at NIR wavelengths.
k. Calculated value; based on the typical rise time at 632 nm and with a 50 Ω load. Bandwidth will decrease at NIR wavelengths.

Part Number	Description	Price	Availability
DET10A2	Si Detector, 200 - 1100 nm, 1 ns Rise Time, 0.8 mm^2, Universal 8-32 / M4 Mounting Holes	$173.03	Today
DET100A2	Si Detector, 320 - 1100 nm, 35 ns Rise Time, 75.4 mm^2, Universal 8-32 / M4 Mounting Holes	$178.58	Today
DET36A2	Si Detector, 350 - 1100 nm, 14 ns Rise Time, 13 mm^2, Universal 8-32 / M4 Mounting Holes	$134.20	7-10 Days

Hide Biased InGaAs Detectors: 500 - 2600 nm

Biased InGaAs Detectors: 500 - 2600 nm

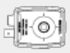
Item #[a]	Housing Features	Active Area	Wavelength Range	Rise Time[b,c]	Bandwidth[d]	Noise-Equivalent Power (NEP) (Typ.)	Dark Current[e]	Junction Capacitance	Bias Voltage	Responsivity Data (Click Here for Raw Data)
DET10N2		0.8 mm^2 (Ø1.0 mm)[f]	500 - 1700 nm	5 ns[g] (Typ.)	70 MHz	2.0×10^{-14} $W/Hz^{1/2}$	1.5 nA (Typ.) 10 nA (Max)	50 pF (Typ.)	5.0 V	
DET20C2		3.14 mm^2 (Ø2.0 mm)[f]	800 - 1700 nm	30 ns[h] (Typ.)	11.7 MHz	1.3×10^{-13} $W/Hz^{1/2}$	55 nA (Typ.) 200 nA (Max)	100 pF (Typ.)	1.8 V	
DET10C2		0.8 mm^2 (Ø1.0 mm)[f]	900 - 1700 nm	10 ns[g] (Typ.)	35 MHz	2.5×10^{-14} $W/Hz^{1/2}$	1 nA (Typ.) 25 nA (Max)	80 pF (Typ.)	5.0 V	
DET05D2		0.2 mm^2 (Ø0.5 mm)[f]	900 - 2600 nm	17 ns[h] (Typ.)	20.6 MHz	1.0×10^{-12} $W/Hz^{1/2}$	2 µA (Typ.) 20 µA (Max)	140 pF (Typ.)	1.8 V	
DET10D2		0.8 mm^2 (Ø1.0 mm)[f]	900 - 2600 nm	25 ns[h] (Typ.)	14 MHz	1.5×10^{-12} $W/Hz^{1/2}$	5 µA (Typ.) 40 µA (Max)	500 pF (Typ.)	1.8 V	

a. Click on the link to view a photo of each item.
b. Low battery voltage will result in slower rise times and decreased bandwidth.
c. For a 50 Ω Load
d. Calculated value; based on the typical rise time and a 50 Ω load.
e. Measured with a 1 MΩ Load
f. The detector active area surface is flush with the front of the housing.
g. Measured with a specified bias voltage of 5.0 V.
h. Measured with a specified bias voltage of 1.8 V.

Part Number	Description	Price	Availability
DET10N2	InGaAs Detector, 500 - 1700 nm, 5 ns Rise Time, 0.8 mm^2, Universal 8-32 / M4 Mounting Holes	$557.91	Today
DET20C2	InGaAs Detector, 800 - 1700 nm, 30 ns Rise Time, 3.14 mm^2, Universal 8-32 / M4 Mounting Holes	$450.32	Today
DET10C2	InGaAs Detector, 900 - 1700 nm, 10 ns Rise Time, 0.8 mm^2, Universal 8-32 / M4 Mounting Holes	$329.42	Today
DET05D2	InGaAs Detector, 900 - 2600 nm, 17 ns Rise Time, 0.2 mm^2, Universal 8-32 / M4 Mounting Holes	$408.18	Today
DET10D2	InGaAs Detector, 900 - 2600 nm, 25 ns Rise Time, 0.8 mm^2, Universal 8-32 / M4 Mounting Holes	$478.05	7-10 Days

Hide Biased Ge Detectors: 800 - 1800 nm

Biased Ge Detectors: 800 - 1800 nm

Item #[a]	Housing Features	Active Area	Wavelength Range	Rise Time[b,c]	Bandwidth[d]	Noise-Equivalent Power (NEP) (Typ.)	Dark Current[e]	Junction Capacitance	Bias Voltage	Responsivity Data (Click Here for Raw Data)
DET50B2		19.6 mm^2 (Ø5.0 mm)[f]	800 - 1800 nm	455 ns[g] (Typ.)	770 kHz	4.0×10^{-12} $W/Hz^{1/2}$	40 µA (Typ.) 80 µA (Max)	4000 pF (Max)	5.0 V	
DET30B2		7.1 mm^2 (Ø3.0 mm)[f]	800 - 1800 nm	650 ns[h] (Typ.)	540 kHz	2.6×10^{-12} $W/Hz^{1/2}$	4.0 µA (Max)	6 nF (Max)	1.8 V	

a. Click on the link to view a photo of each item.
b. For a 50 Ω Load
c. Low battery voltage will result in slower rise times and decreased bandwidth.
d. Calculated value; based on the typical rise time and a 50 Ω load.
e. Measured with a 1 MΩ Load
f. The detector active area surface is flush with the front of the housing.
g. Measured with a specified bias voltage of 5.0 V.
h. Measured with a specified bias voltage of 1.8 V.

Part Number	Description	Price	Availability
DET50B2	Ge Detector, 800 - 1800 nm, 455 ns Rise Time, 19.6 mm^2, Universal 8-32 / M4 Mounting Holes	$463.63	Today
DET30B2	Ge Detector, 800 - 1800 nm, 650 ns Rise Time, 7.1 mm^2, Universal 8-32 / M4 Mounting Holes	$337.18	Today

Hide Replacement Batteries for Photodetectors

Replacement Batteries for Photodetectors

- **A23:** For Currently Shipping DET Photodetectors
- **SBP12:** For Discontinued SV2-FC and SIR5-FC Fiber-Coupled Photodetectors
- **T505:** For Discontinued DET1-SI and DET2-SI Detectors

Click to Enlarge
Exploded View of SBP12 Battery Pack

A23 and T505 Alkaline Batteries
The A23 and T505 are replacement alkaline batteries for Thorlabs' currently shipping and discontinued DET photodetectors. For cases where the finite lifetime of a battery is not acceptable, we also offer an AC power adapter; please see below for more information. Information on expected battery lifetime is in the *Battery Lifetime* tab above.

SBP12 Battery Pack
The SBP12 is a 12 V replacement alkaline battery pack for our SV2-FC and SIR5-FC fiber-coupled photodetectors. It completely replaces the 20 V battery that was originally used (Item # SBP20), which we can no longer offer due to shipping regulations. Our testing shows that a 12 V bias provides performance similar to a 20 V bias, and the performance is within the detectors' stated specifications.

As shown by the photo to the right, the SBP12 consists of an A23 battery in a newly designed housing. You may already own this housing if you purchased your SV2-FC or SIR5-FC in or after October 2013, or if you have already purchased an SBP12. If you do own this housing, then it is necessary to purchase only the A23 battery.

Customers who own an SV2-FC or SIR5-FC detector purchased before October 2013 will need to bend two pins to ensure that the SBP12 battery pack makes electrical contact. The procedure is illustrated in the spec sheet of the battery, which can be downloaded here.

Part Number	Description	Price	Availability
A23	Replacement 12 V Alkaline Battery for DET Series (Except DET1-SI and DET2-SI)	$5.47	Today
SBP12	Replacement 12 V Alkaline Battery Pack for SV2-FC or SIR5-FC	$93.46	Today
T505	Replacement 22.5 V Alkaline Battery for DET1-SI and DET2-SI	$18.63	Today

Hide DET Power Adapter

DET Power Adapter

- **DET2A:** Power Adapter for DET Series Detectors
- **LDS12B**: ±12 VDC Power Supply

DET2B Installation Procedure

- **DET2B:** Bundle of the DET2A and LDS12B

DET2A Power Adapter
The DET2A is a power adapter for our DET series detectors. This power adapter will directly replace the A23 battery and spring-loaded cap to allow the detector to run directly from our LDS12B power supply (sold separately). The DET2A is also compatible with the PDA-C-72 power supply cable for custom connections. Note that when connecting the DET2A and the PDA-C-72 to power DET series detectors, only the brown (+12 V) and black (GND) pins are needed.

LDS12B Power Supply
The LDS12B is a ±12 VDC regulated power supply, which incorporates a current limit, enabling short circuit and overload protection; an on/off switch with an LED indicator; and a switchable AC input voltage (100, 120, or
230 VAC). A region-specific power cord is shipped with the LDS12B power supply based on your location.

DET2B Power Adapter Bundle
The DET2B power adapter bundle includes both the DET2A power adapter and the LDS12B power supply. This power adapter bundle can be used to replace the battery in our DET series detectors. To use the DET2B, simply replace the battery and spring-loaded cap with the included DET2A adapter, insert the three pin plug from the LDS12B power supply into the adapter, and screw the adapter into the detector. This procedure is depicted in the animation to the above right.

Part Number	Description	Price	Availability
DET2A	DET Power Adapter	$42.96	Today
LDS12B	±12 VDC Regulated Linear Power Supply, 6 W, 100/120/230 VAC	$87.35	Today
DET2B	DET Power Adapter & Power Supply Bundle	$128.32	7-10 Days

Hide Internally SM1-Threaded Fiber Adapters

Internally SM1-Threaded Fiber Adapters

- FC/PC (Narrow or Wide Key), FC/APC (Narrow Key or Wide Key), SMA, ST/PC, SC/PC, or LC/PC Receptacles
- Light-Tight Construction When Used with SM1 Lens Tubes
- Compatible with Many of Our Photodiode Power Sensors

Note: The APC adapters have two dimples in the front surface that allow them to be tightened with the SPW909 or SPW801 spanner wrench. The dimples do not go all the way through the disk so that the adapter can be used in light-tight applications when paired with SM1 lens tubes.

FC/PC and FC/APC adapters are available with either narrow (2.0 mm) or wide (2.2 mm) key connectors; for more details on narrow versus wide key connectors, please see our Intro to Fiber tutorial.

Item #	S120-FC2	S120-FC	S120-APC2[a]	S120-APC[a]	S120-SMA	S120-ST	S120-SC	S120-LC
Adapter Image (Click the Image to Enlarge)								
Connector Type	FC/PC, 2.0 mm Narrow Key	FC/PC, 2.2 mm Wide Key	FC/APC, 2.0 mm Narrow Key	FC/APC, 2.2 mm Wide Key	SMA	ST/PC	SC/PC[b]	LC/PC
Threading	Internal SM1 (1.035"-40)							

a. The S120-APC and S120-APC2 are designed with a 4° mechanical angle to compensate for the refraction angle of the output beam.
b. In certain angle-independent applications, this adapter may also be used with SC/APC connectors.

Part Number	Description	Price	Availability
S120-FC2	FC/PC Fiber Adapter Cap with Internal SM1 (1.035"-40) Threads, Narrow Key (2.0 mm)	$43.26	Today
S120-FC	FC/PC Fiber Adapter Cap with Internal SM1 (1.035"-40) Threads, Wide Key (2.2 mm)	$43.26	Today
S120-APC2	FC/APC Fiber Adapter Cap with Internal SM1 (1.035"-40) Threads, Narrow Key (2.0 mm)	$33.78	Today
S120-APC	Customer Inspired! FC/APC Fiber Adapter Cap with Internal SM1 (1.035"-40) Threads, Wide Key (2.2 mm)	$33.78	Today
S120-SMA	SMA Fiber Adapter Cap with Internal SM1 (1.035"-40) Threads	$43.26	Today
S120-ST	ST/PC Fiber Adapter Cap with Internal SM1 (1.035"-40) Threads	$43.26	Today
S120-SC	SC/PC Fiber Adapter Cap with Internal SM1 (1.035"-40) Threads	$54.35	Today
S120-LC	LC/PC Fiber Adapter Cap with Internal SM1 (1.035"-40) Threads	$54.35	Today

Hide Externally SM1-Threaded Fiber Adapters

Externally SM1-Threaded Fiber Adapters

- FC/PC (Narrow or Wide Key), FC/APC (Narrow or Wide Key), SMA, ST/PC, SC/PC, or LC/PC Receptacles
- Light-Tight When Used with SM1 Lens Tubes
- Compatible with Many of Our 30 mm Cage Plates and Photodetectors

Note: Each disk has four dimples, two in the front surface and two in the back surface, that allow it to be tightened from either side with the SPW909 or SPW801 spanner wrench. The dimples do not go all the way through the disk so that the adapters can be used in light-tight applications when paired with SM1 lens tubes. Once the adapter is at the desired position, use an SM1RR retaining ring to secure it in place.

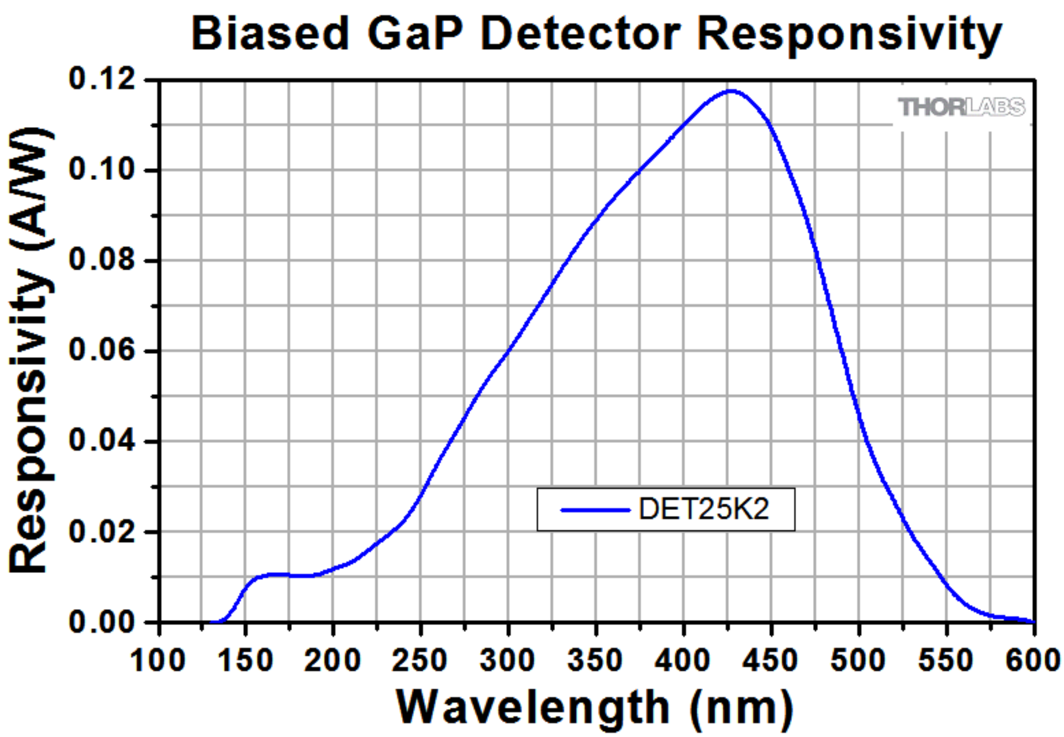
FC/PC and FC/APC adapters are available with either narrow (2.0 mm) or wide (2.2 mm) key connectors; for more details on narrow versus wide key connectors, please see our Intro to Fiber tutorial.

Item #	SM1FC2	SM1FC	SM1FCA2[a]	SM1FCA[a]	SM1SMA	SM1ST	SM1SC1[b]	SM1LC[b]
Adapter Image (Click the Image to Enlarge)								
Connector Type	FC/PC, 2.0 mm Narrow Key	FC/PC, 2.2 mm Wide Key	FC/APC, 2.0 mm Narrow Key	FC/APC, 2.2 mm Wide Key	SMA	ST/PC	SC/PC[c]	LC/PC
Threading	External SM1 (1.035"-40)							

a. The SM1FCA2 and SM1FCA are designed with a 4° mechanical angle to compensate for the refraction angle of the output beam.
b. These adapters can only be threaded in place with the connector facing away from the internal threading.
c. In certain angle-independent applications, this adapter may also be used with SC/APC connectors.

Part Number	Description	Price	Availability
SM1FC2	FC/PC Fiber Adapter Plate with External SM1 (1.035"-40) Threads, Narrow Key (2.0 mm)	$32.16	Today
SM1FC	FC/PC Fiber Adapter Plate with External SM1 (1.035"-40) Threads, Wide Key (2.2 mm)	$32.16	Today
SM1FCA2	Customer Inspired! FC/APC Fiber Adapter Plate with External SM1 (1.035"-40) Threads, Narrow Key (2.0 mm)	$34.11	Today
SM1FCA	FC/APC Fiber Adapter Plate with External SM1 (1.035"-40) Threads, Wide Key (2.2 mm)	$34.11	Today
SM1SMA	SMA Fiber Adapter Plate with External SM1 (1.035"-40) Threads	$31.38	Today
SM1ST	ST/PC Fiber Adapter Plate with External SM1 (1.035"-40) Threads	$29.91	Today
SM1SC1	SC/PC Fiber Adapter Plate with External SM1 (1.035"-40) Threads	$61.23	Today
SM1LC	LC/PC Fiber Adapter Plate with External SM1 (1.035"-40) Threads	$61.23	7-10 Days

Visit the *Free-Space Biased Detectors* page for pricing and availability information:
https://www.thorlabs.com/newgrouppage9.cfm?objectgroup_id=1295


Biased GaP Detector Responsivity
Responsivity (A/W)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
100
150
200
250
300
350
400
450
500
550
600
Wavelength (nm)
DET25K2
THORLABS